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Executive Summary

This document presents the Environmental and Social Impact Assessment (ESIA) for the proposed Sakaka Solar Energy Park (the Park). The aim of the ESIA is to identify and categorize impacts predicted to occur as a result of the construction, operation and decommissioning of the Park, and provide mitigation measures and recommendations to avoid and minimize these impacts wherever possible.

The Park covers an area of approximately 16 km², and is located to the south-west of Sakaka, in Al Jouf Province, northern Saudi Arabia. The Park will be implemented in phases over a period of 10 years. Construction is expected to start in Q2 2018, and will take approximately 20 months. Each phase of the Park is expected to be in operation for 25 years.

The first phase of the Park will have an installed capacity of 300 MW and will be known as the Sakaka Solar Energy Park 1. Sakaka Solar Energy Park 1 will consist of a PV Power Plant, including solar PV modules installed on mounting structures connected to inverter stations, surrounded by a security fence, and an associated grid interconnection, including a medium voltage/high voltage (MV/HV) sub-station and HV overhead line. Subsequent phases of the Park are expected to have similar infrastructure and power generation capacity.

When fully implemented, the Park is expected to generate approximately 2,500 Giga-Watt hours (GWh) per annum, displacing 4,600 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 2,000 Thousand tons (Mt) of CO₂ per annum.

This ESIA document presents the systematic assessment of potential impact. Based on the preliminary design of the facility, and the stakeholder engagement and consultation that has been undertaken to date, there are no predicted residual impacts of moderate or high significance, following the implementation of mitigation and good international industry practice (GIIP). All impacts are predicted to be low to negligible significance.

As the Park will seek funding from international lenders, guidelines laid out by lending organizations have been applied where relevant, including the engagement of stakeholders during the design and implementation of a project. Following approval from the MEIM, stakeholder engagement commenced shortly prior to issuing this ESIA. Representatives of the Government ministries attended a workshop in Riyadh during which the project details were disclosed, and the scope of the assessment was openly discussed. At this stage of the project, the Government Ministries have expressed their support for the project and no objections have been raised.

The IPP must continue to engage and consult with the Government Ministries during the development of the project, and must additionally commence consultation with the local community and potentially vulnerable groups in accordance with the project Stakeholder Engagement Plan.

The findings of the ESIA should be reviewed following more extensive stakeholder consultation, and once the design of the new power plant has been further developed (e.g. transportation plan, constructability plan). If required, an Addendum to this ESIA will be prepared by the IPP, in consultation with project stakeholders.

The Park is expected to have an overall beneficial effect on both its immediate surroundings, through the creation of job opportunities during both construction and operation, and at a national level by establishing a precedent for the Kingdom of Saudi Arabia as it moves away from a traditional hydrocarbon based energy supply, towards more sustainable energy sources.

1. Introduction

1.1 Overview

In April 2016 the Kingdom of Saudi Arabia announced Vision 2030¹, which expresses the long-term social and economic goals of the country. As part of the National Transformation Plan to meet the goals of Vision 2030, the Ministry of Energy, Industry and Mineral Resources (MEIM) launched the National Renewable Energy Program (NREP) to implement 9.5 GW of renewable power by 2023.

A Renewable Energy Project Development Office (REPDO) was established under the jurisdiction of the MEIM to oversee the implementation of the national program. The REPDO is comprised of staff from the MEIM, Saudi Aramco, the Saudi Electricity Company (SEC) and King Abdullah City for Atomic and Renewable Energy (KACARE). MEIM has appointed a team of advisers to provide legal, financial and technical consultancy services. Japanese bank Sumitomo Mitsui Banking Corporation (SMBC) has been appointed as financial adviser, UK-based law firm DLA Piper has been appointed as legal advisor and Germany's Fichtner has been appointed as engineering and technical advisor.

The first round of renewable energy projects has recently been launched, and these renewable schemes will be developed under the independent power project (IPP) model. A special purpose vehicle will be formed for each scheme and will be 100 per cent owned by the successful bidder. Saudi Aramco is supporting this first round of projects by providing land and conducting feasibility and pre-development studies. The Sakaka Solar Energy Park is included within this first round of projects.

The arrangements for the financing of renewable energy developments in the Kingdom of Saudi Arabia are currently under review, but the developments may be funded by third party financing from the international markets. As a result, the lending banks require an ESIA to be undertaken in accordance with international environmental development standards, particularly those of the World Bank, IFC and the 'Equator Principles'. This Environmental and Social Impact Assessment (ESIA) prepared for the Sakaka Solar Energy Park demonstrates compliance with the lending requirements of these financial institutions.

1.2 Project Understanding

The Sakaka Solar Energy Park will utilize photovoltaic (PV) technology on an area of approximately 16.38 km², and is expected to have a total installed capacity of approximately 1 Giga-Watt (GW). The Park will be implemented in phases over a period of 10 years. The first phase will have an installed capacity of 300 MW and will be known as the Sakaka Solar PV Power Plant 1.

The Park consists of a PV Power Plant, including solar PV modules installed on mounting structures connected to inverter stations, surrounded by a security fence, and an associated grid interconnection, including a medium voltage/high voltage (MV/HV) sub-station and HV overhead line connecting the sub-station to the electrical transmission system owned by the Saudi Electricity Company (SEC).

When fully implemented the Park is expected to generate approximately 2,500 Giga-Watt hours (GWh) per annum, displacing 4,600 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum and 2,000 Thousand tons (Mt) of CO₂ per annum, and create 16,500 person years of construction work and 300 operations and maintenance jobs.

Construction of the Sakaka Solar PV Power Plant 1 is expected to start in Q2 2018 and will take approximately 20 months. Each phase of the Park will be in operation for 25 years.

¹ <http://vision2030.gov.sa>

1.3 The Sakaka Solar Energy Park Development Site

The development site is a greenfield site located in the Al Jouf Province of Saudi Arabia, on the edge of the An Nafud desert, approximately 220km south of the Iraqi border, and approximately 27km south-west of central Sakaka. Figure 1-1 shows the development site.

This location has been chosen as the optimal location for a PV Power Plant, as a result of detailed site analysis and survey by Saudi Aramco against four main selection criteria;

- Potential to offset hydrocarbon use;
- Availability of land;
- Regional development; and,
- Solar resource.

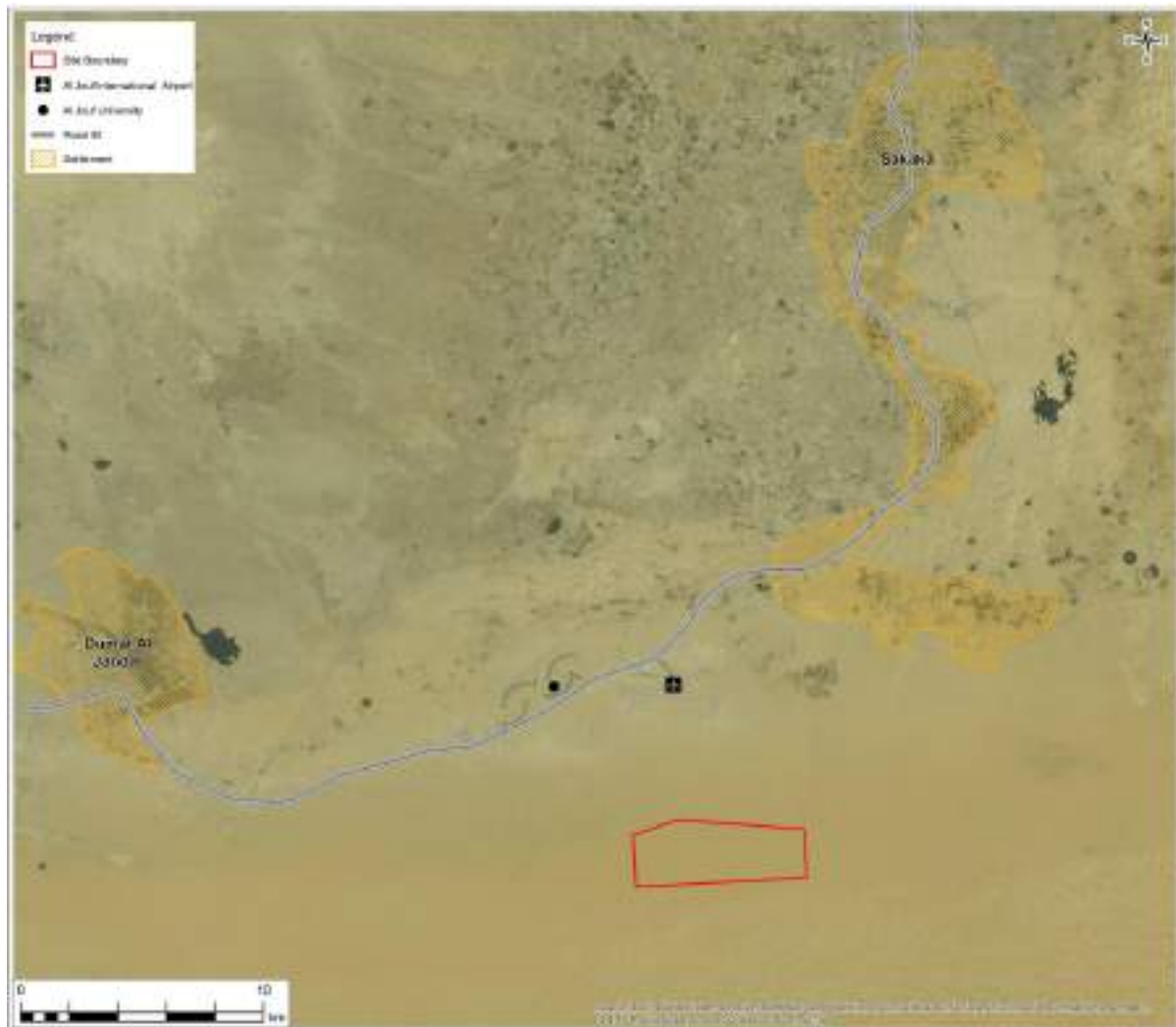


Figure 1-1: Development Site Location

1.4 Objectives of the ESIA

The objective of this Environmental and Social Impact Assessment is to identify significant adverse and beneficial environmental and social impacts attributable to the development of the Sakaka solar energy park, and to propose mitigation and remedial measures to reduce adverse impacts to acceptable levels.

In accordance with World Bank Operational Policy 4.01 the ESIA takes into account the natural environment, human health and safety, social aspects and transboundary and global environmental aspects in a fully integrated assessment and reporting process. This includes the capacity of existing institutions and infrastructure to manage the predicted environmental and social effects.

The ESIA is also intended to provide the relevant parties, regulators, lenders and other stakeholders with sufficient information, to allow them to make informed decisions regarding the proposed Park.

1.5 ESIA Screening

An integral part of the development of renewable energy power plants is to assess and mitigate the potential environmental and social impacts arising from their construction, operation and

decommissioning. The purpose of ESIA Screening is to determine the level of environmental assessment and reporting likely to be required to ensure compliance with regulatory requirements. The Phase 1: Environmental Assessment Legislation and Guidelines Review (Jacobs, 2017a) recommends screening criteria for renewable energy development projects in the Kingdom of Saudi Arabia, aligned to both National and International requirements. These criteria have been used to determine the ESIA Screening Category for the Park.

1.5.1 ESIA Screening Outcome

Following the comparative review, The Phase 1: Environmental Assessment Legislation and Guidelines Review (Jacobs 2017a) concluded that renewable energy park developments in the Kingdom of Saudi Arabia are likely to be classified as General Environmental Regulations and Rules for Implementation (GERRI) Category 3 developments (equivalent to World Bank, IFC and EP Category A). For solar PV energy parks, this is because the footprint required is expected to require the permanent loss of land, and therefore has the potential to cause significant environmental impacts on local human populations, archaeological sites and environmentally or ecologically sensitive receptors. The reflection of the solar panels also poses a risk of creating significant impacts beyond the site boundary. In addition, the GAME Appendix 2 GERRI states solar power villages and plants as example Category 3 developments. Therefore, in line with the Phase 1: Environmental Assessment Legislation and Guidelines Review (Jacobs 2017a), the Sakaka Solar Energy Park is considered to be a **GERRI Category 3 development**.

1.6 Scope of the ESIA

Environmental scoping is a critical first step in the preparation of an ESIA. It is the process of determining the content and extent of matters to be covered in the environmental information to be submitted to a competent authority, in this case the Ministry of Energy, Industry and Mineral Resources (MIEM).

The process helps to clarify key environmental aspects and effects of the Park, and the proposed methods for survey, evaluation and analysis, and impact assessment. It also ensures that the project proponent is aware of the likely environmental issues and has an understanding of the expected implications. The early identification of key environmental effects of a development also maximizes the opportunity to avoid potential impacts through influencing the engineering design. The avoidance of impact by modifying the engineering design can help to manage the risk of potentially expensive mitigation at a later stage.

The scope of the environmental assessment and subsequent ESIA is aligned with the preliminary development design and reported in the Sakaka Solar Energy Park Environmental and Social Impact Assessment Terms of Reference (Jacobs, 2017b).

The ESIA terms of reference identified the following primary issues which require detailed study as part of the ESIA:

- Air Quality.
- Archaeology and Cultural Heritage.
- Community Health and Safety.
- Hydrology and Hydrogeology.
- Indigenous Peoples.
- Landscape and Visual.

- Noise and Vibration.
- Socio-Economics.
- Soils and Geology.
- Terrestrial Biodiversity.
- Traffic and Transportation.

1.6.1 Limitations

Saudi Aramco has developed a preliminary design to facilitate pre-development activities, including environmental permitting. The preliminary design includes the layout of the solar photovoltaic (PV) modules and ancillary infrastructure within the development site, and the proposed connection to an existing overhead power line and transmission to the nearest Saudi Electricity Company (SEC) sub-station. The preliminary design does not however consider the construction phases of the development, including the requirements for material laydown areas and accommodations, supply and transportation of construction materials and equipment, and the transportation of solar PV modules to the site. These aspects will be considered and developed further by the Independent Power Producer (IPP) during the next phases of development.

The scope of the environmental assessment is therefore aligned with the preliminary development design, and the ESIA will be developed as far as possible in terms of the overall development scope to support the in-Kingdom environmental approvals process. For the development site, the assessment of impact will be completed using baseline data and a robust set of design criteria. For aspects of the development which remain uncertain, or are beyond the boundary of the development site and for which there is no design, the precautionary approach will be adopted. This approach will comprise a precautionary assessment of impact against a set of design assumptions to be agreed with the project proponent, using data from desk-based review only.

This approach is assessed as sufficient to secure the in-Kingdom environmental permit, and establish a benchmark against which the ESIA can be reviewed. An addendum to the ESIA will be prepared by the IPP during the next phases of development, to confirm the impact assessment for the finalized design, including an update to the precautionary approach.

1.6.2 Stakeholder Engagement

International lending standards specify the requirement for public consultation and disclosure and engagement with Affected Communities. A Stakeholder Engagement Plan (SEP) has been prepared which establishes a development specific framework for structured and culturally appropriate consultation, in a manner which enables the Affected Communities to express their views on the development risks, impacts and mitigation measures. In particular, the plan communicates how and when consultation will be undertaken and identifies the process for the disclosure of information, consultation and participation, grievance mechanism and ongoing reporting to the Affected Communities (IFC, 2012a).

Although the plan covers the life-cycle of the development, stakeholder consultation with Government ministries and bodies was approved by the MEIM in February 2017. A stakeholder engagement meeting was held in Riyadh with Government ministries on the 15th March 2017 during which the details of the projects were disclosed, and the scope of the environmental and social impact assessment was discussed. The list of identified stakeholders for the project, their attendance at the workshop on 15th March and their main comments / concerns are listed in Table 1-1. It is important to

note that all stakeholders are committed to Vision 2030 and the achievement of the 9.5 GW of renewable energy by 2023, and no objections to the Sakaka solar energy park were raised.

Table 1-1: Sakaka Stakeholder Consultation

Stakeholder	Attended	Interests / Potential Concerns	Action Taken
Ministry of Transportation	X		
Ministry of Defense	X		
Ministry of Interior	✓	Ministry of Interior confirmed that the requirements for the projects to be established near to the Saudi Arabian borders (i.e. 20km from the border as a clear zone with no development and 100km from the border with no sensitive development). Fencing and security of the solar energy park will need to comply with the minimum requirements of High Commission of Industrial Security (HCIS).	The solar energy park will be fully fenced and this will achieve compliance with the HCIS requirements.
Ministry of Energy, Industry and Mineral Resources (MEIM)	✓	No comments	
General Authority for Civil Aviation (GACA)	✓	Sakaka Solar Energy Park is located within the approach zone of Al-Jouf airport so it needs a permit from GACA. Concerns raised about: - Thermal heating of air; - Angle of reflection; and - Solar panels elevation. GACA confirmed that data on flight paths and on radar can be obtained from the Saudi Air Navigation Services website.	Jacobs is supporting MEIM with the GACA permit, including the glare and glint assessment report. The project has already secured a No-Objection letter from the GACA; this additional permit is to ensure the safe development of the project.
Saudi Commission for Tourism and National Heritage (SCTA)	✓	The ESIA has to include the required procedures in case of any chance findings on site. The SCTA has confirmed that there are no features of archaeological interest within the developable area of the site.	ESIA includes procedure for chance finds.
Ministry of Communications and Information Technology (MCIT)	✓	No comments	
Ministry of Environment Water and Agriculture (MOEWA)	✓	Confirmed that the EIA is the most important issue for the projects. He stated also that the projects have to	The ESIA considers bird migration routes and the impact of the project of migratory species. Sufficient

Stakeholder	Attended	Interests / Potential Concerns	Action Taken
		comply with grazing laws in the Kingdom of Saudi Arabia. On behalf of SWA, MOEWA confirmed that bird migration is a key issue and migration routes must have no conflict with the proposed project site. Additional geological data can be secured from the Saudi Geological Survey (SGS) Authority. Additional groundwater data can be obtained MOEWA.	geological data is included within the report based on SGS data and the site based geotechnical investigation. Sufficient groundwater data has also been obtained for the purposes of the impact assessment.
Ministry of Municipal and Rural Affairs (MOMRA)	✓	MOMRA has provided data on the waste management facility which serves the town of Sakaka and villages in Al Jouf Province. No concerns were raised about the capacity of existing infrastructure / utilities.	Information provided by MOMRA on waste management facility has been included in the ESIA.
Saudi Electricity Company (SEC)	✓	No comments or objections to the project.	
General Authority for Meteorology and Environment	X	Represented by MOEWA	
Saudi Wildlife Authority	X	Represented by MOEWA	
Al Jouf Municipality (Amana)	X	Represented by MOMRA	

It should also be noted that the Ministry of Energy, Industry and Mineral Resources (MEIM), the Saudi Electricity Company (SEC), the King Abdullah City for Atomic and Renewable Energy (KACARE) and Saudi Aramco are working in partnership to implement the target of 9.5 GW of renewable energy by 2023. These partners are working in collaboration and have attended regular meetings held in Riyadh to ensure the smooth planning and implementation of projects.

On the basis that the location of the Sakaka Solar Energy Park has not yet been publicly disclosed, and the design is only preliminary, consultation with the community and other public stakeholders will be undertaken during the next phase of the development by the Independent Power Producer (IPP). This approach has been implemented by the Ministry of Energy, Industry and Mineral Resources (MEIM). Consultation with the local communities, including vulnerable and potentially disadvantaged groups, will be undertaken during the next phase of development when the scope and envelope of development impacts are better defined will help to manage effective consultation by avoiding consultation at a time when the development design is still uncertain.

To ensure the views and opinions of public stakeholders are appropriately considered and can influence the design as required, the consultation results shall be incorporated into an addendum to this ESIA during the next phases of development.

1.7 Environmental Permitting

The development is located within a Saudi Aramco reservation, and therefore the environmental permitting jurisdiction for this development falls under the Ministry of Energy, Industry and Mineral Resources (MIEM). Saudi Aramco Environmental Protection Department (EPD) acts as an independent regulatory function for Saudi Aramco projects, under derogation from the General Authority for Meteorology and the Environment (GAME) and the MIEM.

According to GERRI there is a responsibility on the GAME to coordinate with and monitor authorities licensing activities that could cause environmental degradation to ensure the rules and standards are being appropriately applied. However, there is no specific requirement or article that states the licensing authorities are to provide copies of ESIAs/Approvals to GAME. It is considered, therefore, that the MEIM would determine whether the ESIA/required approvals are provided to GAME, or for GAME to request during any auditing process.

1.8 Report Structure

The structure of the ESIA is as follows:

Chapter 1 Introduction. This chapter provides a basic description of the Park, including the key components of the development and an overview of the processes to be undertaken at the Park.

Chapter 2 Policy, Legal and Administrative Framework. This chapter summarizes the key elements of national, local, and international legislation that apply to the Sakaka Solar Energy Park.

Chapter 3 Consideration of Alternatives. This chapter provides a description of the alternatives considered as part of the design development.

Chapter 4 Detailed Description and Layout of the Proposed Development. This chapter provides a description of the development site including details of the process and infrastructure design, plot plans and the different phases of the Park (construction, commissioning, operation and decommissioning) with their proposed schedules (where available).

Chapter 5 Impact Assessment Methodology. This chapter details the criteria applied to the assessment of potential impacts arising from the Park elements described in Chapter 4. It provides definitions of impact magnitude and significance as they apply to the potential effects on environmental and social aspects.

Chapter 6 Meteorology, Climate and Air Quality. This chapter presents the results and conclusions of the assessment of ambient air quality and local climate in the vicinity of the facility in order to establish baseline conditions, and the predicted impacts resulting from air emissions (including greenhouse gases, where appropriate) during the various stages of development of the Park.

Chapter 7 Soils and Geology. This chapter details the geological conditions of the development site and presents an assessment of likely impacts upon them arising as a result of the Park.

Chapter 8 Hydrology and Hydrogeology This chapter details the hydrological and hydrogeological conditions of the development site and presents an assessment of likely impacts upon them arising as a result of the Park.

Chapter 9 Noise & Vibration. This chapter presents the identification of existing noise sources and sensitive receptors that could be affected by the noise generated by the Park, conclusions of the noise baseline survey and assessment of the environmental impacts on receptors resulting from noise generated during the lifetime of the Park (in light of applicable criteria, existing noise levels in the area and modelling based predictions).

Chapter 10 Landscape and Visual. This chapter identifies potential impacts upon landscape and visual receptors within the defined Study Area surrounding the development site and makes an assessment of expected impacts upon them.

Chapter 11 Terrestrial Biodiversity This chapter details the field investigation and literature review, the baseline assessment and presents the evaluation of the potential environmental impacts to ecological receptors during the lifetime of the Park.

Chapter 12 Archaeology and Cultural Heritage This chapter presents the findings of the baseline investigation of regional and local archaeological and cultural heritage assets and presents an assessment of predicted impacts upon them during the lifetime of the Park.

Chapter 13 Traffic and Transport Infrastructure. This chapter includes a description of the existing transport infrastructure and traffic, and an assessment of the potential impacts of the Park on the usage and demands on transport systems.

Chapter 14 Socio-Economic Aspects. This chapter includes a general description of the socio-economic characteristics on a national, regional and local level including demography, economic activity, employment, infrastructure, land use and education. Each characteristic is assessed subjectively based on a review of existing published information.

Chapter 15 Utilities Infrastructure and Usage. This chapter provides a description of the existing utilities, and evaluation of the utility infrastructure and usage impacts associated with the Park.

Chapter 16 Waste Management. This chapter presents the findings of the baseline investigation detailing the waste management facilities that are available for the Park. The potential environmental impacts resulting from waste management during the lifetime of the Park are evaluated.

Chapter 17 Health and Safety Aspects. This chapter presents a description of the potential health and safety issues associated with the Park, including impacts on community health and safety.

Chapter 18 Sustainable Development. This chapter includes an analysis of how the sustainable development elements are integrated into life cycle phases of the Park.

Chapter 19 Cumulative Impacts Assessment. This chapter includes an assessment of the cumulative effects that are likely to result from the Park on all affected environmental and socioeconomic conditions including other existing, approved and/or planned projects in the region that could reasonably be expected to have a combined effect.

Chapter 20 Environmental Monitoring and Management Plan This chapter presents guidelines and recommendations on the preparation of the environmental monitoring and management plan.

Chapter 21 Environmental Emergency Response Plan This chapter presents guidelines on the preparation of the environmental emergency response plan.

Section 22 Summary of Impacts and Mitigation. This chapter summarizes in table form the potential impacts identified and the corresponding mitigation measures/recommendations that have been identified in light of their applicability and cost effectiveness, including any interactive impacts between issues.

Section 23 Abbreviations & Acronyms. This chapter comprises a list of abbreviations and acronyms contained within the ESIA Report.

1.9 References

Jacobs (2017a). Phase 1: Environmental Assessment Legislation and Guidelines Review

Jacobs (2017b). Sakaka Solar Energy Park Environmental and Social Impact Assessment Terms of Reference

2. Policy Legal and Administrative Framework

2.1 Introduction

This chapter provides a summary of the environmental legislative framework relevant to the Kingdom of Saudi Arabia. As the development will potentially seek international financing, this chapter references the international guidance, standards and instruments of the World Bank Group, specifically the International Finance Corporation (IFC), and the Equator Principles. In accordance with the requirements of the IFC, the development shall consider the utilization of Best Available Techniques (BAT) for environmental control where applicable.

The development is located within a Saudi Aramco reservation, and therefore the environmental permitting jurisdiction for this development falls under the Ministry of Energy, Industry and Mineral Resources (MEIM).

The legislation, guidelines and standards relevant to the development are used as a basis for screening and evaluating the development's impacts. These guidelines and standards are presented as a summary. The full and most recent legislation will be consulted prior to undertaking the assessment and the implementation of any mitigation or monitoring plans.

2.2 International Legislation and Standards

The arrangements for the financing of renewable energy developments in the Kingdom of Saudi Arabia are currently under review, but the developments may be funded by third party financing from the international markets. As a result, the lending banks require an ESIA to be undertaken in accordance with international environmental development standards, particularly those of the World Bank, IFC and the associated 'Equator Principles'. This section presents an overview of the environmental assessment standards and policies expected to support applications for international financing.

2.2.1 World Bank

The World Bank Group is a family of five international organizations that provide finance in the form of loans and assistance to developing and transition countries. The Group focuses its efforts on the fields of human health, agriculture and rural development, environmental protection, infrastructure, large industrial construction projects and governance. The Group aims to "*end extreme poverty within a generation and boost shared prosperity*".

The World Bank Group provides financial assistance through different means, including, but not limited to, interest free loans and grants, insurance against risk, debt financing, concessional financing and others.

The organizations that make up the World Bank Group are:

- International Bank for Reconstruction and Development,
- International Development Associated,
- International Finance Corporation (IFC),
- Multilateral Investment Guarantee Agency, and
- International Centre for Settlement of Investment Disputes.

The IFC is the most relevant to the potential financing of proposed renewable energy power plant developments in the Kingdom of Saudi Arabia and is considered further in this report. It is the private sector arm of the World Bank Group with the aim of advancing economic development by investing in strictly for-profit and commercial projects which reduce poverty and promote development.

The World Bank has the following Safeguard Policies to reduce or eliminate the negative environmental and social impacts of potential projects, and improve decision making:

- Environmental Policies
 - o Operations Policy / Bank Procedure (OP/BP) 4.01: Environmental Assessment
 - o OP/BP 4.02: Environmental Action Plans
 - o OP/BP 4.04: Natural Habitats
 - o OP 4.07: Water Resource Management
 - o OP 4.09: Pest Management
 - o OP 4.36: Forests
- Social Policies
 - o OP/BP 4.12: Involuntary Resettlement
 - o OP 4.10: Indigenous Peoples
 - o OP 4.11: Physical Cultural Resources
- Other Policies
 - o OP/BP 4.00: Piloting the Use of Borrowers System
 - o OP/BP 17.50: Bank Disclosure Policy

The World Bank has developed an Environmental Assessment Sourcebook: Volume 3 – guidelines for environmental assessment of energy and industry projects. The purpose of the sourcebook is to assist all involved in environmental assessment. The World Bank also has a set of guidelines and guides identifying good practice approaches.

The World Bank's Environmental and Social Framework (ESF) set out the World Bank's commitment to sustainable development through its Policy and a set of Environmental and Social Standards. The framework applies to projects funded by the World Bank, and comprises (World Bank, 2014):

- A vision for sustainable development – this sets out the World Bank's aspirations.
- Environmental and Social Performance Standards – mandatory requirements that apply to the Borrower and projects (see Table 2-1).

In August 2016, the World Bank's Board of Executive Directors approved a new ESF to help protect people and the environment in the investment projects it finances. The expanded protections in the framework include comprehensive labor and working condition protections and community health and safety measures that address road safety, emergency response and disaster mitigation. It also

includes a responsibility to include stakeholder engagement throughout the project cycle, and a non-discrimination principle augmented by a new mandatory World Bank Directive that lists examples of vulnerable and disadvantaged groups and explicitly requires staff to assist the borrower to consider, mitigate, and manage related issues. The new ESF is scheduled to come into effect in early 2018.

Table 2-1: World Bank and IFC Environmental and Social Performance Standards

Performance Standard	IFC Performance Standards	Comment
Performance Standard 1	Assessment and Management of Social and Environmental Risks and Impacts. <u>Requirements:</u> a methodological Environmental and Social Management System (ESMS) to manage environmental and social risks and impacts on an ongoing basis. <u>Objectives:</u> ▪ To identify and evaluate environmental and social risks and impacts of the project. ▪ To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities and the environment. ▪ To promote improved environmental and social performance of clients through the effective use of management systems. ▪ To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. ▪ To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.	The following documents demonstrate adherence to this Performance Standard: ▪ Environmental and Social Impact Assessment (ESIA) ▪ Environmental Monitoring Management Plan (EMMP) ▪ Emergency Response Plan (EERP); and ▪ Stakeholder Engagement Plan (SEP) and ESIA Socio – Economic Chapter The IPP will establish an ESMS relevant to the Project and support any ongoing management and reporting as required The IPP will use the ESMS to manage the implementation of the actions necessary to meet the applicable requirements of all Performance Standards. Stakeholder engagement will be carried out by the IPP during the detailed design stage in order to gather information with which to make informed decisions.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 2	Labor and Working Conditions <u>Requirements:</u> to outline working conditions, management of the worker relationship and occupational health and safety, plus protecting the work force, third parties and the supply chain. Also requires implementation of a guidance note by IFC and the European Bank for Reconstruction and Development (EBRD) on 'Workers' accommodation: processes and standards'. <u>Objectives:</u> ▪ To promote the fair treatment, non-discrimination, and equal opportunity of workers. ▪ To establish, maintain, and improve the worker-management relationship. ▪ To promote compliance with national employment and labor laws. ▪ To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain. ▪ To promote safe and healthy working conditions, and the health of workers. ▪ To avoid the use of forced labor.	Chapters 14 and 17 of this ESIA (Socio-Economic Aspects and Health & Safety) identify potential impacts that the Park could have upon the health and safety of the workers and working conditions, and propose measures to manage and monitor these aspects. This includes the risk of increased incidence of communicable and vector-borne diseases will be assessed in accordance with the IFC EHS General Guidelines: Construction and Decommissioning (2007). The recommendations put forward in these chapters have been incorporated into the EMMP and the EERP as appropriate. It will be the responsibility of the IPP to take the recommendations made in the ESIA, EERP and the EMMP forward and to update these as required during the lifetime of the Park. A construction management plan will be developed by the IPP and implemented during the detailed design and construction phases of the development. This plan will include standards for worker accommodation and shift patterns, safeguards for the local community and will be reviewed as the development commences.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 3	Resource Efficiency and Pollution Prevention <u>Requirements</u> are to outline: Resource Efficiency (Greenhouse Gases and Water Consumption, Waste); and, Pollution Prevention (General, Hazardous Materials Management and Pesticide Use and Management). <u>Objectives:</u> ▪ To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. ▪ To promote more sustainable use of resources, including energy and water. ▪ To reduce project-related greenhouse gas emissions.	Chapter 3 (consideration of alternatives) includes an assessment of the key strategic and technological alternatives that have been considered for the Park, and the integration of Best Available Techniques (BAT) principles within the facility design in order to minimize significant impacts. Chapter 6 includes an assessment of Greenhouse Gas Emissions. The assessment will consider Scope 1 and 2 emissions, and the energy off-set generated by the solar energy photo voltaic power plant. This assessment will also determine the eligibility of the development to generate CER units. Saudi Aramco's Water Conservation Policy (INT-11) requires a Water Systems Optimization Assessment Study for Category 3 projects. This has been considered in Chapters 8 and 15. The IPP will be required to comply with BAT requirements during the detail design and construction phases of the Park, where applicable. The construction management plan to be prepared by the IPP will include plans for the efficient use of resources.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 4	Community Health, Safety and Security <u>Requirements</u> are to outline: to outline community health and safety (design and materials management and safety, ecosystem services, disease control and emergency preparedness and response) and security personnel. <u>Objectives:</u> ▪ To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. ▪ To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.	Chapters 14 and 17 include an assessment of potential impacts that the Park could have upon workers and community health, and propose measures to manage and monitor those impacts. The recommendations suggested in these chapters have been incorporated into the EMMP and EERP where appropriate. Impacts on local grazing and transient herders have been assessed in Chapter 14. The IPP will be responsible for complying with the recommendations made in the EMMP and the EERP during the construction, operation and decommissioning phases of the development. The most significant impact of the Park upon public health and safety will be a result of increased road traffic accidents due to increased volumes of construction traffic. A traffic management plan will be developed and implemented by the IPP during the detailed design and construction phase of the development in order to minimize impacts from construction traffic upon community health and safety.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 5	Land Acquisition and Involuntary Resettlement <u>Requirements:</u> Deals with project related land acquisition and restrictions on land use. This applies to involuntary resettlement (includes physical displacement and economic displacements). Includes special requirements which deal with compensation and benefits for displaced persons, community engagement, resettlement and livelihood restoration planning and implementation, physical and economic displacements, and private sector responsibilities under government-managed resettlement. <u>Objectives:</u> ▪ To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs. ▪ To avoid forced eviction. ▪ To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. ▪ To improve, or restore, the livelihoods and standards of living of displaced persons. ▪ To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	The proposed development site is located within a Saudi Aramco Reservation within approved Land Use Permit (LUP No. 41641). Chapter 14 (socio economic aspects) includes an assessment of impacts upon grazers and transient herders expected to arise as a result of the Park, including displacement and livelihood restoration. The IPP will be responsible for complying with the recommendations given in the ESIA.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 6	Biodiversity Conservation and Sustainable Management of Living Natural Resources <u>Requirements:</u> protection and conservation of biodiversity, management of ecosystem services and sustainable management of living natural resources and supply chain. <u>Objectives:</u> ▪ To protect and conserve biodiversity. ▪ To maintain the benefits from ecosystem services. ▪ To promote the sustainable management of living natural resources through the adoption of practices which integrate conservation needs with development priorities.	Chapter 11 of the ESIA specifically identifies and assesses the existing ecological status of the site and describes the assessment of potential impacts to the biodiversity, habitats and ecosystem services expected to result from the introduction of the Park. Mitigation measures are also proposed and have been integrated into the EMMP where appropriate. The IPP will be responsible for complying with the recommendations given in the ESIA and for ensuring that any conditions related to the preservation of habitat and environment are adhered to.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 7	Indigenous Peoples <u>Requirements:</u> Issues surrounding any impacts on lands and natural resources subject to traditional ownership or under customary use, relocation of indigenous peoples from lands, critical cultural heritage, and private sector responsibility where governments are responsible for managing issues of indigenous peoples. <u>Objectives:</u> ▪ To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. ▪ To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. ▪ To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. ▪ To establish and maintain an ongoing relationship based on Informed Consultation and Participation with the Indigenous Peoples affected by a project throughout the project's life-cycle. ▪ To ensure the Free, Prior, and Informed Consent of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. ▪ To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.	There are no Indigenous Peoples affected by the development of the Park. Impacts on grazers and transient herders have been assessed in Chapter 14 and 17 of the ESIA (Socio Economic Aspects and Health and Safety) and make recommendations for mitigation. The IPP will be responsible for complying with the recommendations given in the ESIA.

Performance Standard	IFC Performance Standards	Comment
Performance Standard 8	Cultural Heritage <u>Requirements:</u> protection of cultural heritage in project design and execution, plus project's use of cultural heritage. <u>Objectives:</u> - To protect cultural heritage from the adverse impacts of project activities and support its preservation. - To promote the equitable sharing of benefits from the use of cultural heritage.	Chapter 12 of the ESIA describes and assesses the impact upon cultural heritage assets present within the development site. Intangible aspects of cultural heritage have been assessed in Chapter 14. The IPP will be responsible for complying with the recommendations given in the ESIA and implementing the 'chance find' procedure with regard to the discovery of previously unknown cultural heritage assets.

2.2.2 International Finance Corporation (IFC)

2.2.3 Introduction

The IFC is an international financial institution which offers investment, advisory and asset management services to encourage private sector development in projects. It was established in 1956 as the private sector arm of the World Bank Group to advance economic development by investing in strictly for-profit and commercial projects which reduce poverty and promote development.

The IFC has a sustainability framework that consists of the IFC policy on environmental and social sustainability, performance standards and environmental and social categorization (IFC, 2016). The Performance Standards on Social and Environmental Sustainability (IFC, 2012) are relevant to renewable energy developments in the Kingdom of Saudi Arabia as the standards define IFC clients' responsibilities for managing their environmental and social risks. In addition to these standards, the IFC uses World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines) as a technical source of information during project appraisal.

2.2.4 Performance standards

The IFC requires clients to meet the eight Performance Standards listed in Table 2-1 throughout the life of an investment by the IFC.

2.2.5 Guidelines

The IFC developed the World Bank Group EHS Guidelines to provide technical reference documents with general and industry-specific examples of Good International Industry Practice as defined in IFC's Performance Standard 3: Resource Efficiency and Pollution Prevention. The IFC uses these EHS Guidelines as a technical source of information during project appraisal activities. The following are IFC guidelines relevant to renewable energy developments:

- General Environmental, Health, and Safety Guidelines, 2007.
- Environmental, Health and Safety Guidelines for Electrical Power Transmission and Distribution, 2007.
- Utility Scale Solar Power Plants: A Guide for Developers and Investors, 2012.

On applying these guidelines, the IFC expect that when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification of such an alternative should demonstrate that the choice for any alternate performance level still protects human health and the environment.

In the case of almost all large-scale new build, expansion and development projects an ESIA will be required, particularly where project-related international financing is being sought. A comprehensive ESIA, undertaken to international standards, allows both the project sponsor and the investors to assess the full range of potential environmental and social impacts related to a projects development, operation and decommissioning.

2.2.6 Equator Principles (EPs)

The EP is a risk management framework adopted by nearly 80 financial institutions and banks (EP, 2011). It aims to determine, assess and manage environmental and social risks in projects, plus ensure projects are developed in a manner that is socially responsible and reflect sound environmental management practices. The EPs recognize the importance of climate change, human rights and biodiversity by seeking to avoid, where possible, negative impacts on project-affected ecosystems, communities and the climate. If impacts cannot be avoided then the impacts should be minimized, mitigated and/or offset (EP, 2011).

Equator Principles Financial Institutions (EPFI) have adopted the EPs as mandatory in order to ensure that the financed development projects are developed in a manner that is socially responsible and reflects sound environmental management practices. The principles comprise a set of ten ethical lending principles (see Table 2-2) that the Performance Standards and environmental and social policies, standards and guidance of the World Bank / IFC are designed to reflect. The latest EPs (EPIII) align with the IFC Performance Standards and the World Bank Group EHS Guidelines.

For Projects located in Non-Designated Countries, the EPFI assessment process evaluates compliance with the applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group EHS Guidelines (EPs, 2013). The EPs mandate the use of the World Bank EHS Guidelines as the minimum standard and require the implementation of Scope 1 and 2 emissions as defined by the International Panel on Climate Change. Non-Designated Countries are those countries not deemed to have robust environmental and social governance, legislation systems and institutional capacity designed to protect their people and the natural environment. The Kingdom of Saudi Arabia is classified as a non-designated country.

Table 2-2: Equator Principles (EP III, 2013)

Principle	Equator Principles (EP)
Principle 1	Review and Categorization Categorization of the project based on the magnitude of its potential risks and impacts in accordance with the environmental and social screening criteria of the IFC. This is aligned with the IFC categorization of projects into categories A, B and C.
Principle 2	Environmental and Social Assessment Assessment process to address to the EP's satisfaction, the relevant environmental and social risks and impacts of the proposed Project. The Assessment Documentation should also propose measures to minimize mitigate and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed project. For Category A projects the Assessment Documentation includes an ESIA.

Principle	Equator Principles (EP)
Principle 3	Applicable Environmental and Social Standards Compliance with host country legislation / permits is required to be addressed in the first instance. For projects located in Non-Designated Countries, the assessment is required to evaluate compliance with the respective IFC Performance Standards and World Bank Group EHS Guidelines. For projects located in Designated Countries, the relevant host country laws, regulations and permits apply.
Principle 4	Environmental and Social Management System and Action Plan An ESMS to be developed and maintained by the Client for all Category A and B Projects. An Environmental and Social Management Plan (ESMP) is also required to address issues raised in the Assessment and incorporate actions required to comply with the applicable standards.
Principle 5	Stakeholder and Engagement For all Category A and Category B Projects, effective stakeholder engagement must be demonstrated as an on-going process in a structured and culturally appropriate manner with affected communities and where appropriate other stakeholders. For projects with environmental or social risks and adverse impacts, disclosure should occur early in the Assessment process, in any event before the Project construction commences and on an ongoing basis.
Principle 6	Grievance Mechanism For all Category A and, as appropriate, Category B Projects, the client will, as part of the ESMS, establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the project's environmental and social performance.
Principle 7	Independent Review For all Category A and, as appropriate, Category B Projects, an independent Environmental and Social Consultant not directly associated with the client will carry out an Independent Review of the Assessment Documentation including the ESMP, ESMS and the Stakeholder Engagement process documentation in order to assist the EPFI's due diligence, and assess Equator Principles compliance.
Principle 8	Covenants The client will covenant in the financing documentation: to comply with all relevant host country environmental and social laws; regulations and permits to comply with the ESMP and Action Plan (where applicable), to provide periodic reports to the EPFI demonstrating compliance, and to decommissioning facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.
Principle 9	Independent Monitoring and Reporting To assess project compliance with the EPs and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFIs will for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the client retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFIs.
Principle 10	Reporting and Transparency For all Category A and, as appropriate, Category B Projects: ▪ The client will ensure that, at a minimum, as summary of the ESIA is accessible and available online; and

Principle	Equator Principles (EP)
	The client will publicly report greenhouse gas emission levels during the operational phase for Projects emitting over 100,000 tonnes of CO₂ equivalent annually.
Annex A	Climate Change: Alternatives Analysis, Quantification and Reporting of Greenhouse Gas Emissions Clients are encouraged to report publicly on projects emitting over 25,000 tonnes. In some instances, public disclosure of the full alternatives analysis or project-level emissions may not be appropriate.
Annex B	Minimum Reporting Requirements Details the minimum requirements that the EPFI needs to report annually.

2.3 National Legislation and Standards

2.3.1 The Basic Law of Governance

The Basic Law (Royal Decree No. A/90) is commonly referred to as the Constitution of Saudi Arabia. Article 32 of the Basic Law states: “*The State works for the preservation, protection and improvement of the environment and for the prevention of pollution*”.

2.3.2 Public Environment Law 2011 (PEL)

The Public Environmental Law (PEL) was enacted by Royal Decree No. M/34 dated 28/7/1422 H (corresponding to 16 October 2001) and established the general regulatory framework for the development and enforcement of environmental rules and regulations in the Kingdom of Saudi Arabia. Under this law the General Authority for Meteorology and Environment (GAME), previously the Presidency of Meteorology & Environment (PME) has been assigned with the responsibility for the development and enforcement of environmental rules and regulations.

The GAME is therefore responsible for:

- Conducting environmental studies;
- Documenting and publishing the results of any environmental studies;
- Preparing, issuing and reviewing relevant environmental standards;
- Ensuring compliance with relevant environmental standards;
- Working in conjunction with other governmental agencies, establishing plans to deal with environmental disasters;
- Promoting general awareness for the protection of the environment;
- Environmental monitoring; and,
- Updating of environmental standards.

2.3.3 General Environmental Regulations and Rules for Implementation

The General Environmental Regulations and Rules for Implementation were enacted in October 2001 and under this law GAME is responsible for issuing consent for projects to ensure compliance with the Public Environment Law and implementing regulations. Under this regulation, any licensing authority must ensure that an ESIA is prepared for any project that may have a negative environmental impact.

In respect to the completion of environmental assessments, particular reference should be made to the GERRI (2001) articles presented in Table 2-3.

Table 2-3: General Environmental Regulations and Rules for Implementation (2001) articles

Article	Content
Article 2 – aims of GERRI (2001)	The General Environmental Regulations and Rules for Implementation aim to achieve the following: ▪ preserve, protect and develop the environment and prevent its pollution; ▪ protect public health from activities and acts that harm the environment; ▪ conserve and develop natural resources and rationalize their use; ▪ include environmental planning as an integral part of overall development planning in all industrial, agricultural, architectural and other fields; and ▪ raise awareness in environmental issues and strengthen individual and collective feelings of responsibility for preserving and improving the environment and encouraging national voluntary efforts in this field.
Article 5 – verification of ESIs by licensing agencies	Licensing agencies must ascertain that the environmental evaluation studies for projects which may cause negative impacts on the environment are done at the project feasibility stage, the agency in charge of implementation of the project shall be responsible for conducting the environmental assessment studies in accordance with the environmental basics and standards determined by the competent agency in the rules for implementation.
Article 6 – implementation of BAT	The party executing new projects, making major modifications to existing projects, or owning projects whose specified terms of investment have expired must utilize the best possible and most suitable technologies for the local environment and use materials which introduce the lowest possible level of pollution to the environment.
Article 8 – adoptions of mitigation hierarchy	Taking into consideration the GERRI, public agencies and persons shall: ▪ rationalize the use of natural resources to preserve and prolong the reserve life of non-renewable resources and to develop renewable resources; ▪ achieve coherence between the bearing capacity of the resources and utilization levels of the various resource categories; ▪ apply recycling technologies and reuse of resources; ▪ develop conventional technologies and traditional systems that are coherent with the local and regional environmental conditions; and ▪ promote the technologies associated with traditional building materials.

Article	Content
Article 10 – consideration of the environment in the planning process	Environmental considerations must be incorporated in the process of planning for development projects, programs and developmental plans for various sectors and the general developmental plan.
Article 11 – conformance to regulations in the design and operation phases	- Any person responsible for designing or operating any project or activity must commit to ensure that the design and operation of the project are in conformity with the regulations and standards in force. - Any person involved in work which may result in negative impact on the environment must take all appropriate steps to limit the effects or decrease their potential occurrences.
Article 12 – control of emissions	- Anyone performing digging, demolition, construction, or debris and earth transportation works must take necessary precautions for safe storage and transportation of any waste, as well as the proper treatment and disposal of such waste. - All smoke, gases or vapors and solid or liquid residue resulting from the burning of any kind of fuel or similar, whether for industrial, power generation or other activities, must be within allowable limits as permitted in the environmental standards. - The owner of the facility must take all necessary precautions and measures to ensure that there is no leaking or emission of air pollutants to the work place beyond the allowable limits of the environmental standards. - Adequate ventilation requirements must be applied in enclosed and semi-enclosed public places according to the size and space capacity of the place and the kind of activity carried out in the place.
Article 13 – consideration of the environment in the planning process	Environmental considerations must be incorporated in the process of planning for development projects, programs and developmental plans for various sectors and the general developmental plan.

2.3.4 GAME (formerly PME) Environmental Standards

The GERRI were enacted in October 2001, and Appendix 1 of GERRI outlines the Environmental Protection Standards relevant to facilities in the Kingdom of Saudi Arabia.

The GAME (2001) General Environmental Protection Standards for New Facilities (Article 7) are outlined as:

- All new major facilities as well as major modifications to existing facilities shall be designed, operated and maintained so as to avoid exceedances of the ambient environmental standards as promulgated for the Kingdom of Saudi Arabia at the time of approval of the design.
- Each new major facility or major modification of an existing facility shall incorporate the best available technology for control of pollutant discharges and for the disposal of wastes resulting from the operation of the facility.

- All new facilities and modifications of an existing facility shall be designed and operated so as to avoid the discharge of any toxic substance, whether specifically regulated or not, in sufficient quantities to be harmful to public health.

In 2012, the GAME developed a number of draft supplementary Environmental Standards revising in part the General Standards for the Environment issued by the GAME in Appendix 1 to the GERRI. These Standards are listed in Table 2-4.

Table 2-4: Presidency of Meteorology & Environment Environmental Standards

GAME Environmental Standard (PMEES)	Topic
GAME ES 1	Material Recovery & Recycling
GAME ES 2	Mobile Source Emissions
GAME ES 3	Noise
GAME ES 4	Air Emissions for Stationary Sources
GAME ES 5	Prevention of Major Accidents
GAME ES 6	Storage and Material Reclamation Facilities Design and Operation
GAME ES 7	Thermal Treatment and Incineration Design and Operation
GAME ES 8	Waste Acceptance Criteria
GAME ES 9	Waste Classification
GAME ES 10	Drinking Water Quality
GAME ES 11	Biological Treatment Design and Operation
GAME ES 12	Waste Control
GAME ES 13	Waste Handling and Storage
GAME ES 14	Waste Training
GAME ES 15	Waste Transportation
GAME ES 16	Landfill Design
GAME ES 17	Industrial and Municipal Wastewater Discharges
GAME ES 18	Best Practicable Environmental Option for Waste Disposal
GAME ES 19	Ambient Air Quality
GAME ES 20	Ambient Water Quality

Article 6 of the GERRI requires projects to “*utilize the best possible and most suitable technologies for the local environment and use materials which introduce the lowest possible level of pollution to the environment*”. Article 7 of the GERRI, General Environmental Protection Standards for New Facilities requires new facilities to: “*Incorporate the best available technology for control of pollutant discharges and for the disposal of wastes resulting from the operation of the facility*”.

Best Available Technology (BAT) is not elaborated further within the GERRI, but the EU Directive on Integrated Pollution Prevention and Control introduces the definition of BAT used within the ESIA as part of the assessment of alternatives.

2.4 International Environmental Agreements Ratified by Saudi Arabia

The Kingdom of Saudi Arabia cooperates internationally to protect and manage the environment and participates in the work of codification of international environmental law. This commitment is manifested in the signing and ratification of the following International and Regional conventions on the environment² (Table 2-5).

The agreements are a very important legal instrument for the environment. For example, The Convention on Biological Diversity (Rio) states in Article 14 that the signatories must carry out environmental impact studies for projects that may have potential adverse effects on biodiversity, to prevent or minimize these effects.

Table 2-5: Relevant International Agreements Signed by Saudi Arabia

International Agreement	Date Signed
Paris Agreement to the UN Framework Convention on Climate Change	03/11/2016
13/Convention on the Rights of Persons with Disabilities12/2006	13/12/2006
International Treaty on Plant Genetic Resources for Food and Agriculture	06/06/2002
Cartagena protocol on biosafety to the convention on biological diversity	24/05/2000
Rotterdam Convention on the prior informed consent procedure for certain hazardous chemicals and pesticides in international trade	10/09/1998
Kyoto Protocol to the UN Framework Convention on Climate Change	11/12/1997
International Plant Protection Convention - New revised text approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 - Declaration	07/11/1997
Agreement relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982 (UNCLOS)	28/07/1994
United Nations Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	17/06/1994
Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	25/11/1992
Convention on biological diversity	05/06/1992
United Nations Framework Convention on Climate Change	09/05/1992
Amendment to the Montreal protocol on substances that deplete the ozone layer (London Amendment)	29/06/1990
Basel Convention on the control of transboundary movements of hazardous wastes and their disposal	22/03/1989
Montreal Protocol on substances that deplete the ozone layer	16/09/1987
Vienna Convention for the protection of the ozone layer	22/03/1985

² Source: <http://ec.europa.eu/world/agreements/searchByCountryAndContinent.do?countryId=2149&countryName=Saudi%20Arabia>

International Agreement	Date Signed
United Nations Convention on the Law of the Sea (UNCLOS)	10/12/1982
Convention on the conservation of migratory species of wild animals (Bonn Convention)	23/06/1979
Constitution of the Food and Agriculture Organization of the United Nations (FAO)	16/10/1945

2.5 Other Legislation & Guidance Relevant to Saudi Arabia

2.5.1 Wildlife legislation and strategies

The Saudi National e-government portal states that there are several legal instruments and national strategies in the Country to protect the wildlife over and above international instruments to which the Kingdom of Saudi Arabia is party, listing these as:

- The Preserved Areas System and Regulations for Wildlife;
- System and Regulations for Hunting Animals and Wild Bird;
- The National Strategy for Biological Diversity Conservation in the Kingdom of Saudi Arabia; and
- The Convention for Preserving Wildlife in the Six Gulf States.

2.5.2 Sustainability policies

2.5.2.1 Sustainability policy drivers

The principles of sustainable development have been prioritized in global, national, and local government policy as well as the Gulf Cooperation Council in order to ensure steady, balanced and sustainable long-term economic growth. As a result, a number of policies, procedures and guidelines have been generated in order to assist both the public and private sectors, to minimize their impact on the natural and human environment through their decision-making. Identified areas for the improvement of activities towards sustainable behavior are on a wide-ranging scale: from using energy efficiently and reducing greenhouse gas emissions, to using materials and products from sustainable sources in primary production and procurement.

2.5.2.2 Global policy context

Sustainable Development is promoted through international initiatives, including the United Nations Sustainable Development Solutions Network (SDSN), launched by the UN Secretary-General on August 9, 2012. The SDSN aims to create a framework that addresses the challenges of ending poverty, increasing social inclusion and sustaining the planet (UNDP, 2014).

The Solutions Network mobilizes scientific and technical expertise from academic, civil society, and the private sector in support of sustainable development problem solving at local, national, and global scales. The SDSN has launched projects to pilot the rollout of practical approaches to managing the challenges of sustainable development and assist countries in developing sustainable long-term development pathways.

The United Nations Sustainable Development Goals which were adopted on September 25th 2015 aim to end poverty, protect the planet, and ensure prosperity for all as part of a new sustainable

development agenda. Each goal has specific targets to be achieved over the next 15 years (i.e. 2030). In total there are 17 development goals (Figure 2-1).



Figure 2-1: United Nations Sustainable Development Goals

2.5.2.3 National policy context

Saudi Arabia's development plans are a quinquennial publication that sets forth the national socioeconomic direction. The strategic document outlines the targeted aims to be reached within the next 5 year timeframe. The Plans are designed to be responsive and tailored to national requirements, given changing dynamics both domestically and abroad. Additionally, they are used as a measuring tool to gauge effectiveness of implementation against the aims (www.mep.sa). The current ratified plan is the ninth Development Plan which covered the period 2010 – 2014. The tenth Development Plan (2015-2019) has been prepared but is yet to be formally enacted into national law.

The key features of tenth NDP are:

- Developing non-oil exports, and increasing their contribution to the total value of exports.
- Encouraging local and foreign strategic partnership to implement investment projects, which contribute to diversification of the production base of the national economy.
- Maximizing the value added of oil and gas resources in all uses and production activities.

Saudi Arabia has witnessed significant progress on development indicators in recent years, a key focus for the government, and this program supports the need for sustainability of approved development. As such, according to UNDP, this program focuses on three major outcomes related to the three pillars of sustainable development.

- Mainstreaming Sustainability into Development Policy: Key priorities are to monitor implementation of the UNDP 2014; devise new sustainable development indicators and integrate sustainable development approaches into development planning; and diversify growth through regional development and knowledge economy and south-south cooperation.
- Green Economy: The development of strategies for transitioning to green economy, with special focus on energy efficiency and renewable energy and in other priority sectors such as

water, mining, building, transport, and waste. This has gained great attention in recent years as a way of generating new growth; value added, knowledge based economy; creating green jobs; and, increasing competitiveness. Global green economy reached record market capitalization in 2010, of \$386 billion, led by emerging economies, with great scope for the Kingdom of Saudi Arabia to engage in this trend.

- **Social Empowerment:** The development of strategies and policies for poverty reduction, including youth and female employment, is of high priority to engender social stability and equitable growth. Strategies are needed to insure inclusive growth with focus on population policies and labor market adaption, as well as enhanced systems of social subsidies and social safety nets.

2.5.3 Islamic guidance

2.5.3.1 Islamic Principles for the Conservation of the Environment

The sustainable use of natural resources and the conservation of the environment are Islamic principles pertaining to the right and privilege of all people. Islamic principles hold that the protection, conservation and development of the environment and its natural resources are a mandatory duty to which every Muslim should be committed.

The Islamic trust of stewardship towards the natural environment is summarized as follows:

- there should be no extravagance, excessive use or over-utilization;
- there should be no illegitimate or unlawful attempt at destroying natural resources; and
- there should be no damage, abuse, pollution or distortion of the natural environment in any way.

There should be no construction and development of the earth, its resources, elements and phenomena without the improvement of natural resources, the protection and conservation of all existing forms of life, the cultivation of land, and the reclamation and cleaning of the soil, air and water. As ownership of all environmental elements is a common and shared right, it is the responsibility of both individuals, and the ruling authorities, to uphold these duties, especially in terms of prevention or treatment of damage. The state is therefore seen as having the right in Islamic law to hold individuals, organizations, establishments and companies responsible for whatever measures are necessary to protect and conserve the environment and natural resources.

2.6 Saudi Aramco Environmental Standards

2.6.1 Core values

Saudi Aramco has five corporate core values which are: Excellence, Safety, Accountability, Integrity and Citizenship. The last core value embodies Saudi Aramco's commitment to ensuring the protection and enhancement of the natural environment during the execution of its activities within areas in which Saudi Aramco operate or plan to operate in the future. It states:

"We are a positive influence on the Kingdom and its environment and in the communities in which we live and work."

The core value of Citizenship is comprised of four pillars: Economy, Community, Knowledge and Environment and together they provide a framework for the sustainable operation of the company's core business. The design and implementation of all new projects and programs should be influenced

by the corporate value of Citizenship and the key areas of focus. This approach will facilitate the application of the company's corporate objectives at the design level, and contribute to the integration of sustainability at the project level.

2.6.2 Review of Saudi Aramco environmental standards

Saudi Aramco has developed and implemented a comprehensive corporate strategy to protect and enhance the natural and cultural heritage of Saudi Arabia. This strategy is governed by the company's Environmental Protection Policy which reads:

"...the Company will ensure that its projects / operations are in compliance with the Kingdom's environmental protection regulations and do not create undue risks to the environment, public or workers' health."

This Policy also states that:

"In all its project / operations, the Company will attain the highest level of compliance with the Kingdom's environmental regulations. Where there are no established national regulations, the Company will develop environmental standards aligned with industry best practice and compatible with the Kingdom's environmental protection objectives."

To support the company's environmental strategy throughout the execution of its operations and to promote compliance with its Environmental Protection Policy, Saudi Aramco has developed and maintains a framework of procedures, standards and general instructions relating to the protection of the environment. Table 2-6 identifies the relevant Saudi Aramco policies, procedures and standards to the Project and these will be complied with as appropriate by the project team throughout the life of the project.

Table 2-6: Saudi Aramco Policies, Procedures & Standards Relevant to the Development

Saudi Aramco Documentation	Description
Policy Statements	▪ Saudi Aramco Policy Statement No. INT-5, Environmental Protection. ▪ Saudi Aramco Policy Statement No. INT-11, Water Conservation.
Engineering Procedures	▪ SAEP-13 Project Environmental Impact Assessments. ▪ SAEP-340 Air Quality Impact Analysis and Assessment. ▪ SAEP-359 Biodiversity Protection Program. ▪ SAEP-396 Terrestrial Ecology Surveys. ▪ SAEP-391 Environmental Monitoring of Groundwater. ▪ SAEP-1661 Waste Minimization Assessments.
Engineering Standards	▪ SAES-A-102 Ambient Air Quality and Source Emission Standards. ▪ SAES-A-104 Wastewater Treatment, Reuse and Disposal. ▪ SAES-A-105 Noise Control. ▪ SAES-A-112 Meteorological and Seismic Design. ▪ SAES-A-115 Groundwater Monitoring Well Design, Installation and Decommissioning.
General Instructions	▪ GI-0002.714 Environmental Protection Policy Implementation. ▪ GI-0150.000 Industrial Hygiene and Occupational Health Aspects of Environmental Protection Policy.

Saudi Aramco Documentation	Description
	▪ GI-150.001 Asbestos Hazard Management. ▪ GI-0150.100 Hazardous Materials Communication (HAZCOM) Program. ▪ GI-0151.006 Implementing the Saudi Aramco Sanitary Code. ▪ GI-0430.001 Waste Management. ▪ GI 2.718 Contractor Site Allotment Procedure. ▪ GI 298.010 Administration Procedure of Contractor Camps/Parks and Construction Camps.
Sanitary Codes	▪ SAEHC-S-01 Water. ▪ SAEHC-S-02 Sanitary Wastewater & Sewerage System. ▪ SAEHC-S-03 Solid Waste Management. ▪ SAEHC-S-07 Camps & Communal Living Facilities. ▪ SAEHC-S-12 Places of Employment. ▪ SAEHC-S-18 Public Health Nuisance.
Form and Data Sheet	▪ Form 7305-ENG Equipment Noise Data Sheet.
Material Instructions	▪ CU-22.03 Processing and Handling of Hazardous Materials.

3. Consideration of Alternatives

3.1 Introduction

This chapter provides an overview of the justification for the Park and describes the feasible project and design alternatives that have been considered at this stage of the development. The consideration of alternatives is based on the preliminary design and is assessed against the international lending and client requirements. This includes consideration to the application of Best Available Techniques (BAT) to the development in accordance with the requirements of the General Authority for Meteorology and Environment (GAME – formerly Presidency of Environment and Meteorology) (2001) in addition to International Finance Corporation (IFC) Performance Standards.

The consideration of alternatives also considers IFC Performance Standard 3 and the requirements for Resource Efficiency (Greenhouse Gases and Water Consumption) and Pollution Prevention (General, Hazardous Materials Management and Pesticide Use and Management). The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

3.2 Project Justification

In April 2016 the Kingdom of Saudi Arabia announced Vision 2030, a plan which expresses the long-term social and economic goals of the country. The *Vision* for the Kingdom of Saudi Arabia is built on three pillars that represent its unique competitive advantages. The Kingdom's status will enable it to build on its leading role as the heart of Arab and Islamic worlds. At the same time, it will use its investment power to create a more diverse and sustainable economy. Finally, the Kingdom will use its strategic location to build its role as an integral driver of international trade and to connect three continents: Africa, Asia and Europe (www.vision2030.gov.sa). The Vision is built around three themes: a vibrant society, a thriving economy and an ambitious nation.

As part of the National Transformation Plan to meet the goals of Vision 2030, the Ministry of Energy, Industry and Mineral Resources (MEIM) has launched the National Renewable Energy Program (NREP) to implement 9.5 GW of renewable power by 2023. This target is the principle driver behind the development of renewable energy projects in the Kingdom.

Saudi Aramco had initiated its own program of renewable energy projects prior to the launch of the NREP. As a valued partner in the development of the Kingdom's renewable energy targets, these projects have been accelerated to meet the 2023 national target of 9.5 GW of installed capacity.

The Sakaka Solar Energy Park is among the first round of projects within this program, and therefore is considered to represent a crucial step in the transition from non-renewable to renewable energy within the Kingdom of Saudi Arabia.

3.3 Do-Nothing Option

The do-nothing option involves not pursuing the Sakaka Solar Energy Park. In this scenario, no change would occur to the environmental or social aspects of the surrounding area. However, the economic, environmental and social benefits of the Park would not be realized. Additionally, the

potential offset of diesel currently being burned in the Al Jouf Power Plant and the resulting environmental impacts of this activity (particularly those impacts upon air quality), would not be realized.

The Sakaka Solar Energy Park is part of a wider scheme to shift the energy generation mix of the Kingdom of Saudi Arabia away from fossil fuels and towards cleaner energy solutions, not only benefiting the environment but also the economy of the country. As part of the first phase of this wider strategy, it is considered that the Park will be seen as a 'gateway project' to further renewable energy developments within the Kingdom of Saudi Arabia. A failure to pursue the Sakaka Solar Energy Park would prevent optimization of the economic value of petroleum resources.

Therefore, the Park seeks to follow internationally accepted protocols and relevant legislation, design out where possible environmental and social impacts and where impacts remain, apply project-specific mitigation and monitoring measures as identified in this Environmental and Social Impact Assessment (ESIA). In this way the Park will be developed with an acceptable level of environmental and social impact, and will significantly contribute to the Kingdom's economy.

3.4 Alternative Site

Saudi Aramco has completed a review of its reservations and the availability of land within its ownership for the development of renewable energy projects which do not conflict with its current oil and gas operations. The sites available for the development of renewable energy projects are therefore constrained by Saudi Aramco land ownership rights.

Under Saudi Aramco's General Instruction Manual Land Use Permit Procedures G.I. 2.716, there is a requirement to apply for a Land Use Permit (LUP) from Saudi Aramco Facilities Planning Department (FPD) to release the land for the Park. Following receipt of the LUP, FPD will conduct a preliminary review of the release request to ensure that the requested land is not needed for existing short-term or planned long-term land uses; and this process involves internal and external consultation.

Through the LUP application process, those sites which have the potential to be developed for renewable energy have been identified and been awarded an LUP. The development site is one of these locations (LUP No. 41641).

3.5 Alternative Development Type

Saudi Aramco has considered the suitability of renewable energy technologies at the Sakaka development site, within LUP 41641. This assessment has been based on prevailing climatic conditions (i.e. regional wind and solar resource), the proximity of the Park to the power distribution network and other infrastructure. Due to the proximity of Al Jouf International Airport, and the potential for collision with incoming/outgoing airplanes, it was not considered appropriate to pursue wind technology at the development site.

Saudi Aramco installed a solar measurement station on the development site in January of 2015. The station measured monthly average Global Horizontal Irradiation (GHI), humidity, wind speed/direction at 10m, daily heat index (DHI) and temperature. The results of this monitoring demonstrated that the site is suitable for the installation of the proposed Solar Energy Park.

3.6 Alternative Design

A preliminary masterplan for the development has been developed by Saudi Aramco. However at this stage of the development the final configuration of the solar energy park and the solar PV technologies to be deployed are subject to further design effort by the IPP. The assessment of environmental impact undertaken in this ESIA is therefore based on this preliminary design.

At this stage of the design, the solar PV cleaning technologies to be employed at the Park have not yet been specified. The Independent Power Producer will confirm this aspect of the design of the Park. Saudi Aramco has confirmed that an assumption of waterless cleaning technology is acceptable at this stage. This technology deploys automated robotic cleaning devices with rotating soft cleaning brushes which reduce the requirement for daily washing. This technology is proven and is commercially available.

3.6.1 Optimization of Solar Technology

There are three options related to the choice of photovoltaic (PV) solar technology. These are:

3.6.1.1 Thin film PV

Thin film technology is comprised of a film of photovoltaic material deposited across a substrate such as glass or metal. Although flexible, and cheap to produce, the efficiency of this option is less than that of Polycrystalline or monocrystalline photovoltaic technology (although in recent years it has improved significantly) and it degrades much faster than the other two options.

3.6.1.2 Polycrystalline PV

Polycrystalline PV is comprised of a photovoltaic panel made of multiple silicon crystals. This is a simple and cheap production process, and is much less wasteful than monocrystalline PV, which typically results in large amounts of un-used silicon. The efficiency of this technology is lower than that of monocrystalline PV at approximately 14-16% however, in situations where space is not limited, Polycrystalline PV represents a cost effective solution.

3.6.1.3 Monocrystalline PV

Monocrystalline PV is manufactured using a single silicon crystal. The production process involves trimming a single circular unit of silicon into the square shape of a panel, with the remaining excess silicon going to waste. As a result of this, these types of panels are the most expensive option for solar technology. Efficiency of monocrystalline technology is the highest of all three options due to the purity of the material, at approximately 20% however, where space is not limited, the cost of this option is rarely recouped through the greater efficiency.

3.7 Application of Best Available Techniques

IFC Performance Standard 3 requires all Projects to be developed using technically and financially feasible measures that are most suited to avoid, and/or minimize adverse impacts on human health and the environment. This includes consideration of hazardous and non-hazardous chemical pollutants in the solid, liquid, or gaseous phases, pests and pathogens, discharge (Solid, liquid or gaseous) to water, air and surface land, GHG emissions, nuisance odors, noise, vibration, radiation, electromagnetic energy, and the creation of potential visual impacts including light. IFC Performance Standard 8 also requires any removal of Tangible cultural heritage to be undertaken using the Best Available Technique)

The IFC do not require the complete elimination of emissions, but advocates the avoidance at source whenever possible, and, if not possible, then subsequent minimization of pollution to the extent that the Performance Standard objectives are satisfied.

Efficient use of resources and pollution prevention is required to be considered using technical and financially feasible measures. The IFC definition of technical feasibility is based on whether the proposed measures and actions can be implemented with commercially available skills, equipment, and materials, taking into consideration prevailing local factors such as climate, geography,

infrastructure, security, governance, capacity and operational reliability. Financial feasibility should be assessed and tailored to the hazards and risks associated with the nature of the project and consistent with good international industry practice (GIIP).

Within the European Union, the application of the Best Available Technique (BAT) is undertaken on all large industrial installations as defined by Industrial Emissions Directive (IED, 2010/75/EU). The BAT process is implemented using a series of BREF (Best available techniques Reference documents). Solar Parks are not currently considered through the BREF documents, although Energy Efficiency is considered more generally for all industrial installations.

As the design of the Park is refined by the Independent Power Producer (IPP), the application of BAT or more broadly the Technically and Financial feasibility of the design issues will be undertaken to ensure that the most suitable technology is utilized for the Park. This shall consider all aspects of Environmental and Social sustainability, and shall consider the use of Value Improving Practices for aspects such as Waste, Water and Carbon Emissions.

4. Detailed Description and Layout of the Proposed Development

4.1 Introduction

This chapter provides a detailed description of the Park, its layout and ancillary infrastructure, as well as construction schedule, workforce and associated requirements for infrastructure and services.

The description has been prepared based on preliminary design information available at the time of preparing the ESIA. The Independent Power Producer (IPP) will be responsible for the further development of the design. The IPP design has the potential to vary from the preliminary design used as the basis for this ESIA, and if necessary an addendum to the ESIA will be prepared. Where design assumptions remain, they have been agreed with the project proponent, and have been noted.

4.2 Objectives of the Project

The objective of the Park is to aid the Kingdom of Saudi Arabia in meeting the target of 9.5GW of renewable energy by 2023 put forward as part of Vision 2030.

The Park will be implemented in phases over a period of 10 years. The first phase will have an installed capacity of 300 MW and will be known as the Sakaka Solar PV Power Plant 1. At completion, the Park is expected to have a total installed capacity of approximately 1 Giga-Watt (GW).

4.3 Site Location

The development site is a greenfield site located in the Al Jouf Province of Saudi Arabia, on the edge of the An Nafud desert, approximately 220km south of the Iraqi border, and approximately 27km south-west of central Sakaka.

This location has been chosen as the optimal location for a PV Power Plant, as a result of detailed site analysis and survey by Saudi Aramco against four main selection criteria;

- Potential to offset hydrocarbon use;
- Availability of land;
- Regional development; and,
- Solar resource.

Figure 4-1 shows the location of the development site.

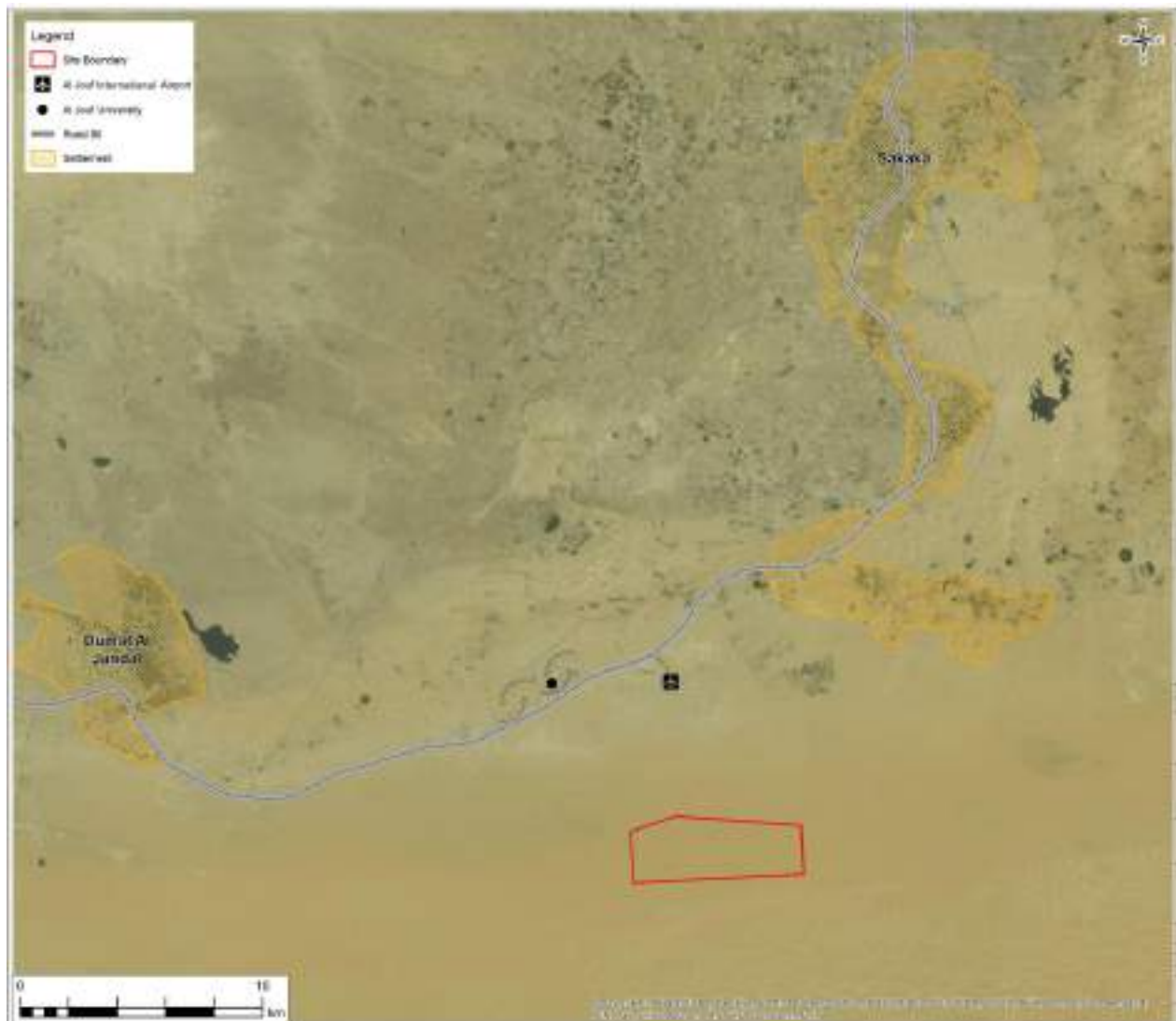


Figure 4-1: Location of the Development Site

4.4 Development Site Layout

The development site will cover an area of approximately 16.38 km² and will consist of solar panels, developer compounds, ancillary infrastructure and grid connectivity infrastructure such as cables and wires.

4.4.1 Road Infrastructure

An 8m wide perimeter asphalt road with a 2m shoulder will be constructed. Within the Park there will be two types of internal road. The main internal spine roads which lead from the sub-stations will be asphalt, 5m wide with a 0.5m shoulder. The minor internal access roads will be constructed from compacted gatch material (i.e. limestone material generally used as a road base). These roads will be 5m wide with a 0.5m shoulder.

All roads which lead into the facility from the SEC service road and provide access to the sub-stations and associated service buildings and infrastructure will be asphalt.

4.4.2 Developer Compounds

The Park will be divided into four areas (i.e. Phases), and each area will be operated by an individual developer. Each developer will require a separate compound of approximately 1.3 x 0.5 km in area which will contain a water pumping and storage area, an Medium Voltage collector building, a visitor building, a workshop and storage building and a cleaning system building. At this stage of the development, it is not clear whether one developer will operate more than one phase of the Park, if this is the case, that developer would require a single compound to cover both areas.

4.4.3 Solar Panels

The majority of the surface area of the development site will be occupied by solar panels. A total of 90 solar modules comprise a single solar table, and the solar tables are 29.55m in length. The solar tables will be arranged in parallel strings of 90 modules along the west-east axis, and the strings will be typically set 4.84m apart. The total height of the installed modules will be 3.4m above ground level. Based on the preliminary design, a total of 181,800 strings will be installed and 2,908,800 solar modules.

Figure 4-2 shows the development site layout.

Figure 4-2: Development Site Layout

4.4.4 Electrical Infrastructure

4.4.4.1 33kV HV Switching Station

The preliminary design includes four 33kV HV switching stations to collect all 33kV power lines from the inverter stations in centralized locations and to transfer the power of the Park to the Saudi Electricity Company (SEC) collector sub-stations. The SEC Al Jouf sub-station is located 8km north-west of the development site, north of Road 80.

The 33 kV HV switching stations will be comprised of rooms for electrical equipment, battery units, supervisory control and data acquisition (SCADA) and communication equipment, engineering work stations for on-site maintenance, washrooms, toilets, conference room, prayer room, pantry and a waste separation room. The SCADA system will perform monitoring and control of the solar photovoltaic energy park functional areas which will include power generation, power collection, power regulation, energy resources and auxiliary systems.

The 33 kV HV Switching Stations will accommodate the Low Voltage Auxiliary (LV AUX) distribution equipment including AUX transformer, LV switch breakers and service equipment such as lighting, ventilation and air-conditioning unit (HVAC). The switching station will also be equipped with an Emergency Shutdown (ESD) system for the Park.

A conceptual layout of a 33 kV HV Switching Substation is shown in Figure 4-3.

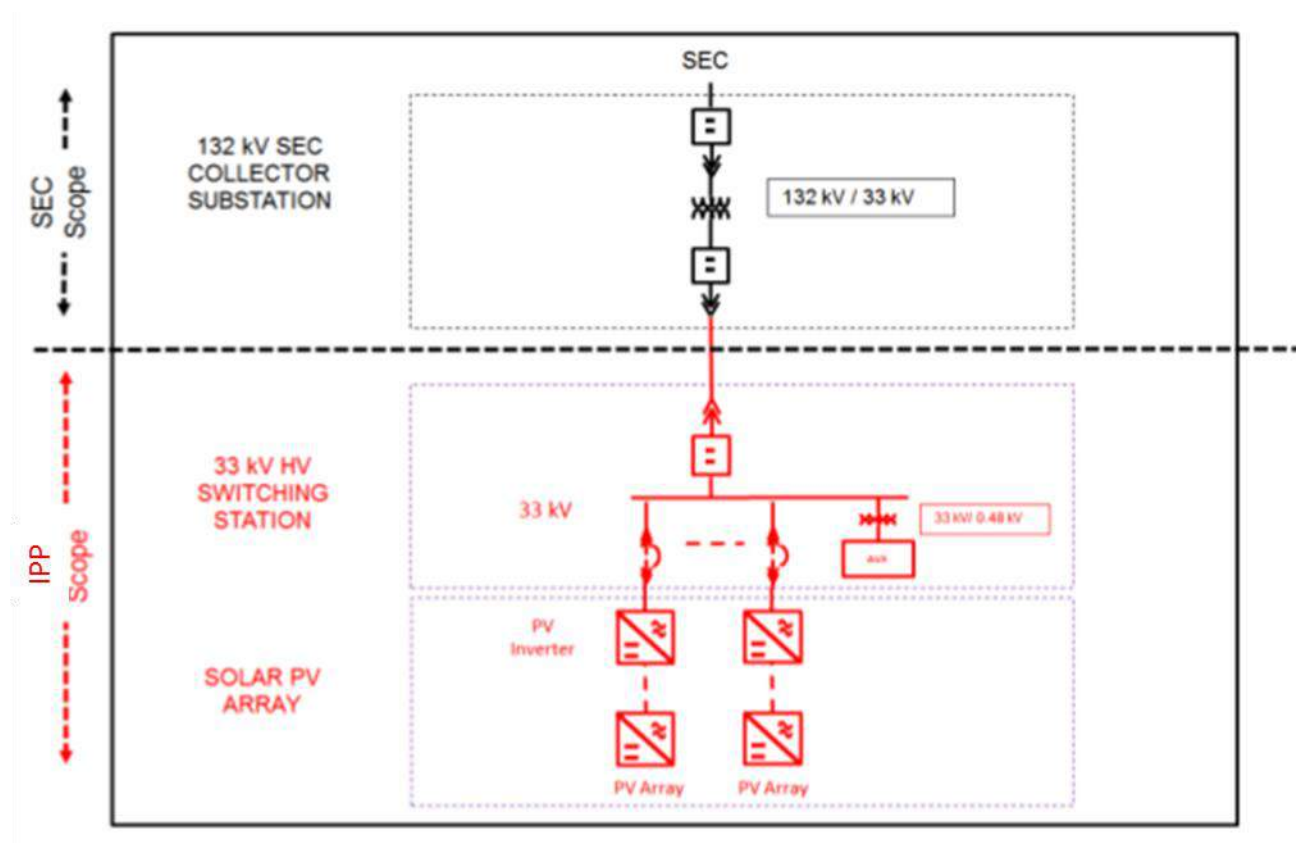


Figure 4-3 : Conceptual Layout of the Switching Station

In addition, the 33 kV HV Switching Stations will include a cleaning system building, a visitor building, a workshop and storage building and car parking. Figure 4-4 shows a typical developer compound layout.

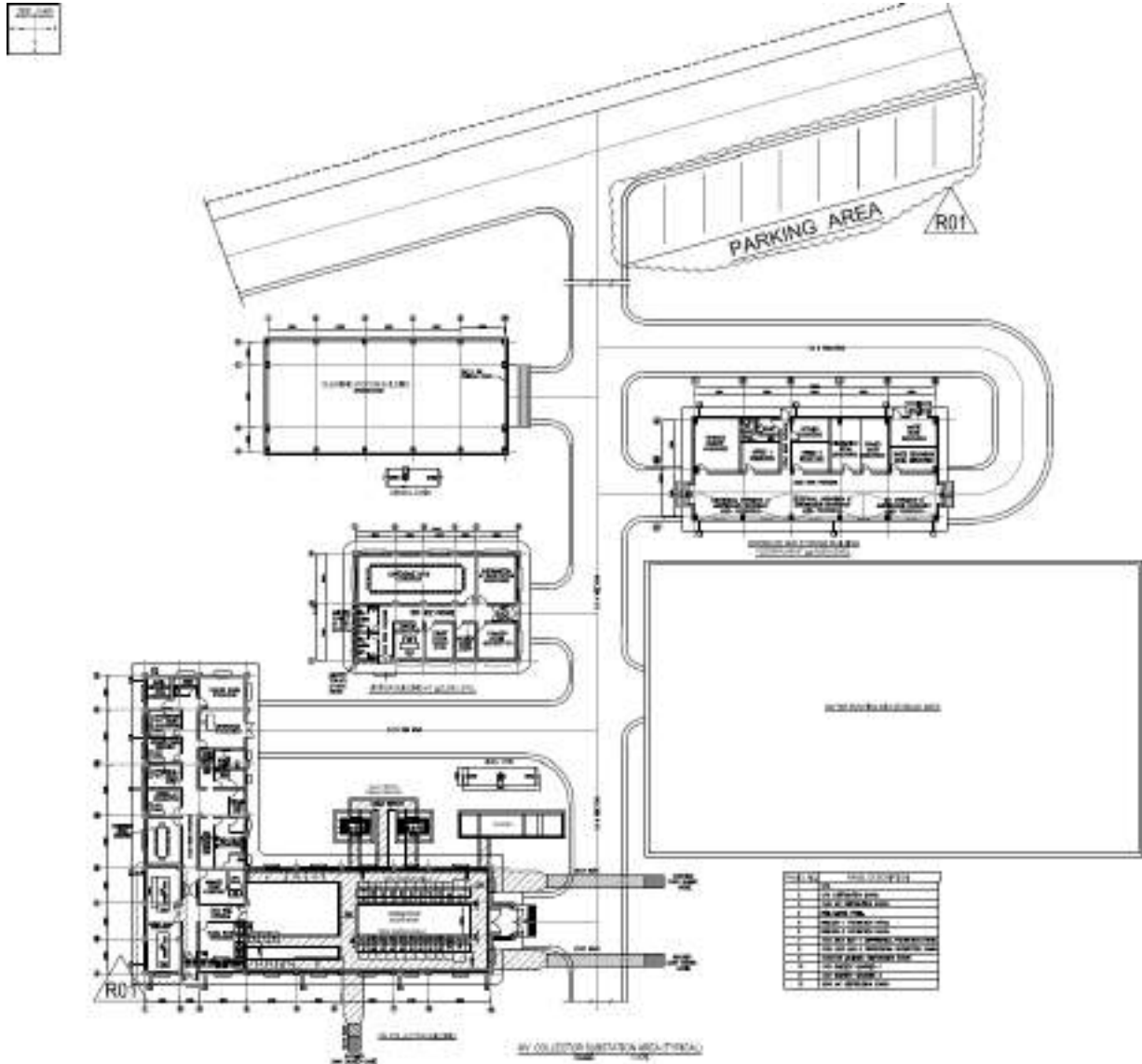


Figure 4-4: Typical Developer Compound Layout

4.4.4.2 SEC Collector Station

An SEC collector sub-station shall be built by SEC as outlined in the Memorandum of Understanding between Saudi Aramco and SEC. The SEC collector sub-station shall provide the required auxiliary supply for power plant energy consumption. The location of the SEC collector sub-station will be identified during the next phase of development, but it will preferably be located in close proximity to the 33kV HV switching station. It will connect to the existing transmission line using overhead power lines.

4.4.4.3 Meteorological Station

Saudi Aramco will install two permanent meteorological stations to accurately measure meteorological data with calibrated sensors. The stations will be equipped with a dedicated Uninterrupted Power Supply (UPS) and a data back-up system. The location of the meteorological stations will be confirmed during the next phase of development, but it is possible the existing meteorological station will be retained.

The meteorological stations will provide the minimum following measurements:

- Solar PV module temperature (back-of module sensor);
- Ambient temperature;
- Humidity;
- Wind speed and direction;
- Dust measurement;
- Plane of array irradiation; and,
- Data logger.

4.4.4.4 Metering

A redundant power quality and revenue meter (i.e. class II) will be installed to measure and report the net electricity exported by the Park to the grid in accordance with the grid code. The meter will directly interface with the sites supervisory control and data acquisition (SCADA) system.

4.4.4.5 Transformer Stations

Based on the preliminary design, a total of 75 2000kVA inverter–transformer stations (ITS) will be installed. The inverter stations will comprise of interconnected standalone inverter units, transformers, switch breakers and Remote Terminal Units (RTU). The inverter stations are likely to come on integrated skids, and the units installed directly on a concrete pad by a forklift truck, with only in-and out cabling needed for quick commissioning. A shade shelter will also be provided for each inverter station, to safeguard against direct sunlight. There will be two invertors per ITS station, and a single transformer.

4.4.4.6 Remote Terminal Unit

Each inverter station will be equipped with a Remote Terminal Unit (RTU) to capture inverter, transformer and switch-breaker information, and perform any required computation and transmit data to the SCADA system through a fiber optic communication link.

4.4.5 Site Connectivity

4.4.5.1 Fiber Optic Cable

A fiber optic cable will be installed to integrate all field devices and systems with the 33kV switching station and facilitate the process automation system network. The fiber optic cable will be buried within a utility corridor.

4.4.5.2 Other Cables and Wires

Direct Current (D.C.) cables will be installed to transfer the D.C. power from the solar PV modules and DC junction boxes to the inverter stations. Subject to further engineering design, the DC cables could be buried or alternatively ultra-violet resistant cables could be installed behind the solar PV mounting structures on cable trays. Alternating Current (A.C.) cables will be installed from the inverter stations to the 33kV switching station.

4.4.6 Solar Photovoltaic Modules

The preliminary design of the Sakaka Solar Energy Park, proposes the use of polycrystalline solar PV technology from Jinko Solar (Model: JKM320P).

The technical specifications of these panels is shown in Table 4-1.

Table 4-1: Specification of Jinko Solar Panels JKM320P

S. No	PV Module		
1	Model		JKM320P
2	Technology		Poly Crystalline
3		Module Peak Power	320Wp
4		Open Circuit Voltage, Voc, V	46.4V
5		Short Circuit current, ISC, A	9.05A
6		Maximum Voltage, Vmp, V	37.40V
7	Standard Test Conditions, STC	Maximum Current, Imp, A	8.56A
8		Fill Factor	76.2%
9		Module Efficiency	16.5%
10	Temperature coefficient of Pmax		-0.40%/°C
11	Plant Capacity (MWp)		1358.5

4.4.7 Solar Module Foundations

The solar PV modules will be installed on prefabricated galvanized steel mounting structures. The design of the mounting structures, including foundations, will be confirmed during the next phase of engineering design. At this stage, it is assumed that panels would be installed using pre-fabricated concrete anchors at the base of each mounting structure.

For the purposes of the desk-based assessment, it will be assumed that the solar PV modules and mounting structures will be manufactured, and procured from a supplier based outside the Kingdom of Saudi Arabia. For the purposes of this ESIA it has been assumed that no upgrades to highway infrastructure are required.

4.4.7.1 Polycrystalline Photovoltaic Technology

Polycrystalline is the semi conducting material used to manufacture solar panels. Polycrystalline consists of multiple silicon crystals whereas monocrystalline is made of one single silicon crystal.

Polycrystalline solar panels are cheaper and simpler to manufacture than monocrystalline and, although slightly less efficient than monocrystalline technology, are broadly able to perform at similar efficiency.

4.4.8 Solar Inverter

Each solar table will be connected to a solar inverter, which will convert the direct current of the solar panel into useable alternating current for supply to the grid. Solar inverters manufactured by ABB are proposed for use in the design of the Park. The specification of these inverters is shown in Table 4-2.

Table 4-2: Inverter Properties

S. No	Inverter Technical Parameters	
1	Maximum Input Voltage, V	1500
2	MPPT range, V	935-1500 at 35°C 935-1100 at 50°C
3	Output main voltage, V	660
4	Output main frequency, Hz	50/60
5	Output Nominal power, kVA	2000
6	Output Nominal current, A	1750
7	Maximum efficiency, %	98.8
8	Weight, kg	3850
9	Protection class	IP65
10	Number of Inverters in plant	530

4.4.8.1 Overhead Power Lines

The development of the Park does not require the installation of any new overhead power lines. Immediately to the north of the Park there are two existing 132kV and one 13.8kV SEC overhead power lines which run to the SEC Al Jouf sub-station. The 132kV power lines are mounted on pylons approximately 30m high, and the 13.8kV power line is mounted on a pylon approximately 5m high. These transmission lines run east to west to the north of the development site. Figure 4-5 shows the overhead power lines.



Figure 4-5: Overhead Power Lines

Additionally, there is a new 380kV line currently being installed approximately 9km to the west of the Park which runs in a north south direction and originates at the SEC Al Jouf Sub Station to the north-west of the development site.

4.4.9 Non-Electrical Utilities

The 33kV switching station will be provided with a 2 inch utility water pipeline, a PVC septic tank with capacity for 5 persons, a 500 gallon water tank, drinking water coolers and fire extinguishers. Storm water shall be surface drained. The 33kV switching station shall also be equipped with two 3 ton air conditioning units.

4.4.9.1 Site Drainage

The Park is located on a site without critical flooding problems. Rainfall events are scarce and runoff episodes infrequent thanks to the very small slope of the topography and the pervious properties of the sandy soil / highly porous bedrock. No traces of flooding have been observed during the site visits. Despite this, possible runoff has to be managed in order to protect the infrastructure of the Park (mainly the roads) (Tractebel, 2016). It is proposed to construct open swales / drainage channels to protect the internal road infrastructure.

All drainage systems will be designed during the next phase of development, and will be designed in compliance with the requirements of IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality*. Where required, oil water separators will be included in the design in order to prevent contamination from standing hydrocarbons as a result of runoff from hard surfaces.

4.4.10 Security Fencing

A security fence will be installed around the perimeter of the Park, with a minimum of 2 access gates. The fencing and gate requirements will account for potential intruders and theft. The typical elevation of the boundary fencing will be 2.4m to post height, and 2.9m including the extension arms and barbed wire. The perimeter of the site will have security lighting comprised of 2 x 400W High Pressure Sodium Vapor (HPSV) flood lights, 10m in height. These will be spaced approximately at 10m intervals.

4.5 Neighboring Development

4.5.1 Existing Development

4.5.1.1 Al Jouf Bulk Plant

Al Jouf Bulk Plant is located 11.5km north-east of the development site. The bulk plant consists of gas holders and other storage infrastructure.

4.5.1.2 SEC Power Station at Sakaka

Saudi Electric Company (SEC) operates a power station which is located 27km south-west of central Sakaka. This power station provides power to the town of Sakaka and the neighboring industries/residential areas, and has an installed capacity of 382 Mega-Watt (MW) and an average thermal efficiency of 25.8 %. The power station is estimated to consume 1.5 million barrels of oil equivalent (MMBOE) of Diesel per annum. SEC plans to operate the power station until at least 2032 supplying peak and cycling power demand.

4.5.2 Future Development

4.5.2.1 Airport Expansion

At present, there are no plans to expand the Al Jouf International Airport. However, it is noted that the land immediately to the north of the development site is owned by the Airport, and may be used for expansion projects in the future.

4.5.2.2 MODON City for Women

An industrial city for women is proposed approximately 10km north-west of the development site boundary. This city will be developed by MODON and will include accommodation blocks for women. No further details are known at the time of writing the ESIA.

4.6 Project Schedule

The Park is expected to be implemented over a ten year period. Construction of Phase one of the Park is expected to start in Q2 2018 and will take approximately 20 months and will be in operation for 25 years.

4.7 Workforce and Number of Employees

The Park is expected to create 16,500 person years of construction work and 300 operations and maintenance jobs. Phase one of the Park is expected to require a workforce of approximately 2,500 people to construct within the required timeframe.

4.8 Construction Phase

4.8.1 Pre-Construction Activities

Prior to the installation of the solar PV modules, the development site will require civil works including site clearance, grading and the preparation of foundations for the module mounting structures, roads and structures. The site exhibits comparatively uniform topography, and there is no obvious wadi drainage system. Civil works will primarily be restricted to the alignment of solar PV mounting structures, the internal access roads which will run between the modules, cable trenches for Direct Current (D.C.) cabling from DC junction boxes to inverter stations, cable trenches for Alternating

Current (A.C.) from inverter stations to 33kV switching stations. Localized site preparation will also be undertaken for the 33kV switching stations.

Pre-construction activities are expected to include the following:

- Grading and levelling of the development site to prepare for the installation of foundations;
- Installation of security fencing surrounding development site;
- Excavation of cable trenches and other ground works required to install electrical infrastructure; and,
- Installation of developer compound and associated temporary infrastructure.

The following raw materials are expected to be utilized during the pre-construction phase of the Park.

- Pre-fabricated accommodation blocks and offices;
- Security Fencing; and,
- Temporary construction lighting.

4.8.2 Main Construction Phase

Construction phase activities are expected to include the following:

- Construction of internal 5m wide asphalt roads;
- Construction of internal 5m wide gatch road;
- Construction of hard standing for transformer stations;
- Construction of transformer stations, inverter stations and power generation utilities;
- Connections to local utilities where required;
- Construction of switching stations;
- Construction of contractors car park;
- Construction of 8m wide asphalt perimeter road surrounding the development site;
- Installation of solar modules and foundations; and,
- Construction of operational buildings and infrastructure

The following raw materials are expected to be utilized during the pre-construction phase of the Park.

- Pre-fabricated concrete foundations;
- Solar modules;
- Asphalt, tack coat and aggregate to form roads;
- Concrete masonry blocks for permanent operational buildings; and,

- Ready mix concrete to form areas of hard standing.

4.8.3 Temporary Facilities

The preliminary design on which the ESIA is based does not include a Constructability Plan. However a temporary construction camp with an estimated footprint of 0.3 km² is proposed. The temporary construction camp will provide accommodations for an estimated 2,500 expatriate workers on site during the construction phase simultaneously. The location of these facilities has not yet been identified as part of the preliminary design but it will be assumed that they will be located within the boundary of the approved Land Use Permit (LUP).

While the construction camp is yet to be designed, it is anticipated to include site offices and associated facilities, and accommodation. Communal facilities proposed for the camp include:

- Recreation area;
- Kitchens and Dining halls;
- Laundry;
- Medical Centre; and,
- Mosque.

4.8.4 Construction Materials

At this stage of the development, the quantities of construction materials have not yet been calculated. However an estimate of the principal construction materials has been developed based on the preliminary engineering design (Table 4-3). It is likely that the ready mix concrete for the solar tables will be replaced by pre-cast concrete blocks which rest on the surface of the ground. This will be confirmed by the IPP during the next phase of development.

Table 4-3 : Estimated Construction Materials

Item	Unit	Quantity (Approx.)
Asphalt for access roads	m3	25,270
Tack coat for asphalt roads	m3	9,600
Aggregate sub-base for roads	m3	82,125
Gravel base for un-sealed roads	m3	118,360
Ready mix concrete for foundations (i.e. permanent buildings, car park, invertor stations, sub-station)	m3	33,550
Pre-cast concrete construction blocks	No.	27,500

4.8.5 Construction Utilities

4.8.5.1 Water

The estimated water requirement of the construction workforce is based on an average per person per day water usage of 0.325m³, based on Saudi Aramco Engineering Standard SAES-A-104. The construction workforce is expected to comprise of approximately 2,500 persons, and therefore, the

daily water requirement for the construction camp is expected to be approximately 810m³. It has been assumed that this water will be supplied from the municipal supply which runs adjacent to Road 80.

Potable water will be supplied by tanker for use by personnel at the construction compound. It is estimated that 3 liters /person/day of potable water will be required. As such an average of 7.5m³ of potable water per day will be required during the construction period and will be supplied by water tanker.

Water used for dust damping, and other construction activities will be supplied via connection to municipal water supply adjacent to Road 80. Water used for construction activities will be in compliance with the requirements of SAES-A-104 - *Wastewater Treatment, Reuse and Disposal*.

All water storage and discharge systems to be used during the construction phase of the Park including washout of concrete mixing areas, disposal of wastewater and on site storage will be designed during the next phase of the development and will be in compliance with IFC EHS Guidelines: Environmental 1.3 *Wastewater and Ambient Water Quality*.

4.8.5.2 Power

Power at the construction camp will be provided by four 500kw diesel or petrol fueled generators running for 720 hours per month each. A two further standby generators will be present on site, although these are not expected to be operational unless required. There is no intention at present to supply direct power from the SEC power plant, to the construction camp. Based on an average consumption of 33 gallons of diesel fuel per 24 hour day, this equates to an average monthly running utilization of 1,000 gallons per generator per month. These figures are based on conservative estimates of fuel utilization and do not account for summer cooling of buildings and other uses which may place additional demand upon the generators.

Diesel fuel for power generation will be stored in accordance with Section 1.5 of the IFC General EHS Guidelines, in particular the guidelines for secondary containment. The guidelines state that appropriate secondary containment structures for above ground tanks consist of berms, dikes or wall capable of containing the larger of 110% percent of the largest tank or 25% percent of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 liters.

Generators used will be selected and supplied according to the requirements of IFC Environmental Health and Safety Guidelines 1.1 *Air Emissions and Ambient Air Quality*. Particularly the requirements for Small Combustion Facilities Emissions Guidelines.

4.8.5.3 Vehicle Re-Fueling and Fuel Storage

Construction vehicles will be diesel or petrol fueled. Re-fueling of vehicles will take place at designated areas where fuel will be stored in 60m³ 110% double bunded containers or similar as specified in the relevant standards.

Detailed design of areas for the storage of fuels on site will be carried out during the next phase of the development and will be in compliance with IFC EHS Guidelines 4.0: *Construction and Decommissioning*.

This includes the following requirements:

- Providing adequate secondary containment for fuel storage tanks and for the temporary storage of other fluids such as lubricating oils and hydraulic fluids, · Using impervious surfaces for refueling areas and other fluid transfer areas ·

- Training workers on the correct transfer and handling of fuels and chemicals and the response to spills
- Providing portable spill containment and cleanup equipment on site and training in the equipment deployment
- Assessing the contents of hazardous materials and petroleum-based products in building systems (e.g. PCB containing electrical equipment, asbestos-containing building materials) and process equipment and removing them prior to initiation of decommissioning activities, and managing their treatment and disposal according to Sections 1.5 and 1.6 on Hazardous Materials and Hazardous Waste Management, respectively
- Assessing the presence of hazardous substances in or on building materials (e.g., polychlorinated biphenyls, asbestos containing flooring or insulation) and decontaminating or properly managing contaminated building materials Construction Wastes

A Construction Site Waste Management Plan (CWMP) will be prepared, in compliance with regulations and best practice, and implemented by the Contractor before the production of any waste material. This plan will identify in detail the types and volumes of waste and how this waste will be handled, stored, managed, treated, disposed of and controlled. The requirements for this CWMP are addressed in the outline Environmental Management and Monitoring Plan.

Suitably qualified and accredited sub-contractors will be used during the removal and transportation of hazardous materials. All records for the transportation and disposal of hazardous waste will be maintained (and kept available for random inspection) on site.

Where hard surfaces have the potential to collect fluids such as diesel, lubricants or other construction fluids (e.g. car parks and vehicle maintenance areas), oil interceptors will be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction of any harmful fluids into the environmental resources of the development site.

4.8.5.4 Sanitary Waste

Sanitary waste is expected to be generated at a rate of 0.325m³ per person per day, based on Saudi Aramco Engineering Standard SAES-A-104. It is anticipated therefore that approximately 810m³ of sanitary waste will be generated on site each day.

Sanitary waste will be stored in underground tanks in designated storage areas and disposed of through a closed system. Detailed design of these storage areas and this system will be undertaken during the next phase of the development and will be compliant with IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality*.

4.8.5.5 Solar Panel Packaging

Due to the large volume of solar panels required to be delivered to the development site, and the delicate nature of those panels, it is anticipated that a large volume of packaging material will be required in order to ensure the safe transit of the panels.

While there is no generally accepted best practice for the safe transportation of solar panels, they are typically packaged in soft foam or polystyrene, with reinforced corners, and then stacked either vertically or horizontally on pallets, before being shrink wrapped and transported.

For the purposes of assessment, it has been estimated that a volume equal to 40% of the total volume (in m³) of panels will be generated in packaging material. This will equate to a total volume of approximately 126,500m³ of packaging which is expected to be generated during the first phase of the Park.

It is expected that special facilities will be required to ensure the storage and disposal of this packaging. Further detail on the logistics and capacity of this storage will be covered within the Construction Waste Management Plan to be prepared by the main contractor (Independent Power Producer).

Waste will be managed in accordance with IFC EHS Guidelines Environmental: 1.6 *Waste Management* and disposed of in accordance with GAME (PME) Environmental standards at registered and licensed facilities.

4.8.6 Traffic and Logistics

On average 27 vehicle movements per day will be required in order to bring all of the required construction materials to the development site and construct the first phase of the Park. This will include a combination of dumper trucks, concrete mixing trucks, water tankers and HGVs.

Traffic will be managed in accordance with best practice recommendations laid out in IFC EHS Guidelines 3.0 Community Health and Safety and IFC ENS Guidelines 4.0: Construction and Decommissioning.

The route of entry to the Kingdom of Saudi Arabia which the solar modules will utilize is currently unknown. It has been assumed for the purposes of this assessment that modules would be transported via sea, and would enter the Kingdom of Saudi Arabia via the port at Dammam, as this represents a 'worst case' scenario.

Table 4-4 : Anticipated Construction Traffic

Activity	Plant Item	No.	Description	Estimated hours of operation per day
Site clearance and grading, road infrastructure and fencing, laydown area and temporary construction compound etc.	Asphalt Pavers	2	4.5l engine	10
	Roller Vibrator	2	6.75l engine	10
	Bulldozers	2	6.7l engine	10
	Rolling/Vibrating Compactor	2	3.4l engine	10
	Road Planer	2	5.9l engine	10
	Road Wagons	2	11.2l engine	10
	Grader	2	10.3l engine	10
	Dust Suppression (Water Truck)	2	10l engine, 5-10,000 gallon capacity	10
Installation of solar panels and infrastructure (foundations, cabling, power supply etc.)	Excavator	10	12l engine	10
	Piling Machine	10	9.8l engine	10
	Trailer Pump	10	9l engine	10
	Concrete Mixer Truck	10	10.5l engine – 6m ³ capacity	10
	Flat Bed Truck	10	6l engine- to be used across all activities for general site deliveries and other	10

			purposes	
	Mobile Crane	10	10l engine	10
	Hand Operated Tools	100	Drills, power tools, saws etc.	10
	Telescopic 4wd Fork Lift	15	7l engine	10
	Mini Excavator	5	2.3l engine	10
	Trenching Machine	5	0.5l engine, 3m wide trench.	10
	Cable Drum Trailer	5	Standard cable drum – wooden construction.	10
	HV Test Equipment Truck	5	Standard test equipment truck.	10
	Generators	4	500kv generators to be used at site compound	24
	Mobile Crane	1	10l engine	10
	Excavator	2	12l engine	10
	Flat Bed Truck	2	6l engine	10
	Dump Truck	2	10.5l engine – 32t capacity	10
	Site Operation	4WD Utility vehicles	10	General site management vehicles
Flat Bed Truck		1	General delivery and maintenance vehicle	1
Tanker		5	3.8l engine	1
Waste Truck		5	3.8l engine	1
Cleaning Truck		4	5l engine	10
Decommissioning	Telescopic 4WD Forklift	10	7l engine	10
	Flat Bed Truck	10	6l engine	10
	Hand Operated Tools	100	Drills, power tools etc.	10
	Flat Bed Truck	10	6l engine	10
	Pneumatic Drills and Jackhammers	50	Hand operated	10
	Excavator	10	12l engine	10
	Dump Trucks	50	11.2l engine – for moving spoil material off site.	10

4.8.7 Waste Generation

The estimated wastes anticipated to be generated during the approximately 20 month construction period for each Phase of the Park are listed in Table 4-5.

Table 4-5 : Estimated Construction Wastes

Waste type	Source	Classification	Estimated Quantity (t)	Destination
Inert soils, sand, rocks	Spoil from grading activities and other inert rock materials requiring removal from site.	Inert	10	Stored on site and reinstated following decommissioning
Residual construction material e.g. brick, ceramics etc.	Residual materials from construction of construction compound, O&M buildings,	Non-haz	5	Class II Landfill
Scrap Metal	Off cuts from building construction	Non-haz	4	Class II Landfill
Scrap Metal	Off cuts from fencing	Non-haz	2	Class II Landfill/Recycling
Scrap Metal	Off cuts from panel foundations	Non-haz	2	Class II Landfill/Recycling

Waste type	Source	Classification	Estimated Quantity (t)	Destination
Solar Panels	Failed and broken solar panels	Haz	5	Manufacturer Reclaim
Excess Cables	Power Transmission Cables	Non-Haz	5	Class Landfill/Recycling II
Plastic Bottles, cans, food waste, paper etc.	Site office & Canteen waste	Non-haz	1,672	Class Landfill/Recycling II
Paper, Cardboard & Plastic Packaging	Materials packaging	Non-haz		Class Landfill/Recycling II
Waste Electrical & Electronic Equipment	Residual materials from installation of electrical equipment	Haz	0.05	Recovery/Class I Landfill
Residual construction material e.g. plaster & cement	Residual materials from construction of compounds	Haz	3	Class I Landfill
Oil contaminated wastes	Construction vehicle maintenance	Haz (liquid)	1	Recovery/Class I Landfill
Asphalt	Site access road	Haz	10	Class I Landfill
Paint, thinners, contaminated painting equipment, solvents etc.	Residual materials from construction of compounds.	Haz (liquid)	0.1	Class I Landfill
Total Non-Hazardous Solid Waste			18 t	
Total Hazardous Solid Waste			19.5 t (inclu. solar panels)	
Total Hazardous Liquid Waste			1 t	

The waste receiving site to the project site is located approximately 33km to the west of the Park. The site is owned by the Ministry of Municipal and Rural Affairs and operated by Saraya Al Jazera Contracting Company. The landfill serves Sakaka and the neighboring villages and is comprised of two areas. The first area is currently in operation and covers an area of 2,000,000m² and only 2% of capacity has been utilized. The second area covers an area of 750,000m² and has 100% capacity available (i.e. it has not yet been put into operation).

The facility receives municipals waste, construction waste, green waste (e.g. tree cuttings etc.) and liquid waste from abattoirs. Daily, the facility receives approximately 450 tons of municipal waste, 180 tons of solid waste including construction waste and debris. No waste segregation or recycling is undertaken.

The landfill is not engineered and waste is placed within designated cells (100m x 25m) to a height of 1m and then covered with 0.3m of sand. This layer is then compacted using a bull dozer. Subsequent layers are filled on top of each other in the same manner until approximately 6-8 layers have bene compacted.

Liquid waste from the abattoir is put into a 4m deep pit with sodium hydroxide and then buried with sand to prevent odors.

Based on the data provided by the Ministry of Municipal and Rural Affairs there is capacity within this facility to receive construction waste from the project.

4.9 Operation Phase

4.9.1 Operation Phase Activities

Operational activities will be limited to routine monitoring and maintenance of the solar modules and infrastructure, and regular cleaning of the solar panels. There are no other significant operational activities.

4.9.2 Operation Utilities

4.9.2.1 Water

The estimated water requirement of the operations workforce is based on an average per person per day water usage of 0.325m^3 , based on Saudi Aramco Engineering Standard SAES-A-104. The operation construction workforce for the Park is expected to reach 300 persons, and therefore, the daily water requirement for the construction camp is expected to be approximately 97.5m^3 per day. It is assumed that water supplies to the site will be via the municipal supply which runs parallel to Road 80.

Potable water will be supplied by tanker for use by personnel at the operation phase. It is estimated that 3 liters /person/day of potable water will be required. As such an average of 0.9m^3 of potable water per day will be required during the construction period and will be supplied by water tanker.

The Park will employ waterless cleaning technologies to keep the panels free of dust and fouling and, maintain optimal operational efficiency. Water will be needed for spot cleaning only. This water will be supplied from the water municipal supply which runs parallel to Road 80.

4.9.2.2 Power

An SEC collector sub-station shall be built by SEC as outlined in the Memorandum of Understanding between Saudi Aramco and SEC. The SEC collector sub-station shall provide the required auxiliary supply for power plant energy consumption. The location of the SEC collector sub-station will be identified during the next phase of development, but it will preferably be located in close proximity to the 33kV HV switching station.

A backup diesel generator will be installed to provide power in case of network failure. A diesel fuel tank will be installed to store diesel fuel for the generator.

4.9.2.3 Vehicle Refueling and Fuel Storage

It is not anticipated that there is any requirement for on-site vehicle refueling facilities, including the storage of fuel. The vehicles on site will primarily be road vehicles and these will be filled from local service stations.

4.9.2.4 Sanitary Waste

Sanitary waste is expected to be generated at a rate of 0.325m^3 per person per day as defined in Table 4 of the Saudi Aramco Engineering Standard SAES-A-104. It is anticipated therefore that 97.5m^3 of sanitary waste will be generated on site each day.

Sanitary waste will be stored in underground tanks in designated storage areas and disposed of through a closed system. Detailed design of these storage areas and this system will be undertaken during the next phase of the development and will be compliant with IFC EHS Guidelines 1.3 Wastewater and Ambient Water Quality.

4.9.2.5 Traffic and Logistics

It is anticipated that ten four-wheel drive vehicles will be utilized at the development site, to transport the on-site staff around the site as they perform general management and operational duties.

Maintenance vehicles will visit the site to perform general monitoring and maintenance activities such as the removal of expired solar panels, and the delivery of new panels where required. These vehicles are anticipated to be flatbed trucks or similar and are expected to visit on average once per day.

Sanitary waste will be emptied daily by vacuum trucks. Domestic waste including office consumables and other non-sanitary waste will be removed daily using standard capacity waste trucks.

Details of vehicle rotations will be confirmed during the next phase of development.

4.9.2.6 Waste Generation

Solid waste includes office consumables and other general waste. It is anticipated that this waste will be generated at a rate of 1.1kg per person per day as indicated in World Bank guidance (World Bank 2014). This would result in a total of 330kg of waste being generated at the development site each day. The waste management facility owned by the Ministry of Municipal and Rural Affairs has capacity to receive this waste.

Decommissioned and expired solar panels will be stored on site in the operations and maintenance building until such time that sufficient quantity exists to merit a bulk reclaim by the supplier. It is estimated that approximately 5% of the total number of tables would experience irreparable failure each year and this quantity would therefore constitute approximately 1600 tables.

4.9.2.7 Telecommunications

Temporary telecommunication facilities will be installed at the development site office. A temporary extension of telephone connection from the existing telecommunication facility including Telephone sets and associated cabling shall be installed. Due to the infrequent use expected of this system, no impact upon existing infrastructure is expected during either the construction or operation phase.

4.10 Ongoing Design Optimization

During the next phase of the development, there will be a requirement to refine materials and equipment utilized in the construction of the Park in order to integrate the principles of cleaner production as specified in IFC Performance Standard 3 which require the investigation of financially feasible options for all resources.

The objective of this requirement is to promote the conservation of resources and the minimization of impacts associated with construction of infrastructure. During the detailed design phase of the Park, continuous improvement in design should be pursued in order to ensure that energy and resource efficiencies are identified and integrated into the design of the Park wherever possible.

4.11 Assumptions

The assumptions shown in Table 4-6 have been made in the assessment of the Park.

Table 4-6: Assumptions

Reference	Project Element (Phase)	Assumption
1	Solar PV technology	Solar PV Modules of Poly Crystalline technology from Jinko Solar (Model: JKM320P) (Tractebel 2016, Solar Resource and Energy Yield Assessment).
2	Solar PV technology	Solar PV modules installed on galvanized steel frame - maximum height above ground 3.4m (Tractebel 2016, Solar Resource and Energy Yield Assessment).
3	Construction Workforce	2,500 construction staff per Phase of the Park. Construction staff to be accommodated on-site.
4	Phasing	Each phase of construction is 20 months. Each Phase of construction will not overlap with others. Total installation period of Park (i.e. 4 Phases) will be 10 years.
5	Power supply during construction.	6 x 500 kV diesel generators will be used to provide power during construction phase (20 months). Assume 4 in operation and 2 on stand-by, 24hrs operation. Assume that these will be placed at distance to the worker accommodation to avoid potential impacts of noise and air quality.
6	Drinking Water (Construction)	Drinking water is brought to site by tanker - on-site storage tank (above-ground). Assume local supplies are adequate.
7	Wastewater generation (Construction)	Assume 0.325m ³ per person per day
8	Wastewater collection (Construction)	Septic tank is emptied by suction tanker. Assume local wastewater treatment infrastructure is adequate.
9	Fuel for vehicles (Construction)	Diesel fuel for construction plant and generators is brought to site by tanker - on-site storage tank (above-ground)
10	Solid Waste generation (Construction)	1.1kg per person per day. Assume local waste management infrastructure is adequate.
11	Concrete supply (Construction)	Local supplies are adequate to meet project needs - no concrete batching plant on site
12	Delivery of solar PV modules	Total 2,908,800 modules; 30 modules per pallet, 46 pallets per HGV - therefore 2157 HGV deliveries for solar PV modules
13	Delivery of solar PV mounting structures.	538 HGV deliveries for solar PV mounting structures.

Reference	Project Element (Phase)	Assumption
14	Concrete deliveries for concrete plinths for buildings(Temporary Buildings)	14 HGV deliveries.
15	Ash crete block deliveries for buildings (Operational Buildings)	14 Deliveries (total of 301 pallets)
16	Road construction deliveries	10,041 HGV deliveries.
17	Road construction deliveries	61 concrete mixer deliveries.
18	Solar PV Installation	Installation of solar PV modules will be by hand using hand-tools.
19	Cleaning of solar PV modules	Waterless cleaning technologies will be utilized, with only spot cleaning with water required.
20	Operation workforce	75 permanent staff per Phase of the Park. In total, 300 permanent staff. Staff not to be accommodated on-site but in nearby towns.
21	Sanitation(Operation)	A septic tank will collect sanitary wastewater - and this will be collected by suction tanker and taken to local wastewater treatment facility for disposal. Assume local wastewater treatment infrastructure is adequate.
22	Power (Operation)	Connection to grid - SEC adequate supply to meet demand. There will also be a back-up diesel generator.
23	Solar Panel Packaging Waste	Assumed that packaging waste will be generated as a quantity equal to roughly 30% of the total volume of panels.
24	Solid Waste generation (Operation)	1.1kg per person per day. Assume local waste management infrastructure is adequate.

5. Impact Assessment Methodology

5.1 Introduction

This chapter presents an overview of the methodology to be applied to the assessment of potential environmental and social impacts arising from the proposed construction, operation and decommissioning phases of the Sakaka solar energy park.

The impact assessment criteria outlined in the following sub-sections will be applied to the assessment of each of the proposed project elements during the construction, operation and decommissioning phases of the development. Where specific methods of assessment are to be applied and which deviate from the approach described in this section, these will be presented in the relevant sections of the ESIA. For ease of referencing, a unique identification code (ID) is used to refer to each impact. For instance, impacts associated with Air Quality are coded as AQ1, AQ2, etc.

The technical scope of this Environmental and Social Impact Assessment (ESIA) is comprised of four stages, which are listed below:

- Description of the environmental baseline, including identification of potential receptors and their sensitivity to change
- Prediction of environmental impacts, characterization of environmental impacts and the assessment of likely magnitude of change upon receptors
- Assessment of impact significance
- Environmental mitigation, compensation and enhancement

In the Kingdom of Saudi Arabia, key principles provided by GERRI (2001) provide a basis for assessing environmental impacts. The GERRI Key Principles are as follows:

- Nature and magnitude of the intended activity and the existence of similar projects at the site or similar sites.
- Extent of depletion by the installation of the natural resources, particularly agricultural lands and mineral resources.
- Location of the installation and the nature of the surrounding environment and nearby residential clusters.
- Type of power used.

The approach to the assessment of environmental impact will fully consider the criteria of the GAME and Saudi Aramco's Engineering Procedure for Project Environmental Impact Assessments (SAEP-13), in addition the requirements of the lending bodies (i.e. World Bank and IFC).

5.2 Establishment of Baseline Conditions and Receptor Identification

The environmental baseline on which the assessment of impact will be undertaken will be established using desk based studies, literature reviews and reviews of current reports, field visits and analysis of monitoring data.

Site visits were carried out by qualified Environmental Engineers between the dates shown below:

- 22nd September 2016 – 10th November 2016.
- 20th November 2016 – 24th November 2016.
- 10th December 2016 - 15th December 2016.
- 10th January 2017 – 26th January 2017.

The commencement of stakeholder of stakeholder engagement has been delayed and had not been undertaken prior to the publication of this ESIA. Stakeholder consultation will be addressed by way of an addendum to this ESIA.

An initial evaluation of sensitivity of baseline environmental aspects will be determined using the findings of the literature review and field work, and the professional experience of Jacob's environmental impact evaluators. The general definitions of sensitivity that have been used are described in Table 5-1 below.

Table 5-1: Sensitivity of receptors

Sensitivity of Receptor	Description
High	An unmodified natural environment with high levels of healthy life that may include 'protected areas' (or be of an equivalent standard to such areas) or 'protected species'. Areas where humans exist for extended periods in particular vulnerable groups. Examples include residences, schools, hospitals and places of worship.
Moderate	A natural environment subject to some adverse impacts from human or natural causes but still with high levels of healthy life. Although a valuable environment, it is not classed as a protected area. Areas where humans exist for lesser periods including commercial and leisure areas. Places of work are also considered moderate as it is assumed that those at work are not the vulnerable (old, young, infirm).
Low	A natural environment which has already been substantially affected in some form by either human influences or natural events. Ecological life is sparse or impacted by various pressures. Areas that humans exist transiently such as large roads.
Negligible	Heavily impacted natural environment and/or low species presence & diversity. Areas that have little human activity.

5.3 Prediction of Environmental Impacts

Environmental impacts are the changes to baseline conditions which occur as a direct result of the development. The assessment of impact accounts for natural change that might reasonably be predicted in the absence of the development ("the do-nothing alternative").

Predicting the effects of a development is a fundamental stage in ESIA, which allows the significance of impacts to be determined.

The predicted environmental and social impacts of the development will be characterized using the criteria in Table 5-2 in order to ensure objectivity in the assessment process.

Table 5-2: Impact Characterization

Category	Terminology	Definition
Type of Impact		
Impact	Positive	Beneficial Impact
	Negative	Adverse impact
Action	Direct	Impact caused solely by activities within scope of project.
	Indirect	Impact which does not result directly from activities within the scope of the project, but which has a connection with the project.
Probability of Impact		
Likelihood	Certain	Impact possibility estimated to be 100%
	Likely	Impact possibility estimated as between 50% and 99%
	Unlikely	Impact possibility estimated as < 50%
	No impact	Zero estimated possibility of impact
Frequency	Continuous	Uninterrupted or on a daily basis
	Frequent	Once or more per day
	Infrequent	Less than once per day
	Rare	Single event / less than once per year
Consequence of Impact		
Duration	Short	Less than the life of project
	Medium	The life of the project
	Long	Greater than the life of project
Extent	Local	Within 2 km of the Project Site boundary
	Provincial	Outside the Project Site boundary, but <20 km away
	Regional	Outside the Project Site boundary, but < 200 km away
	National	Within KSA
	International	Outside KSA
Permanence	Reversible	Impact is not permanent and change is reversible
	Irreversible	Impact is permanent and cannot be reversed

Considering the above criteria, magnitude of change can be described in absolute terms. The general criteria used for describing impact magnitude are included in Table 5-3. The application of these criteria enables the type, probability and consequence of each predicted impact to be described and categorized.

Table 5-3: Magnitude of Impact

Impact Magnitude	Description
High	An accepted limit or standard may be exceeded or significant or permanent degradation/adverse alteration to resource/receptor.
Moderate	An effect within accepted limits and standards. Moderate degradation/ adverse alteration to resource/receptor. Moderate impacts may cover a broad range, from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit.

Impact Magnitude	Description
Low	An effect will be experienced, but the magnitude is small and well within accepted standards. Minor degradation/ adverse alteration to resources/receptor.
Negligible	A resource or receptor will not be affected in any way by a particular activity or the predicted effect is deemed to be 'negligible' or indistinguishable from natural background variations

The significance of the predicted environmental impact takes account of the sensitivity or the importance of the baseline aspect subject to change, and the type, probability and the consequence of the impact and the magnitude of the potential impact.

A table can be prepared; combining information on the sensitivity of the receptor with the information about the magnitude of impact. Combining the two sets of analysis, from Table 5-2 and Table 5-3, enables a simple matrix of significance to be compiled, as shown in Table 5-4. The definitions of significance are given in Table 5-5.

Table 5-4: Significance of Impact

Magnitude	Sensitivity			
	High	Moderate	Low	Negligible
High	High	High	Moderate	Negligible
Moderate	High	Moderate	Low	Negligible
Low	Moderate	Low	Low	Negligible
Negligible	Low	Negligible	Negligible	Negligible

Table 5-5: Definition of Significance

Significance	Description
High	Any high magnitude impact that is certain or likely to occur and of medium or long duration, and regional in extent.
Moderate	Any moderate magnitude impact that is certain or likely to occur and of medium or long duration. Also any high magnitude impact that is unlikely to occur of short duration or local in extent.
Low	Any low magnitude impact or medium magnitude impact that is unlikely to occur or is of short duration.

5.4 Impact Assessment Reporting

The findings of the assessment process for each environmental aspect will be presented as indicated in Table 5-6. The ID codes assigned to each impact are used to reference the impacts and associated mitigation measures throughout the chapters of the ESIA.

Table 5-6: Example of Impact Assessment Summaries

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
AQ1	Faculty, staff and students	High	Potential dust inhalation/ nuisance resulting from construction activities.	Effect: Negative Action: Direct Likelihood: Likely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Moderate

5.5 Mitigation Measures and Reporting

5.5.1 Approach to Mitigation

The environmental assessment process requires the ESIA to recommend measures in order to avoid, reduce and remedy significant adverse environmental impacts. Development impacts which are identified as being of moderate to high significance are assessed against appropriate mitigation measures, to predict the residual impact significance. An example of the table used to report the mitigation identified for impacts of moderate to high significance is shown in Table 5-7.

Table 5-7: Example of Impact and Mitigation Summaries

ID	Potential Significance	Mitigation Measures	Residual Significance

Mitigation measures and recommendations identified in this ESIA report to manage potential impacts can be categorized as:

- Primary: Measures to be taken to manage potential impacts considered to be of moderate or high significance. Following the application of these measures, residual impacts are expected to be lowered
- Secondary: Recommended measures that could be taken to manage impacts classified as low/insignificant. These measures can be considered as good management practices

The approach to mitigation will adopt the mitigation hierarchy whereby priority will be given to avoiding / preventing adverse effects and then minimization of impacts through the identification of appropriate abatement / mitigation measures. For impacts which cannot be adequately mitigated, restoration or reinstatement might be required to address temporary construction effects. In the cases of the permanent loss of a feature, compensation might be required. The mitigation hierarchy is illustrated in Figure 5-1 : Mitigation Hierarchy.

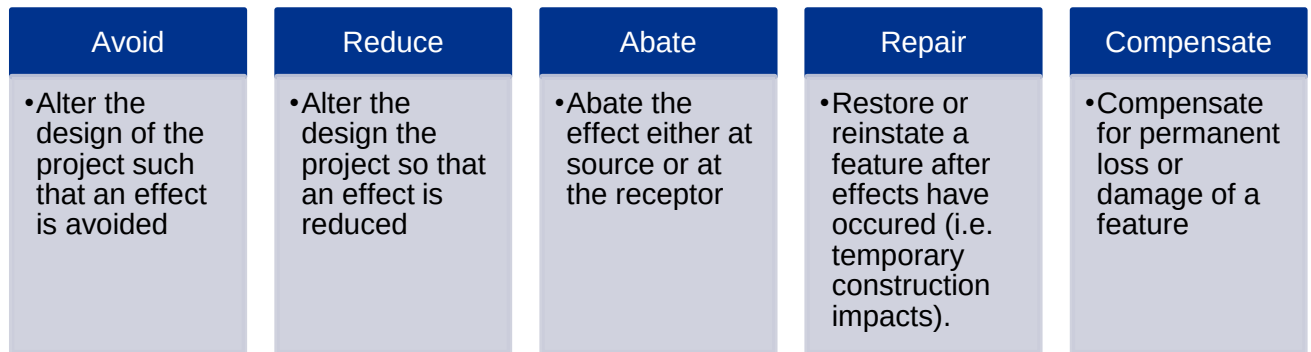


Figure 5-1 : Mitigation Hierarchy

5.6 Conclusion

The methodology applied to this EIA defines appropriate mitigation measures for expected impacts, giving preference to the avoidance of impacts. This is achieved initially through the examination and analysis of alternatives, design or operational processes, and then by outlining alternative ways identified for mitigating any predicted environmental and social impacts.

6. Meteorology, Climate & Air Quality

6.1 Introduction

This chapter presents a summary of the meteorological conditions and the existing ambient air quality in the vicinity of the Sakaka Solar Energy Park (referred to hereafter as the Park) and the prediction of potential air quality impacts resulting from the various stages of the development. The phases considered in this assessment include construction, operation, and de-commissioning.

6.2 International and National Standards and Guidance

This section presents a summary of the existing ambient air quality in the vicinity of the Sakaka Solar Energy Park (the Park), the prediction of potential air quality impacts and an assessment of the greenhouse gas (GHG) emissions resulting from the construction, operation and decommissioning phases of the Park.

There are six 500kW diesel fired generators proposed for the construction phase, although typically only four generators will operate simultaneously with the additional two generators for back-up. However, the generators to be used will comply with the emission standards set out in the GAME emission standards. The power rating for these generators falls below the threshold of the IFC EHS Guidelines for Small Combustion Facilities. Diesel fuel used for the generators will have a sulfur content less than 1.5%. In addition the location of the generators is proposed to be greater than 500m from the workers accommodation. An air quality assessment of emissions to air from the generators has been screened out and is not considered further in this assessment.

In addition, the operational phase of the Park does not have any significant diesel (or other fossil fuel) powered energy generating plant (such as boilers or generators) and only requires a low number of maintenance and staff vehicle movements. Therefore, there will be no significant emissions to air and an air quality assessment of emissions to air during the operational phase of the Park has been screened out and is not considered further in this assessment.

6.2.1 International and National Standards and Guidance

6.2.1.1 International Conventions

The relevant International Agreements and Conventions of potential significance to the Project are:

- 1985 Vienna Convention for the protection of the ozone layer, Vienna;
- 1987 Montreal Protocol on substances that deplete the ozone layer and its Amendments (1990 and 1992);
- 1991 The Arab Declaration on Environment and Development;
- 1992 Agenda 21 and the Rio Declaration on Environment and Development;
- 1992 UN Framework Convention on Climatic Change (UNFCCC), New York;
- 1997 Kyoto Protocol to the UN Framework Convention on Climate Change, Kyoto;
- 2005 Kyoto Protocol to the UN Framework Convention on Climate Change, ratified in 2005.
- 2016 Paris Agreement to the UN Framework Convention on Climate Change, ratified in 2016.

According to the Kingdom of Saudi Arabia's Intended Nationally Determined Contribution (INDC) under the United Nations Framework Convention on Climate Change (UNFCCC) Saudi Arabia is aiming to avoid up to 130 MtCO₂e by 2030 annually through contributions that have co-benefits in diversifying the economy and mitigate GHG emissions. Some of the plans to meet this target include improved energy efficiency, use of renewable energy, increase the use of gas and methane recovery and flare minimization (INDC, 2015).

6.2.1.2 IFC (World Bank Group) EHS Guidelines (2007)

The IFC guidelines (2007) establish ambient air quality limits and guidelines for projects with significant sources of air emissions and potential for significant impacts to ambient air quality. Projects with emissions should not result in pollutant concentrations that reach or exceed relevant ambient air quality guidelines and standards by applying national legislated standards, or in their absence, the current World Health Organization (WHO) Air Quality Guidelines. In this instance national legislated standards are those implemented by the General Authority for Meteorology and Environment. Furthermore, emissions should not contribute to a significant portion to the attainment of relevant ambient air quality guidelines or standards. As stated in the IFC EHS Guidelines, as a general rule, this Guidance suggests 25 percent of the applicable air quality standards to allow additional, future sustainable development in the same airshed (IFC, 2007).

The WHO ambient air quality guidelines are presented in Table 6-1.

Table 6-1 : WHO and National Ambient Air Quality Standards

Pollutant	Averaging Period	GAME ($\mu\text{g}/\text{Nm}^3$)	WHO ($\mu\text{g}/\text{m}^3$)
Sulfur Dioxide	10 Minute		500
	1 Hour	730	-
	24 Hour	365	20
	Annual	80	
Nitrogen Dioxide	1 Hour	660	200
	Annual	100	40
Particulate Matter PM ₁₀	24 Hour	340	50
	Annual	80	10
Particulate Matter PM _{2.5}	24 Hour	35	25
	Annual	15	10
Ozone	8 Hour	157	100
Carbon Monoxide	1 Hour	40,000	
	8 Hour	10,000	

The IFC EHS Guidelines include emission guidelines for small combustion facilities which are designed to deliver electrical or mechanical power, steam, heat or any combination of these, regardless of the fuel type, with a total rated heat input capacity of between three Megawatt thermal hours (MWth) and 50 MWth. The 500kW power rating of the diesel generators to be used during the construction phase of the project fall below the threshold of these IFC EHS Guidelines and are not applicable. The emission standards developed by GAME will apply to the project.

6.2.1.3 National Standards

The General Authority for Meteorology and Environment (GAME), formerly the PME, is the competent authority for environmental regulation in Saudi Arabia and is responsible for the general regulatory framework for the development and enforcement of environmental rules and regulations. Appendix 1 of the GAME's General Environmental Regulations and Rules for Implementation 2001 (GERRI, 2001) outline the environmental protection standards relevant to facilities in the Kingdom of Saudi Arabia (EPSD-2001).

Ambient Air Quality

In 2012, the former PME developed a number of guidance environmental standards revising those enacted under GERRI in 2001. The ambient air quality standards for the Kingdom of Saudi Arabia are presented in Table 6-1. In accordance with the IFC EHS Guidelines (2007), local atmospheric and climatic conditions should be applied when considering air quality standards and guidelines. The standards for particulate matter for the Kingdom of Saudi Arabia have been tailored to reflect the regional context and naturally high levels of particulate matter, and accordingly are higher than the WHO standards. Whilst the WHO standard for PM₁₀ is listed for reference, its achievement is unlikely.

Air Quality Standards for Emissions from Stationary Sources

Emission standards for emissions from stationary sources have been developed by GAME. These standards introduce emission limits for individual facilities, and assist in the protection of the Kingdom's public health, occupational health and natural ecosystems, including cropland, forest, desert and wetlands whilst allowing economic and social development (GAME, 2012). The standards obligate operators to apply effective process controls or best available pollution abatement techniques to meet emission limit criteria.

The standards cover industrial facilities and emission standards for toxic, organic, carcinogenic, inorganic and volatile organic carbons are included. However those which are relevant to the project are presented in Table 6-2.

Table 6-2 : Emission Limit Values for Emissions to Air from Stationary Sources

Pollutant	Emission Limit Values (µg/Nm ³)		Threshold (g/hr.)	Comment
	(A) Normal	(B) Degraded Airshed		
Particulate Matter PM ₁₀	150	100	500	Above background levels
Particulate Matter PM _{2.5}	50	25	100	Above background levels
SO _x	600	400	1000	
NO _x	500	350	1000	

As per the standard, in all circumstances point source air emissions from any facility must not contain substances in concentrations that exceed the Normal Limit Values as set out in Table 6-2. If a facility is within a degraded airshed the competent agency has the power to enforce all or some of Degraded Airshed Emission Limits. These emission limit values are based on what is technologically feasible to achieve while not incurring excessive costs.

Air Quality Standards for Emissions from Mobile Sources

Emission standards for emissions from mobile sources have similarly been developed by GAME. The objective of this standard is to set the framework and activities required to enable sustainable management of mobile source emissions within the Kingdom of Saudi Arabia (GAME, 2012).

The standard introduces emission limits for individual pieces of equipment used outdoors and aims to protect, maintain and improve the Kingdom's quality of life, human health, occupational health and natural ecosystems including croplands, forests and deserts whilst maintaining appropriate economic and social development (GAME, 2012).

This standard refers to air emissions from non-road engines, equipment and vehicles. This includes sources such as mobile generators and large earth-moving equipment (Table 6-3 and Table 6-4). This standard does not include emissions from road vehicles (GAME, 2012).

Table 6-3 : Non-Road Petrol (Compression Ignition) Engines

Rated Power	CO (g/kW-hr)	HC (g/kW-hr)	NOx (g/kW-hr)	PM (g/kW-hr)	Smoke (%)
50≤ hp ≤100	n/a	n/a	9.25 (ABT)	n/a	20/15/50
100≤ hp ≤175	n/a	n/a	9.25 (ABT)	n/a	20/15/50
175≤ hp ≤750	11.4	1.34	9.25 (ABT)	0.54	20/15/50
hp = 750+	11.4	1.34	9.25 (ABT)	0.54	20/15/50

Table 6-4 : Non-Road Diesel (Spark Ignition Engines)

Rated Power	CO (g/kW-hr)	HC (g/kW-hr)	NOx (g/kW-hr)	HC + NOx (g/kW-hr)
<225cc (non-handheld)	518.97	n/a	n/a	n/a
≥225cc (non-handheld)	518.97	n/a	n/a	n/a
<20cc (handheld)	804.6	295.02	5.36	0.54
≥20cc >50cc (handheld)	804.6	241.38	5.36	n/a
≥50cc (handheld)	603.45	160.92	5.36	n/a

6.2.2 Construction dust guidance

In the absence of guidance on construction dust impacts specific to the Kingdom of Saudi Arabia or the United States, the assessment of dust during construction has been carried out using a qualitative risk-based appraisal with reference to the sites location in relation to sensitive locations, the planned activities and site characteristics, as described by the UK specific Institute of Air Quality Management IAQM guidance³.

³ Institute of Air Quality Management (IAQM). 2014. *Guidance on the Assessment of Dust from Demolition and Construction*. London: Institute of Air Quality Management.

6.3 Baseline Conditions

6.3.1 Regional Meteorological Conditions

6.3.1.1 Overview

The GAME has confirmed the installation of a permanent meteorological station at Al Jouf airport. The meteorological data from this station was provided by the GAME and has been analyzed to characterize the meteorological conditions of the Sakaka Solar Energy Park. This data-set provides continuous meteorological records for almost 40 years (i.e. 1978 to 2016). This data has been supplemented with the 2016 analysis of site-specific meteorological conditions undertaken using a ground measurement station.

6.3.1.2 Temperature

There is a large seasonal variation in monthly mean temperatures throughout the year. Mean temperatures range from 9.8°C in the winter to 33.1°C in the summer. The data showed that Al Jouf's hottest months are June–August, and the coldest month is January. The monthly maximum, mean and minimum temperatures for 1978 to 2016 are provided in Figure 6-1. The extreme minimum temperature recorded in Al Jouf was logged in January 1989 (i.e. -7°C) and the extreme maximum temperature recorded was logged in August 2016 (i.e. 47.2°C).

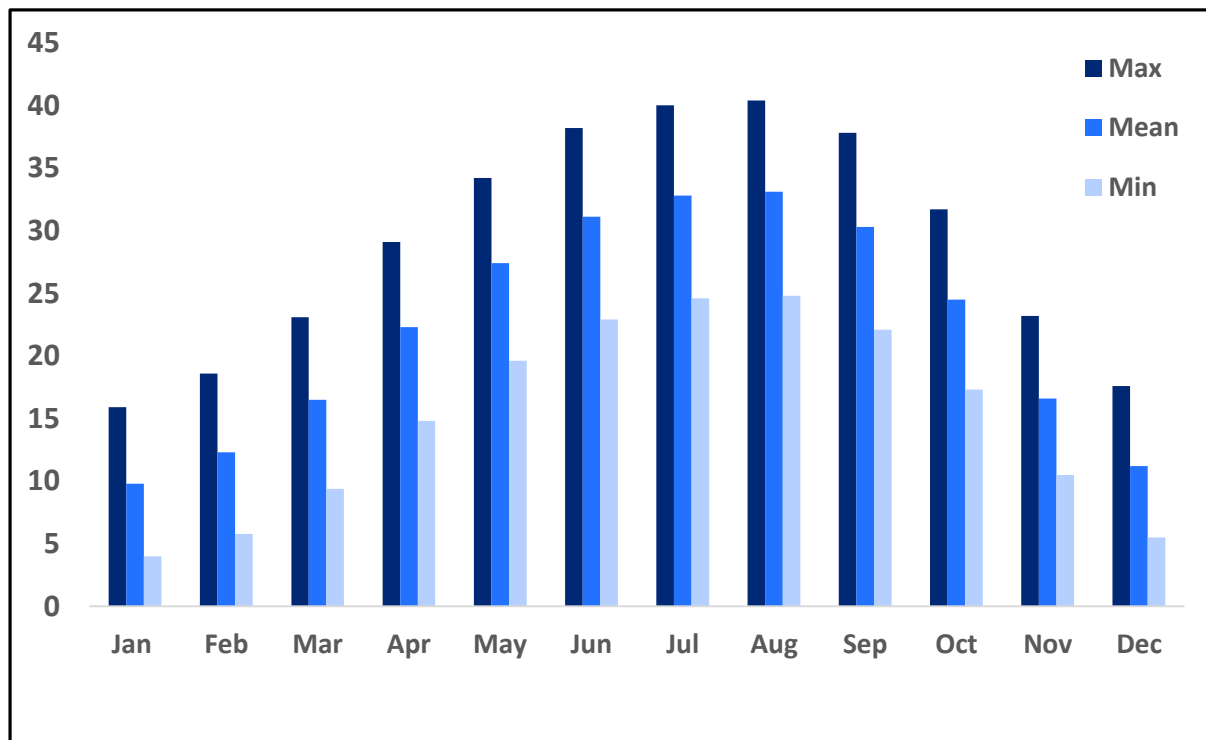


Figure 6-1: Monthly Temperature for Al Jouf from 1978 to 2016 (°C)

6.3.1.3 Humidity

The monthly maximum, mean and minimum humidity data collected at Al Jouf airport meteorological station over the period 1978 to 2016 are shown in Figure 6-2.

The data shows a large seasonal variation in monthly mean humidity throughout the year. Mean humidity ranges from 16% in the summer (i.e. June and July) to 55% in the winter (i.e. December and January).

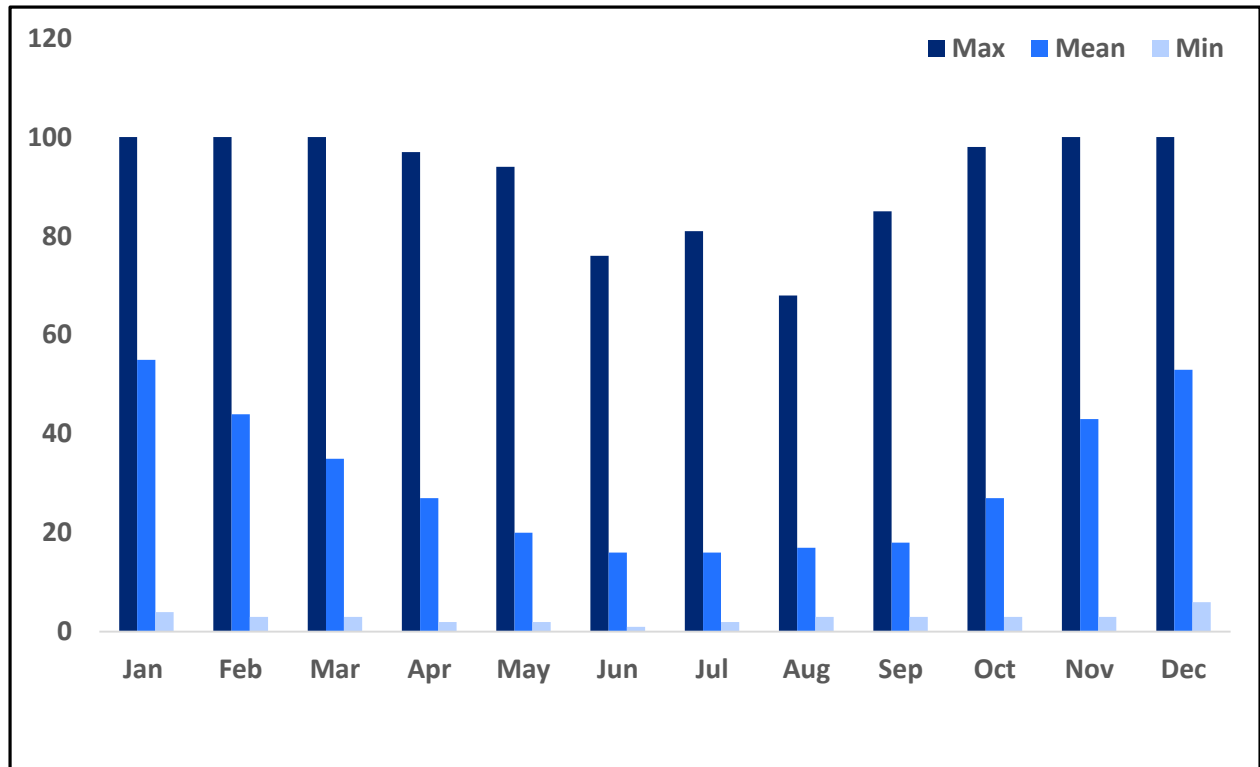


Figure 6-2: Monthly Humidity for Al Jouf from 1978 to 2016 (%)

6.3.1.4 Precipitation

Figure 6-3 shows that the monthly mean precipitation for Al Jouf over the monitoring period (i.e. 1978-2016) is 0-0.4mm in summer and 6.3–10.5mm in winter. There is almost no precipitation in the months from May to August. The highest total precipitation value of 10.5mm was recorded in January 2002.

There is significant variation between the monthly mean values of precipitation and the monthly extreme events. The most significant event occurred in November 2003 when 63.5mm of rain fell.

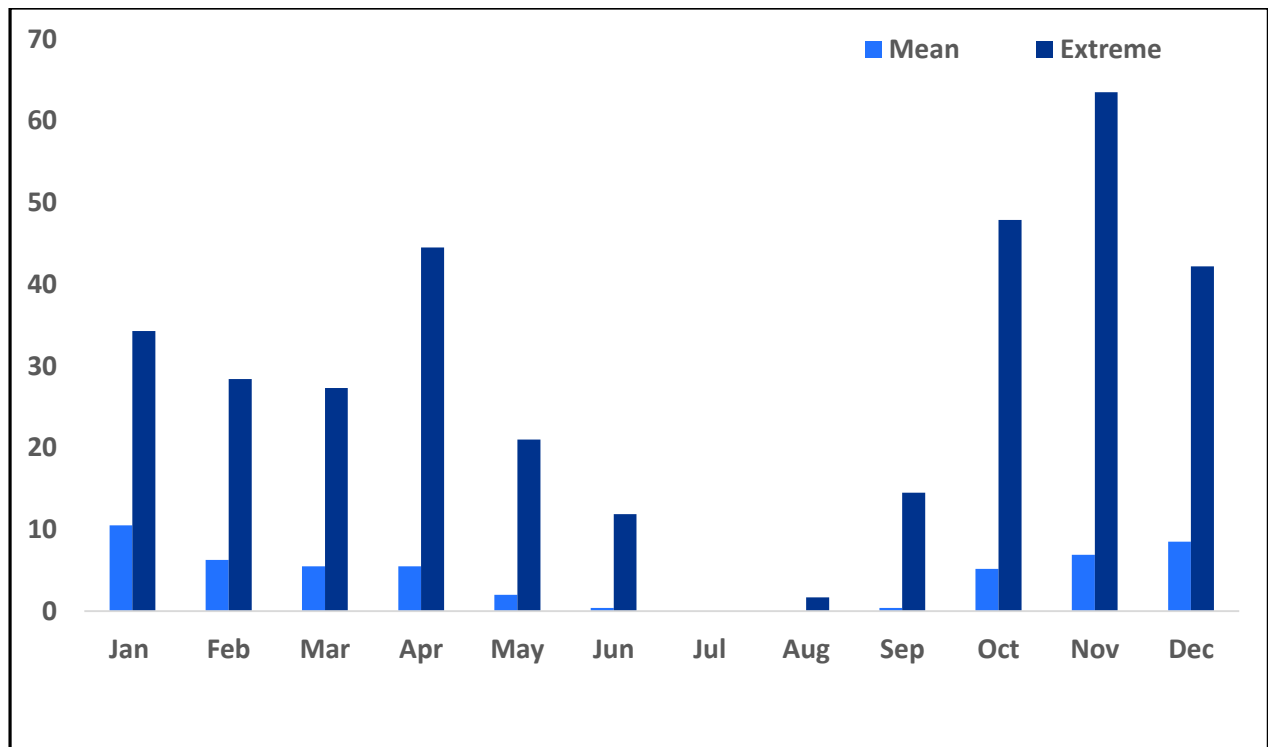


Figure 6-3: Monthly Mean & Extreme Precipitation for Al-Jouf from 1978 to 2016 (mm)

6.3.1.5 Wind

Saudi Arabia's winds are highly complex and variable due to a combination of effects from large scale (synoptic) flows, high terrain, hot sandy deserts, and large, irregularly shaped water bodies. The three prevailing winds over the Arabian Gulf are the winter and summer Shamal ('north') winds, Kous ('south-east') winds, and sea breezes. The Shamal and Kous are larger scale winds with effects felt over the whole Arabian Gulf.

In summer, the high temperatures over the Arabian Peninsula lead to the development of Tropical Continental air which forms part of the Monsoon low circulation centered over north-west India. During this period the very dry and intense convection raises vast quantities of dust into the lower atmosphere and gives rise to poor visibility and generally hazy conditions (Vincent, 2008).

Throughout the year, the mean monthly wind speed ranges between 6 and 9 knots and shows minimal variation. The maximum monthly wind speeds are typically recorded during the spring transitional months (i.e. 60 knots).

The meteorological data from Al Jouf airport meteorological station over the period 1978 to 2016 shows that the prevailing wind direction is westerly.

6.3.1.6 Dust Storms

Dust storms play a major part in the weather of Saudi Arabia and these events influence air quality in the Arabian Gulf region. Airborne impacts have recently been exacerbated due to grazing pressure and subsequent reduction in vegetation cover increasing wind erosion. Soil moisture, an inhibiting factor to dust production, is very low in the Arabian Gulf region. Therefore, soils are highly erodible, particularly during periods of higher wind speeds.

Key airborne dust particle ('particulate matter') indicators are:

- For the protection of human health, Particulate Matter 10 (PM10); and PM2.5. PM10 is the mass concentration of airborne particulate matter comprising a collection of particles with aerodynamic diameters less than 10 microns. Similarly, PM2.5 is the indicator for the collection of particles less than 2.5 microns in size.
- For the protection of amenity, Total Suspended Particulates (TSP) comprising particles up to sizes of approximately 30-50 microns; and simple dust deposition comprising particles of all sizes.
- In relation to construction activities, research undertaken in the USA suggests that 85% to 90% by weight of the fugitive dust emissions of PM10 from construction sites are PM2.5-10 and 10% to 15% are in the PM2.5 fraction (IAQM, 2011).

Dust storms are predominantly made up of suspended silt and dust particulates and generally originate on the northern side of the Arabian Gulf from the clay soils of Iran and the silty-clayey soils of Kuwait and Iraq (especially the Tigris and Euphrates River basins) (Goudie and Middleton, 2001). During dust transport, the largest particles in the dust storm (with the most mass) fall out of suspension earlier than smaller sized aerosols. Visibility is reduced to a few meters in severe dust storms with very high particulate concentration. Aeolian or wind transport may be facilitated in three ways:

- Suspension – small particles (silt, dust) suspended in air;
- Saltation – larger particles (sand particles) which are lifted and continuously dropped out of the air column, "hopping" along the land surface; and
- Surface creep – largest particles (pebble size) which are pushed along the ground, they may be transported by other saltation grains.

Dust source activity in the Arabian Gulf region is greatest during pre-monsoonal (spring) and monsoonal (summer) periods, typically when strong Shamal winds tend to blow. This corresponds with the long-term meteorological data-set provided by GAME for 1978 to 2016. The recorded days of blowing dust and dust storms occur with greatest frequency between February and May.

6.3.1.7 Thunder Storm

Most rainfall extremes are associated with intense thunderstorms. The data from Al Jouf airport meteorological station over the period 1978 to 2016 shows that thunderstorms occur most frequently in autumn and winter (i.e. October to March).

6.3.2 Local Meteorological Conditions

In depth analysis of solar irradiance and other climatic parameters such as ambient temperature, wind speed, relative humidity and precipitation is required for assessing the potential of a particular site for

electricity generation from solar energy. Weather data can be obtained from two modes: ground measured and satellite data. A reliable data source must be derived from the long term recorded data and represent the hourly value of solar irradiance and other weather parameters.

A ground measurement station is present adjacent to the development site, located approximately 100m north of the development site boundary. One year of weather data has been gathered and is available for this location, which has been extrapolated using Solar GIS and GeoModel and used for the purposes of the energy yield assessment.

Solar irradiance is a measure of the solar radiation hitting a surface and varies throughout the course of a day as well as seasonally. The lowest values are recorded at the extremities of the day which increases towards the middle of a clear sunny day with no cloud cover. Seasonal variations indicate that the highest values of irradiation are usually recorded in the summer.

Long term data is usually recorded as Global Horizontal Irradiance (GHI - the amount of solar energy that falls on 1 m² of horizontal area). Irradiance on the tilted surface can also be measured or calculated from the GHI. Different sources of satellite based data are NASA, Meteonorm, Solar GIS etc.

The available databases are as follows:

- NASA: The US National Aeronautics and Space Administration (NASA) based satellite measurements produce the general assessment of GHI and other weather parameters for any grid reference across the globe. The Surface Meteorology and Solar Energy (SMSE) dataset provides the satellite data of daily GHI (grid 10x10) for a 22 year period. The data is in the form of daily monthly average derived from 22 years of satellite data.
- METEONORM: Meteonorm is the weather data and modelling tool that provides approximately 20 years of data for GHI and other climatic parameters like ambient temperature, humidity, wind speed etc. The data is collected from ground based weather stations and supplemented with satellite data where there is a low density of ground weather stations. Meteonorm database also provides solar irradiation data for a particular coordinate through 3D interpolation between the nearest ground stations. Hourly values are calculated from the collected data using a stochastic model comprising interpolation.
- SolarGIS: SolarGIS is a high-resolution meteorological database comprising of weather parameters such as GHI and others. The hourly data is generated which has comparatively greater certainty when compared to other similar databases. The spatial resolution of the data is up to 90m x 90m and time resolution of 15/30 minutes derived from approximately 17 years of satellite data. Further, one year ground measurement data has been utilized for site adaptation of 17 year SolarGIS satellite data. Using this site-adapted time series and modelled meteorological data, long-term averages of solar resource and its inter-annual variability have been calculated and a Typical Meteorological Year (TMY) has been generated using the Sandia Method.

Saudi Aramco installed a solar measurement station on the development site in January of 2015 (Figure 6-4). The station measured monthly average Global Horizontal Irradiation (GHI), humidity, wind speed/direction at 10m, daily heat index (DHI) and temperature. The GHI and temperature data from the measurement station for 2015 is shown in Table 6-5.



Figure 6-4: Solar Measurement Station

Table 6-5: Monthly Average Sunlight Conditions at Project Site (2015)

Month	Global Horizontal Irradiation (GHI - kWh/m ²)	Temperature (°C)
January	113	8.8
February	131	11.1
March	187	15.4
April	206	21
May	232	26
June	248	29.29
July	251	30.9
August	230	31.2
September	196	27.5
October	156	22.79

Month	Global Horizontal Irradiation (GHI - kWh/m ²)	Temperature (°C)
November	116	14.8
December	103	9.9

6.3.2.1 Solar Energy

Monthly GHI data from different databases for the selected project location is presented in Table 6-6.

Table 6-6: Monthly GHI Data from Different Data Sources

Month	NASA	Site Adapted Solar GIS	Meteonorm 7
January	3.31	4.12	3.61
February	4.36	4.95	4.36
March	5.58	6.29	5.87
April	6.71	7.23	6.93
May	7.42	7.73	7.61
June	8.38	8.52	8.27
July	8.05	8.58	7.9
August	7.49	7.76	7.19
September	6.47	6.9	6.57
October	4.87	5.22	5.35
November	3.58	4.15	3.97
December	2.95	3.55	3.48
Average	5.77	6.25	5.93

The annual average daily GHI at the selected location from the selected data sources indicate a value of more than 5.7 kWh/m², which is considered suitable for the development of a solar PV Park.

Figure 6-5 shows a comparison of the total annual GHI for the Park, using the data described in section 6.3.2.

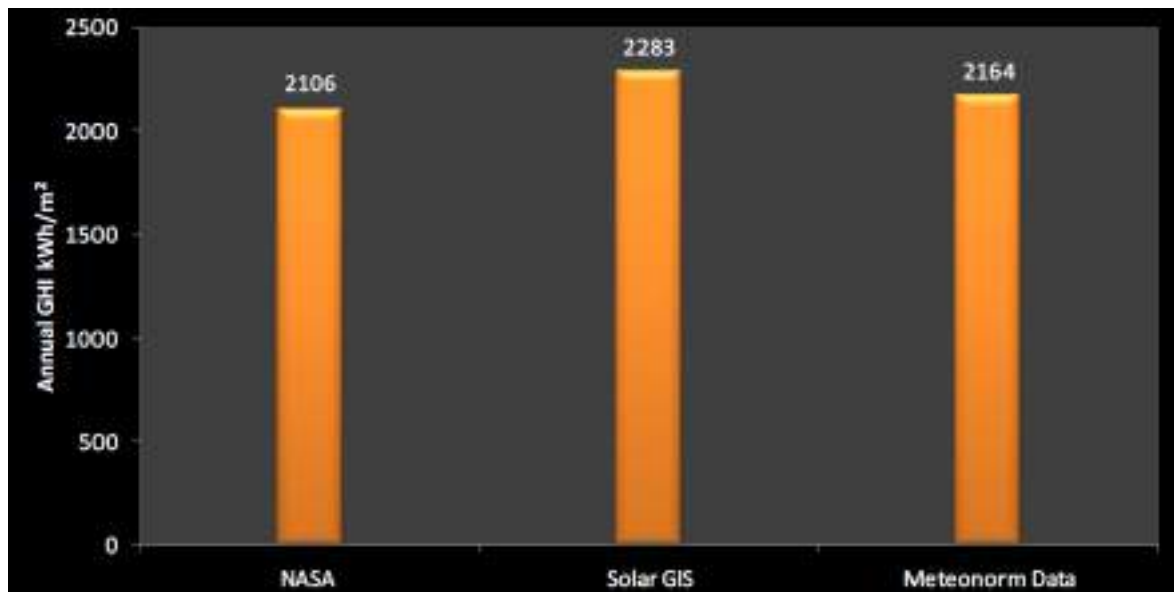


Figure 6-5: Annual GHI at the Development Site (Tractebel 2016)

An Independent Expert Survey (International Energy Agency, SHC Task 36 – Data cross-comparison) has identified SolarGIS as the best database commercially available, in terms of accuracy, reliability and data representativeness. Therefore, SolarGIS data has been used to calculate the energy yield estimation for the Park.

Figure 6-6 depicts the graphical representation of monthly variations of site adaptive SolarGIS generated GHI and DHI data for a 12 month period.

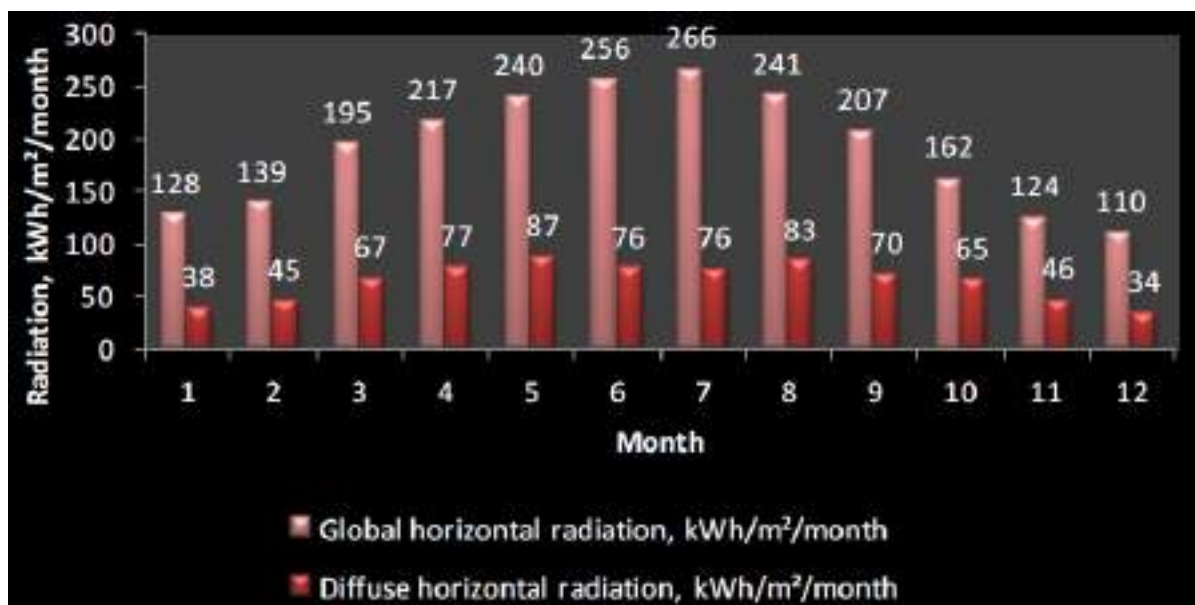


Figure 6-6: Monthly GHI and DHI at the Development Site (Tractebel 2016)

The pattern of GHI values increase between January and July reaching a peak value in July. After this point, the irradiance value decreases gradually till December.

The annual radiation data suggests that the current location is suitable for a solar energy park.

6.3.2.2 Site Temperature

The development site experiences extreme ambient temperature conditions. The minimum and maximum instantaneous temperatures observed at the development site were -4°C and 44.2°C respectively. The annual average ambient temperature is 20.8°C. Figure 6-7 shows the monthly average ambient temperature profile of the development site over a typical year.

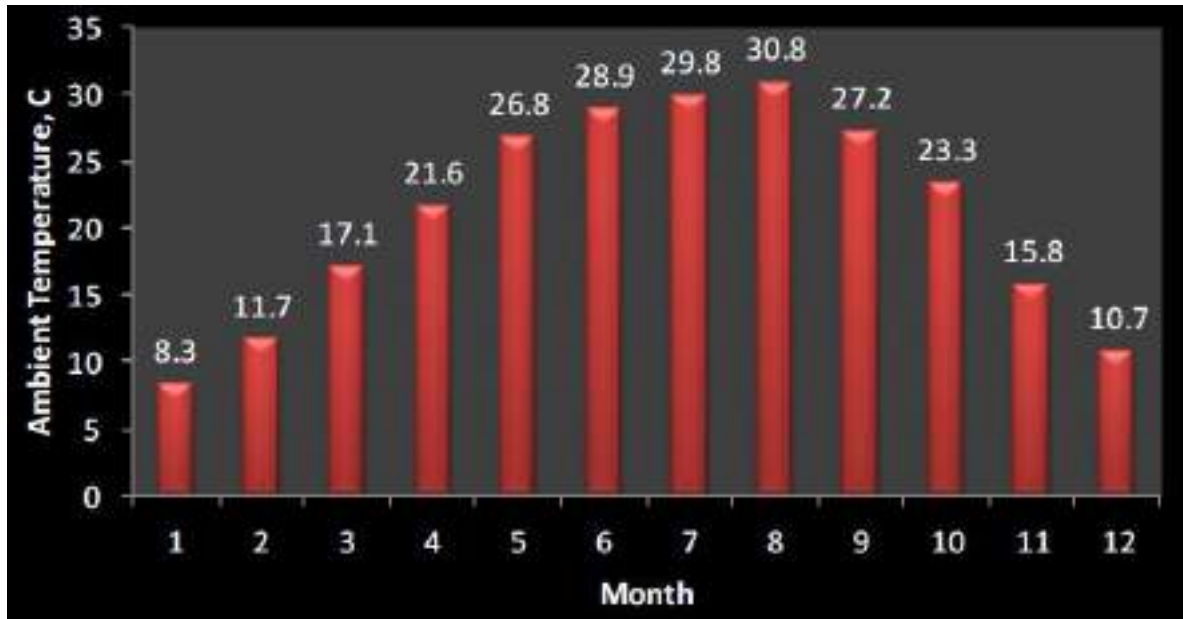


Figure 6-7: Ambient Temperature of the Project Location (Tractebel 2016)

6.3.2.3 Wind Speed

Wind speed at the development site is low. The minimum and maximum instantaneous wind speeds were observed as between 0.1 m/s and 11.9 m/s respectively. The annual average wind speed is 3m/s. Figure 6-8 shows the monthly average profile of prevailing wind speed at the development site location over a typical year.

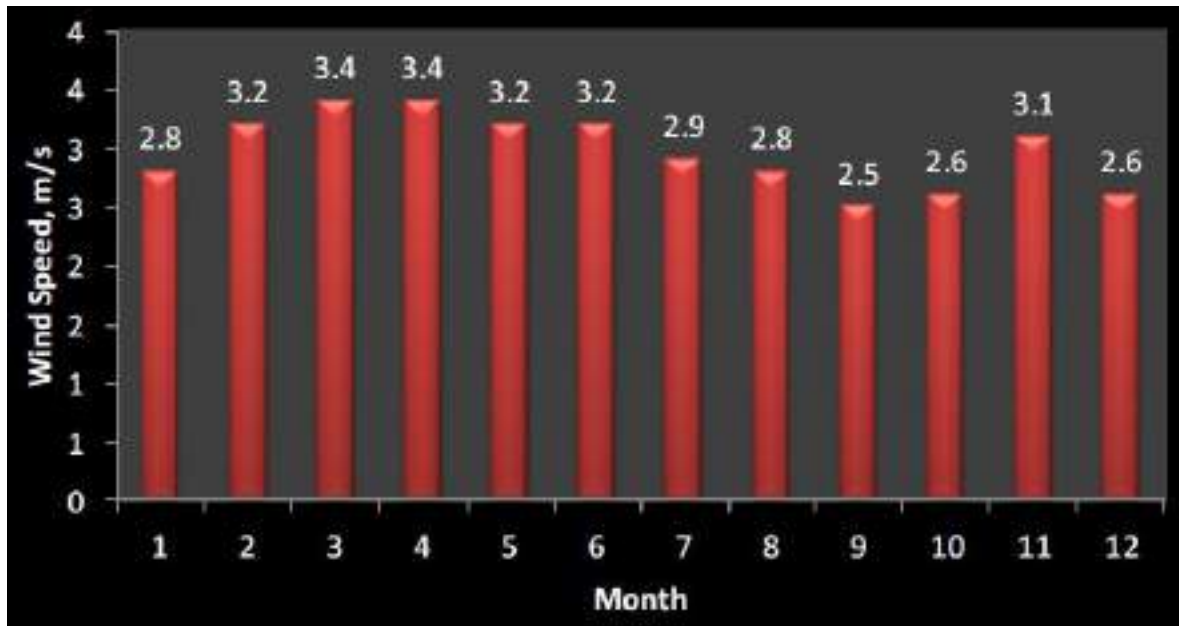


Figure 6-8: Average Monthly Prevailing Wind Speed at the Development Site (Tractebel 2016)

The maximum wind speed at a height of 10m is 11.9 m/s which will progressively reduce as the height reduces.

The prevailing wind direction at the development site is westerly (Saudi Aramco, 2016)

6.3.2.4 Relative Humidity

Relative humidity data was not available in the SolarGIS data provided for the development site. Hourly Meteorological data from the development site has been used. The annual average relative humidity is recorded as approximately 28%. Figure 6-9 presents the monthly average profile of Relative Humidity at the development site over a typical year.

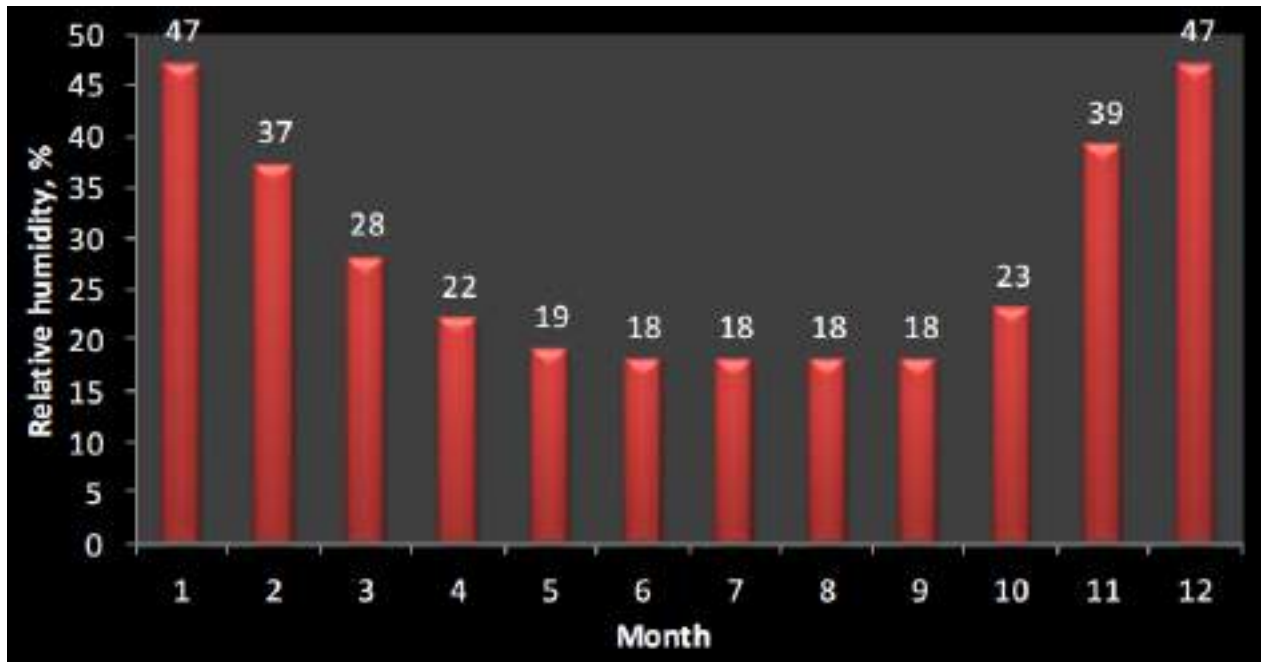


Figure 6-9: Relative Humidity at the Development Site Location (Tractebel 2016)

6.3.2.5 Rainfall

Rainfall data is not available in the provided Solar GIS data base. Meteonorm data has been used. The average annual rainfall was observed as approximately 23 mm. Figure 6-10 shows the monthly average profile of Rainfall at the development site over a typical year.

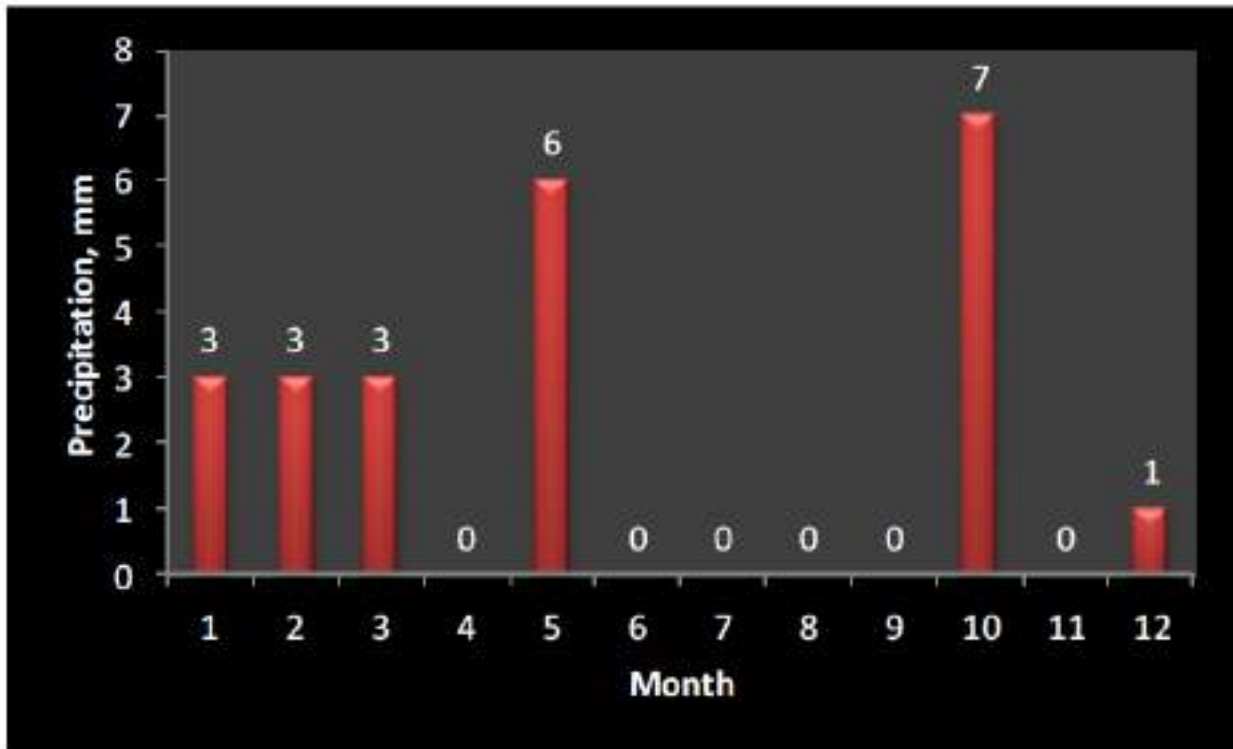


Figure 6-10: Average Annual Rainfall (Tractebel 2016)

6.3.3 Air Quality Baseline Environmental Conditions

6.3.3.1 Existing sources

There are no significant existing sources of point source emissions within the development site or immediately adjacent to the site boundary. The primary source of point source emissions in the vicinity of the development site is the Saudi Electricity Company (SEC) power plant, located approximately 8.5km to the north-west of the development site. This is an oil power plant with a design capacity of 175 MW. It has seven turbine generators, the first of which was commissioned in 1984. It is understood that crude oil and diesel oil are the fuel sources for the power plant. During visits to this site, visible emissions with high Sulphur content were observed emanating from the turbines during power generation.

6.3.3.2 Mobile Emission Sources

Mobile emission sources identified within the Study Area include highway traffic on Road 80 and air traffic from Al Jouf International Airport. Emissions at airports include: ground-based emissions from gasoline and diesel fuel for airport vehicles and ground support equipment (GSE); jet fuel for auxiliary power units (APUs) that power aircraft at airport gates; and other sources.

Petrol and diesel-engine motor vehicles emit a wide variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NO_x), volatile organic compounds (VOCs) and particulate matter (PM₁₀), which have an increasing impact on urban air quality. In addition, pollutants from these sources may not only prove a problem in the immediate vicinity of these sources, but can be transported long distances.

Airplanes emit particulates, carbon dioxide (CO₂), water vapor, hydrocarbons, carbon monoxide, nitrogen oxides, Sulphur oxides and black carbon. Photochemical reactions resulting from the action

of sunlight on nitrogen dioxide (NO₂) and VOCs, typically emitted from road vehicles, lead to the formation of ozone. Ozone is a secondary pollutant, which often impacts rural areas far from the original emission site as a result of long-range transport. Aviation is responsible for 12% of all CO₂ emissions from all transportation sources, compared to 74% for road transport.

6.3.3.3 Natural Sources

Due to high winds in the vicinity of the development site, wind-blown particulate matter is a significant source of air pollution. Saudi Aramco Engineering Standard 112, Meteorological and Seismic Design Data (SAES-112), contains information regarding the concentrations of dusts and particles.

“The mass of total suspended airborne particulate matter per unit volume of air. Usual airborne dust concentration is 1 mg/m³. During sandstorms, dust concentrations may reach 500 mg/m³. Particle sizes are as follows:

- 95% of all particles are less than 20 micrometers
- 50% of all particles are less than 1.5 micrometers

Elements present in dust include compounds of calcium, silicon, magnesium, aluminum, potassium, chlorides and sodium. When wetted (high humidity conditions) these compounds function as electrolytes and can result in severe corrosion.

Other pollutants present in the atmosphere under the most extreme conditions are:

- H₂S 20 ppm (vol/vol).
- Hydrocarbon 150 ppm (vol/vol).
- SO₂ 10 ppm (vol/vol).
- CO 100 ppm (vol/vol).
- NO_x 5 ppm (vol/vol).
- O₃ 1 ppm (vol/vol).”

6.3.3.4 Local climate conditions

Although not specifically required as part of the IAQM dust assessment method, analysis of the local climatic conditions was also undertaken to provide additional context to the risk assessment and assist in the determination of the sensitivity of the area.

Local climatic conditions, such as wind speed and precipitation (rainfall), will affect the probability of airborne dust occurring from potentially dusty activities or open areas and stockpiles; and can also affect the dispersion of dust in the air. The prevailing wind direction is a useful parameter to understand the likelihood of effects occurring at sensitive locations if dust is emitted or becomes airborne and how severe its effects could potentially be.

Saudi Aramco Environmental Standard 112 (SAES-A-112) contains regional meteorological data for Saudi Arabia. The nearest Saudi Aramco permanent meteorological station to the development site is located in Al Jouf. This meteorological station indicates that the predominant wind direction is westerly; wind speed at the development site is low. The minimum and maximum instantaneous wind speeds were observed as between 0.1 meters per second (m/s) and 11.9 m/s, respectively. The annual average wind speed is 3 m/s.

The assessment requires characterization of the existing conditions with regard to PM₁₀ concentrations to determine the sensitivity of the area. There are no local monitoring data available, so it is believed that the annual mean PM₁₀ concentration would be relatively low. However, during infrequent dust storms high concentrations of PM₁₀ are experienced for short periods of time.

A PM₁₀ concentration of greater than 16 micrograms per m³ (µg/m³) has been assumed and used in this assessment to represent the baseline conditions. This is based on factoring the IAQM guidance (IAQM, 2014) concentrations to take account of the difference between the UK air quality standard for PM₁₀ of 40 µg/m³ and the IFC ambient air quality guideline for PM₁₀ of 20 µg/m³.

6.4 Impact Assessment

6.4.1 Assumptions

The assessment of impact for construction related dust emissions has assumed that the IPP will implement best practice measures for dust control as part of an agreed Dust Management Plan. Based on the Institute of Air Quality Management Guidance on the Assessment of Dust from Demolition and Construction (IAQM, 2014), good practice dust management measures are listed in Table 6-7 to Table 6-12. The applicability of these measures to the development of the Park are specified as highly recommended, desirable and not required.

Table 6-7 Mitigation for all sites: communications

Mitigation Measure	Highly recommended / Desirable / Not required
1. Develop and implement a stakeholder communications plan that includes community engagement before work commences on the Park.	Desirable
2. Display the name and contact details of person(s) accountable for air quality and dust issues on the Park boundary. This may be the environment manager/engineer or the site manager.	Highly recommended
3. Display the head or regional office contact information.	Highly recommended

Table 6-8 Mitigation for all sites: dust management

Mitigation Measure	Highly recommended / Desirable / Not required
4. Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the Amana. The level of detail will depend on the risk, and should include as a minimum the highly recommended measures in this assessment. The desirable measures should be included as appropriate for the Park.	Desirable
Site management	
5. Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner and record the measures taken.	Desirable
6. Make the complaints log available to the Amana when asked.	Desirable
7. Record any exceptional incidents that cause dust and/or air emissions, either on-site or off-site, and the action taken to resolve the situation in the log book.	Desirable
8. Hold regular liaison meetings with other high-risk construction sites within 500m of the Park boundary, so plans are coordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.	Not required
Monitoring	

Mitigation Measure	Highly recommended / Desirable / Not required
9. Undertake daily on-site and off-site inspection, where receptors (including roads) are nearby, to monitor dust and record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of the Park boundary, with cleaning to be provided if necessary.	Not required
10. Carry out regular site inspections to monitor compliance with the DMP, record inspection results and make an inspection log available to the Amana when asked.	Desirable
11. Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	Desirable
12. Agree dust deposition, dust flux or real-time PM ₁₀ continuous monitoring locations with the local authority. Where possible, commence baseline monitoring at least three months before work commences on site or, if at a large site, before work on a phase commences. Further guidance is provided by IAQM on monitoring during demolition, earthworks and construction.	Not required
Preparing and maintaining the site	
13. Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	Highly recommended
14. Erect solid screens or barriers around dusty activities, or the Park boundary, which are at least as high as any stockpiles on site.	Not required
15. Fully enclose site or specific operations where there is a high potential for dust production and the Park is active for an extensive period.	Highly recommended
16. Avoid site runoff of water or mud.	Not required
17. Keep Park Site fencing, barriers and scaffolding clean using wet methods.	Not required
18. Remove materials that have a potential to produce dust from the Park as soon as possible, unless being re-used on site. If they are being re-used on-site, cover as described below.	Not required
19. Cover, seed or fence stockpiles to prevent wind whipping.	Not required
Operating vehicle/machinery and sustainable travel	
21. All vehicles to switch off engines when stationary - no idling vehicles.	Highly recommended
22. Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Not required
23. Impose and signpost a maximum speed limit of 15mph on surfaced and 10mph on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate).	Desired
24. Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	Highly recommended
25. Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking and car sharing).	Not required
Operations	
26. Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems.	Highly recommended
27. Ensure an adequate water supply on the Park for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	Highly recommended
28. Use enclosed chutes and conveyors and covered skips.	Highly recommended
29. Minimize drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	Highly recommended

Mitigation Measure	Highly recommended / Desirable / Not required
30. Make sure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	Desirable
44. Avoid dry sweeping of large areas.	Highly recommended
45. Make sure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	Highly recommended
46. Inspect on-site haul routes for integrity and instigate any necessary repairs to the surface as soon as reasonably practicable.	Highly recommended
47. Record all inspections of haul routes and any subsequent action in a site log book.	Highly recommended
48. Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowzers, and regularly cleaned.	Highly recommended
Waste management	
31. Avoid bonfires and burning of waste materials.	Highly recommended

Table 6-9 Mitigation measures specific to demolition

Mitigation Measure	Highly recommended / Desirable / Not required
32. Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Desired
33. Use effective water suppression during demolition operations. Hand held spays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high-volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	Desired
34. Avoid explosive blasting, using appropriate manual or mechanical alternatives.	Not required
35. Bag and remove any biological debris or damp down such material before demolition.	Not required

Table 6-10 Mitigation measures specific to earthworks

Mitigation Measure	Highly recommended / Desirable / Not required
36. Re-vegetate earthworks and exposed areas/soil stockpiles to stabilize surfaces as soon as practicable.	Not required
37. Use hessian fabric, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Not required
38. Only remove the cover in small areas during work and not all at once.	Not required

Table 6-11 Mitigation measures specific to construction

Mitigation Measure	Highly recommended / Desirable / Not required
39. Avoid scabbling (roughening of concrete surfaces) if possible.	Desired
40. Store sand and other aggregates in bunded areas and do not allow to dry out unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place.	Not required
41. Deliver bulk cement and other fine powder materials in enclosed tankers and store in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Desired

Mitigation Measure	Highly recommended / Desirable / Not required
42. For smaller supplies of fine powder materials, make sure bags are sealed after use and stored appropriately to prevent dust.	Desired

Table 6-12 Mitigation measures specific to track-out

Mitigation Measure	Highly recommended / Desirable / Not required
43. Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site. This may require the sweeper being continuously in use.	Desired
49. Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	Not required
50. Provide an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	Not required
51. Access gates to be located at least 10m from receptors where possible.	Not required

6.4.2 Construction Dust Assessment Methodology

This chapter sets out the assessment of emissions of dust which could potentially occur from the construction of Phase 1 of the Park. However, the risks of impacts and associated mitigation measures identified for the construction of Phase 1 are assumed to be applicable for the future phases of the Park as the site is fully developed. This assessment has been carried out in accordance with the latest IAQM guidance (IAQM, 2014) on the assessment of dust from demolition and construction. This report sets out the full construction dust assessment, including description of the methodology, relevant input data, the assessment itself, recommended mitigation and monitoring measures and conclusions.

Activities carried out on construction sites can give rise to emissions of dust which could cause annoyance to human receptors or damage to vegetation due to the soiling of surfaces. Dust could also lead to increased short term and long term particulate matter concentrations (e.g. PM₁₀ and PM_{2.5}, particulate matter with aerodynamic diameter less than 10 microns (µm) or 2.5µm or less, respectively) at off-site locations that may affect human health, unless the appropriate mitigation measures are implemented. The impacts of dust emissions from construction therefore need to be addressed in order to identify the required mitigation measures.

IAQM guidance aims to estimate the impacts of both PM₁₀ and dust together, through a combined risk-based assessment procedure. IAQM guidance provides a methodological framework, but notes that professional judgement is required to assess impacts. This assessment does not consider the air quality impacts of dust from any contaminated land or buildings. Although PM_{2.5} is not specifically included as a parameter within the assessment, the risk levels associated with PM₁₀ and any subsequent mitigation measures would apply to PM_{2.5}.

Six 500 kW generators are proposed for the construction phase, for both the workers accommodation and other construction related activities. Typically only four generators will operate simultaneously with the additional two generators for back-up. If only four generators operate the aggregated size of the generators would fall outside the IFC guidelines for small combustion plant (between 3MWth and 50MWth). However, the generators to be used will comply with the emission standards set out in the GAME environmental standards for air emissions from stationary sources. The diesel fuel used for the generators will have a sulfur content less than 1.5%, in line with the requirements set out in Section 1 of the IFC General EHS guidelines 2007. . The location of the generators is proposed to be greater than 500m from the workers accommodation. Therefore, an assessment of emissions to air from the

generators has been screened out and is not considered further in this assessment. It is noted that the generators have been included in the assessment of GHG emissions.

The GHG emissions have been evaluated based on CO₂ equivalent and estimated based on fuel consumption. The method of calculation of the project's operational carbon is based on the GHG Protocol, assessed in accordance with the Royal Commission Environmental Regulations (RCER) 2015 Environmental Permit Program and the Saudi Aramco Engineering Procedures 13 (SAEP-13) and guidance from the UK Government's Department of Energy and Climate Change⁴. These methods are in accordance with the requirements of both IFC Performance Standard 3 and Equator Principle 3 and considers both Scope 1 and Scope 2 emissions. The process involves:

- identifying the activities/processes which release GHG,
- categorization of the activities by scope, and
- quantification of the emissions.

This assessment includes CO₂ emissions associated with the following elements of the project:

- transport of construction materials and the solar panels;
- fuel required for the plant and equipment required for the construction, operation and decommissioning phase; and
- materials used for the construction of the Park, such as stainless steel and concrete.

A description of the approach taken to complete the air quality assessment is presented in Appendix A of this Environmental Statement.

6.4.3 Construction Phase Impact Assessment Approach

6.4.3.1 Step 1: Identify the need for a detailed assessment

Sensitive human receptor

There are human receptors within 350m of the site boundary. Therefore, further assessment is required.

Four receptors have been identified within the site area; these are seasonal herder settlements. Seasonal herder settlements are not permanent receptors but, for the purposes of this assessment they have classed as permanent receptors. During construction it is considered unlikely that seasonal herders will set up camps adjacent to areas of phased construction, however, there is a risk the herders may camp near the fenced construction work area with construction works close on the other side. Therefore, as a conservative approach we have considered these seasonal receptors to be located between 20m-50m from areas of construction. In reality these receptors would locate themselves further away from construction activities.

A count of the relevant human receptors within the specified assessment bands was carried out as recommended in IAQM guidance, the results of which are set out in Table 6-13. The receptors have been identified as being of High sensitivity in line with Step 2B.

In line with the IFC guidance construction workers are also required to be considered as sensitive human receptors. However, although there are expected to be over 2,000 workers not all of the workers will be exposed to the potential dust generating construction activities. Therefore, it has been

⁴ https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69282/pb13309-ghg-guidance-0909011.pdf.

assumed that there will be between 1-10 workers within 20m of construction activities and greater than 10 workers for each of the other distance bands.

There are no human receptors within 50m of the road network up to 500m from the site entrance and therefore trackout has not need been considered further in the assessment. Similarly there are no receptors within 350m of the proposed SEC service road. Therefore, an assessment of construction related activities on the SEC service road are screened out and are not considered further in this assessment.

Table 6-13 Dust soiling and human receptor count

Receptor count				
Demolition, Earthworks & Construction		Receptor sensitivity		
		High	Medium	Low
Distance from the Park boundary	<20m	0	1-10	0
	20m–50m	4	>10	0
	50m–100m	0	>10	0
	100m–350m	5	>10	0
Distance from SEC service road	No receptors within 350m			
Trackout		High	Medium	Low
Distance from roads up to 500m from the proposed site exit	No receptors within 50m of access roads.			

Ecological receptors

Dust can have direct physical effects including reduced photosynthesis, respiration and transpiration through coating and smothering. Chapter 11 demonstrates that there are no ecology sites within the relevant distances from the site boundary.

6.4.3.2 Step 2: Assess the risk of dust impacts

6.4.3.2.1 Step 2A: Define the potential dust emission magnitude

The construction works would be split into several phases, which would involve different periods of earthworks, construction and trackout, and activity levels which will not peak simultaneously. This assessment is based on Phase 1 of the Park. The risks and mitigation measures identified in Phase 1 are applicable to future construction phases of the Park.

The dust emission magnitudes of each activity have been specified using the definitions of dust emission magnitudes in section 6.4. These are summarized in Table 6-14.

Demolition: The development site encompasses undeveloped land, no demolition will be required, therefore, demolition is not considered further in this assessment.

Earthworks: Earthworks activities associated with The Park are likely to require a duration of approximately four months. The total area of earthworks is estimated to be approximately 16,250m². On this basis, the proposed earthworks have been classified as a dust emission class of 'Large'.

Construction: Construction activities associated with The Park are likely to require a period of approximately 16 months. The total building volume associated with construction

can be split into two phases: firstly the construction of the roads and hard standing areas, and secondly the construction of the solar panel supporting structures, masonry units, contractors compound and substation. The first phase has an estimated area of 25,890m³, whilst the second phase of construction is estimated to have a volume of 33,400 m³. On this basis, the assessment for construction is based on a dust emission class of 'Medium'.

Trackout: During construction, the maximum number of daily outward movements of HGVs is anticipated to be approximately 100. Although, there are no human receptors within 50m of the road network or up to 500m from the site entrance, therefore trackout has not need been considered further in the assessment.

Table 6-14 presents as a summary of the dust emission magnitude for each activity based on the criteria set out in Section 6.2.1.

Table 6-14 Dust emission magnitude

Activity	Dust emission magnitude
Demolition	N/A
Earthworks	Large
Construction	Medium
Trackout	N/A

6.4.3.2.2 Step 2B Define the sensitivity of the area

The area surrounding the development site is only inhabited by seasonal herders. If the proposed activities produce excessive dust emissions, significant impacts may be experienced at sensitive receptors unless suitable mitigation measures are employed. These mitigation measures will also protect the construction workers. It is noted that dust to the location of the site is on the edge of the An Nafud desert and so typical levels of dust regularly experienced would be greater than those generated during the construction of the Park. Therefore, the general sensitivity of the area to additional dust would be low.

Effects on human health are considered within this assessment to assign the suitable mitigation measures but the impacts are described separately in Chapter 17 Health and Safety Aspects.

Table 6-15 displays the sensitivities of the surrounding area to demolition, earthworks, construction and trackout based on the criteria set out in Appendix D.

Table 6-15: Sensitivity of the area for human receptors

Potential Impact	Sensitivity of the surrounding area			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low	Low	N/A
Human health		Medium	Medium	

Table 6-15 shows that, based on the number and proximity of sensitive receptors to the development site and background PM₁₀ concentration, the sensitivity of the area for dust soiling is categorized as

Low for earthworks and construction activities. For human health impacts, the sensitivity of the area is categorized as Medium for earthworks and construction activities.

The sensitivity of human receptors to demolition and trackout activities is categorized as 'N/A' as there are no demolition activities anticipated and no receptors that will be affected by trackout.

6.4.3.2.3 Step 2C Define the risk of impacts

Using the dust emission magnitudes for the various activities in Table 6-14 and the sensitivity of the area provided in Table 6-15, the definition of the risks for each activity are provided in Table 6-16 for dust soiling impacts.

Table 6-16 Summary of the dust risks for human receptors

Potential impact	Risk			
	Demolition	Earthworks	Construction	Trackout
Dust soiling	N/A	Low	Low	N/A
Human health		Medium	Medium	

The results in Table 6-16 indicate that for potential dust soiling impacts, there is predicted to be a Low risk for earthworks and construction activities; for potential human health impacts, there is predicted to be a Medium risk for earthworks and construction activities.

6.4.3.3 Summary

The results in Table 6-16 indicate that there would be Low or no risks to sensitive human receptors for dust soiling effects during earthwork and construction activities. There will also be a medium risk to human health during earthwork and construction activities. It is noted that dust to the location of the site is on the edge of the An Nafud desert and so typical levels of dust regularly experienced would be greater than those generated during the construction of the Park. However, in order to follow best practice, it would be necessary to adopt mitigation measures to reduce the potential for effects to occur at nearby sensitive receptors.

6.4.4 Operation Phase Impact Assessment Approach

The operational phase of the Park does not have any significant diesel (or other fossil fuel) powered energy generating plant (such as boilers or generators) and only requires a low number of maintenance and staff vehicle movements. Therefore, there will be no significant emissions to air and no further assessment is required.

6.4.5 Decommissioning Phase Impact Assessment Approach

For the decommissioning phase of the Park, it is assumed that the risk of dust emissions or dust soiling associated with the construction phase (as provided in Table 6-16) are also likely to be expected for the decommissioning phase.

6.4.6 Greenhouse Gas Emissions

6.4.6.1 Transport

Table 6-17 shows the calculation of CO₂ emissions related to road transport of the construction materials for Phase 1 from the town of Sakaka to the Park (approximately 35km), the solar panels

from Beijing to Shanghai (approximately 1,100km) and from the port at Dammam to the Site, which is a distance of approximately 1,300km. It has been assumed that the port at Dammam will be utilized as this would represent a 'worst case' scenario. Other potential ports which may be utilized include those at Jeddah and Yanbu.

Table 6-17 CO₂ emissions from transport

Transport Route	Mode	HDV numbers / tonnes of panels	Distance travelled (one-way) (km)	Cumulative Distance (km)	CO ₂ emissions factor	CO ₂ emissions (tonnes)
Pre-construction (materials)	Road	10,041	35	702,859	1.134 kg CO ₂ e/km	797
Pre-construction (concrete)	Road	61	35	4,304		4.88
Construction (materials)	Road	3,296	35	230,720		262
Construction (concrete)	Road	2,107	2400	10,114,220		11,473
Panel delivery	Road	733	35	51,310		58
	Ship	92,714 tonnes	11,500	11,500	0.016 kg CO ₂ e/tonne.km	17,106
Total Phase 1 Transport CO₂ emissions						29,701

6.4.6.2 Plant and equipment

Table 6-18 shows the calculation of CO₂ emissions from the plant and equipment to be used on site for the construction, operation and decommissioning of Phase 1 of the Park using the diesel emission factor of 0.268 kg CO₂e/kWh.

Table 6-18 CO₂ emissions from plant and equipment

Stage	Description	Total daily power (kWh-day)	Duration (months)	Total power (kWh)	CO ₂ emissions (tonnes)
Pre-construction	Installation of access roads	23,146	4	2,816,097	753
	Site Grading	50,800	4	6,180,667	1,654
	Install Construction Compound	28,600	4	3,479,667	931
	Installation of Fencing/lighting	82,250	4	10,007,083	2,677
Construction	Install Foundations for panels	119,100	16	57,962,000	15,508
	Pre-Fabrication (Installing Mounting Structures)	35,300	16	17,179,333	4,596
	Installing Solar Modules	45,350	16	22,070,333	5,905
	Installing Cabling	9,650	16	4,696,333	1,257
	Power Supply at Construction Site	72,000	16	35,040,000	9,375
	Building Developers Compound	14,870	16	7,236,733	1,936
Total Construction					44,593
Operation (per year)		16,280	12	5,942,200	1,590
Decommissioning		234,550	16	114,147,667	30,541
Total Phase 1 Plant and Equipment CO₂ emissions					114,882

6.4.6.3 Construction Materials

Table 6-19 shows the calculation of CO₂ emissions from the construction materials to be used on site for the construction of Phase 1 of the Park.

Table 6-19 CO₂ emissions from construction materials

Material	Quantity (tonnes)	CO ₂ emissions factor (T CO ₂ e/ T material)	CO ₂ emissions (tonnes)
Asphalt	44,475	0.086	3,825
Panel foundations	77,568	0.083	6,471
Building Contractors Compound – concrete masonry units	865	0.083	72
Building Contractors Compound - concrete plinth	510	0.083	43
Building SEC Substation and Gate House – concrete masonry units	185	0.083	15
Building SEC Substation and Gate House - concrete plinth	1,026	0.083	86
Steel framework	16,468	6.519	107,356
Total Phase 1 Materials CO₂ emissions			117,868

6.4.6.4 Total CO₂ Emissions

The total CO₂ emissions for Phase 1 are summarized in Table 6-20. In addition, the CO₂ emissions for the different elements have been annualized to allow for comparison to the Equator Principals limit of 100,000 tonnes of CO₂ emissions per year (it is noted that this limit is based on the operation of the project and does not specifically apply to the construction phase).

Table 6-20 CO₂ emissions from construction materials

GHG Emission Source	CO ₂ emissions (Phase 1) (tonnes)	Annualized CO ₂ emissions (Phase 1) (tonnes)
Transport	29,701	17,821
Plant and Equipment - Construction	44,593	26,756
Construction Materials	117,868	70,721
Construction Total	192,163	115,298
Plant and Equipment – Operation (per year)	1,590	1,590
Plant and Equipment – Decommissioning	30,541	22,906

Based on the requirement of the equator principals, projects emitting more than 100,000 metric tonnes of CO₂ annually during operation are required to undertake an alternatives analysis. Table 6-20 shows that the annualized CO₂ emission (based on a total construction duration of 20 months) is 115,298 tonnes which is greater than the 100,000 metric tonnes reporting limit. However, as mentioned previously, the limit of 100,000 tonnes of CO₂ is based on the operation of a project and is therefore not directly applicable for the construction phase.

When averaged over the lifetime of the Park, the total annual CO₂ emissions for the operational phase and decommissioning are below the 100,000 metric tonnes reporting limit.

It is assumed that additional phases will be constructed in similar sized quantities, as such; the annual quantity of CO₂ emissions reported will be also representative of the future stages of development.

During the next phase of the development, there will be a requirement to refine materials and equipment utilized in the construction of the Park in order to integrate the principles of cleaner production as specified in IFC Performance Standard 3 which require the investigation of financially feasible options for all resources.

The objective of this requirement is to promote the conservation of resources and the minimization of impacts associated with construction of infrastructure. During the detailed design phase of the Park, continuous improvement in design should be pursued in order to ensure that energy and resource efficiencies are identified and integrated into the design of the Park wherever possible.

In addition, it is expected that the Park will generate approximately 2,500 GWh per annum of energy, displacing 4,600 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons and 2,000,000 tonnes of CO₂ per annum. Therefore, the GHG emissions for the construction phase are considered not to be significant, and the overall impact of the development of the Park will represent an overall benefit (i.e. reduction) in GHG emissions; plus contribute to the Kingdom of Saudi Arabia's INDC target to avoid up to 130 MtCO₂e by 2030 annually.

6.4.7 Impact Assessment Summary

Table 6-21 summarizes the impact significance of the project based on the criteria set out in Chapter 5.

Table 6-21 Summary of Impact Significance

ID	Receptor	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
AQ01 Construction Dust	Human receptors within 350m of construction activities	Low	Potential dust inhalation/ nuisance resulting from construction activities	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Medium	Low
AQ02 GHG Emissions: Construction	N/A	Moderate	Increase GHG emissions from the construction of the Park	Effect: Negative Action: Direct Likelihood: Certain Frequency: Frequent Duration: Short Extent: International Permanence: Irreversible	Low	Low
AQ03 GHG Emissions: Operation	N/A	Moderate	Overall reduction in GHG emissions due to the operation of the Park	Effect: Positive Action: Indirect Likelihood: Certain Frequency: Frequent Duration: Long	Medium	Moderate benefit

				Extent: International Permanence: Irreversible		

6.4.8 Mitigation

6.4.8.1 Construction Phase

The effects during the construction phase are temporary and the impacts will be short term and will only arise during specific construction activities. Following the application of the good practice dust control and mitigation measures it is considered that impacts at all receptors would be 'not significant' in accordance with the IAQM guidance.

6.4.8.2 Operation Phase

Although the overall impact of the Park is considered to be a benefit. It is recommended that to reduce the emissions of GHG during the operational phase, the use of electric vehicles is advised.

6.4.8.3 Decommissioning Phase

No additional mitigation, above the mitigation measures which are likely to be similar to those set out as part of the construction phase, are envisaged in relation to emissions of dust during decommissioning.

6.4.8.4 Impact Assessment Summary

Table 6-22 summarizes the impact significance of the Park based on the criteria set out in Chapter 5.

Table 6-22 Summary of Impact and Mitigation

ID	Potential Significance	Mitigation	Residual Significance
AQ1 Construction Dust	Low	Non required	Low
AQ2 GHG Emissions: Construction	Low	Non required	Low
AQ3 GHG Emissions: Operation	Moderate benefit	Recommend the use of electric vehicles during the operation of the Park.	Moderate benefit

6.4.9 Conclusion

This chapter has set out a summary of the existing ambient air quality in the vicinity of the Sakaka Solar Energy Park and the prediction of potential air quality impacts resulting from the construction, operation and decommissioning phases of the Park.

For construction, the results indicate that there would be Low or no risks to dust soiling at sensitive human receptors.

The assessment of GHG emissions from the Park show that although CO₂ emissions are likely, particularly during the construction stage, the overall impact of the scheme is considered to be a 'net benefit' based on the displacement of emissions of CO₂ from the use of fuel oil as an alternative for power generation and contributes to the Kingdom of Saudi Arabia's INDC target to avoid up to 130 MtCO₂e by 2030 annually.

Therefore, it is concluded that the Sakaka Solar Energy Park is acceptable from an air quality and greenhouse gas emissions basis.

6.4.10 References

Saudi Aramco (2016). Saudi Aramco Engineering Standard 112 *Meteorological and Seismic Data*.

Saudi Aramco (2016) *BI-10-02080, Photovoltaic Power Plant – Al Jouf (Final)*

Tractebel (2016) *Solar Resource and Energy Yield Assessment Report (Phase-1)*

7. Soils & Geology

7.1 Introduction

This chapter presents the findings of the soils and geology baseline review and the impacts likely to arise as a result of the Park. The assessment addresses regional and local geological and soil conditions, characterizes the soil and geological quality, and assesses potential impacts on receptors.

Baseline conditions and related impact assessment for surface and ground water are provided in chapter 8 – *Hydrology & Hydrogeology*. Similarly, any impacts on the terrestrial environment relating to dust are covered in Chapter 6- *Air Quality & Meteorology*.

7.2 International and National Standards and Guidance

7.2.1 IFC General EHS Guidelines

Section 1.8 of the IFC EHS Guidelines provides a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. Releases of these materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal (IFC, 2007).

Section 1.8 states that contaminated lands may involve surficial soils or subsurface soils that, through leaching and transport, may affect groundwater, surface water, and adjacent sites. Where subsurface contaminant sources include volatile substances, soil vapor may also become a transport and exposure medium, and create potential for contaminant infiltration of indoor air spaces of buildings (IFC, 2007).

Contaminated lands should be managed to avoid the risk to human health and ecological receptors. The preferred strategy for land decontamination is to reduce the level of contamination at the site while preventing the human exposure to contamination (IFC, 2007).

An approach to managing the risk of contaminated land is set-out in the IFC General EHS Guidelines. To determine whether risk management actions are warranted, the following assessment approach should be applied to establish whether the three risk factors of 'Contaminants', 'Receptors', and 'Exposure Pathways' co-exist, or are likely to co-exist, at the project site under current or possible future land use:

- Contaminant(s): Presence of hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations;
- Receptor(s): Actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern; and,
- Exposure pathway(s): A combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes (e.g., ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants (IFC, 2007).

7.2.2 IFC Performance Standard 3

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that

may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenant of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

Although the management of soil as a resource is not specifically stated in the performance standard, soil is a resource and its impairment has potential to adversely impact on humans and the environment.

7.2.3 National Legislation

The GAME has not developed or published soil quality guideline values for the Kingdom of Saudi Arabia. U.S. Environmental Protection Agency (EPA) values are typically applied in the absence of national values.

7.3 Baseline Environmental Conditions

7.3.1 Baseline Review

7.3.1.1 Regional Geology

The geology of Saudi Arabia extends in age from the Precambrian era to the present day and forms part of a larger unit that includes the Arabian Peninsula, and is known as the Arabian Plate (www.sgs.org.sa). Based on the Saudi Geological Society classification system, Saudi Arabia can be divided into four distinct geological divisions as shown in Figure 7-1:

- Arabian Shield.
- Arabian Platform.
- Harrats.
- Red Sea Rift Basin.

In addition to these divisions, Vincent (2008) identifies the two major sand seas (i.e. Rub' al Khali and An Nafud) as a fifth geological division. These sand seas are located on the Arabian Shield.

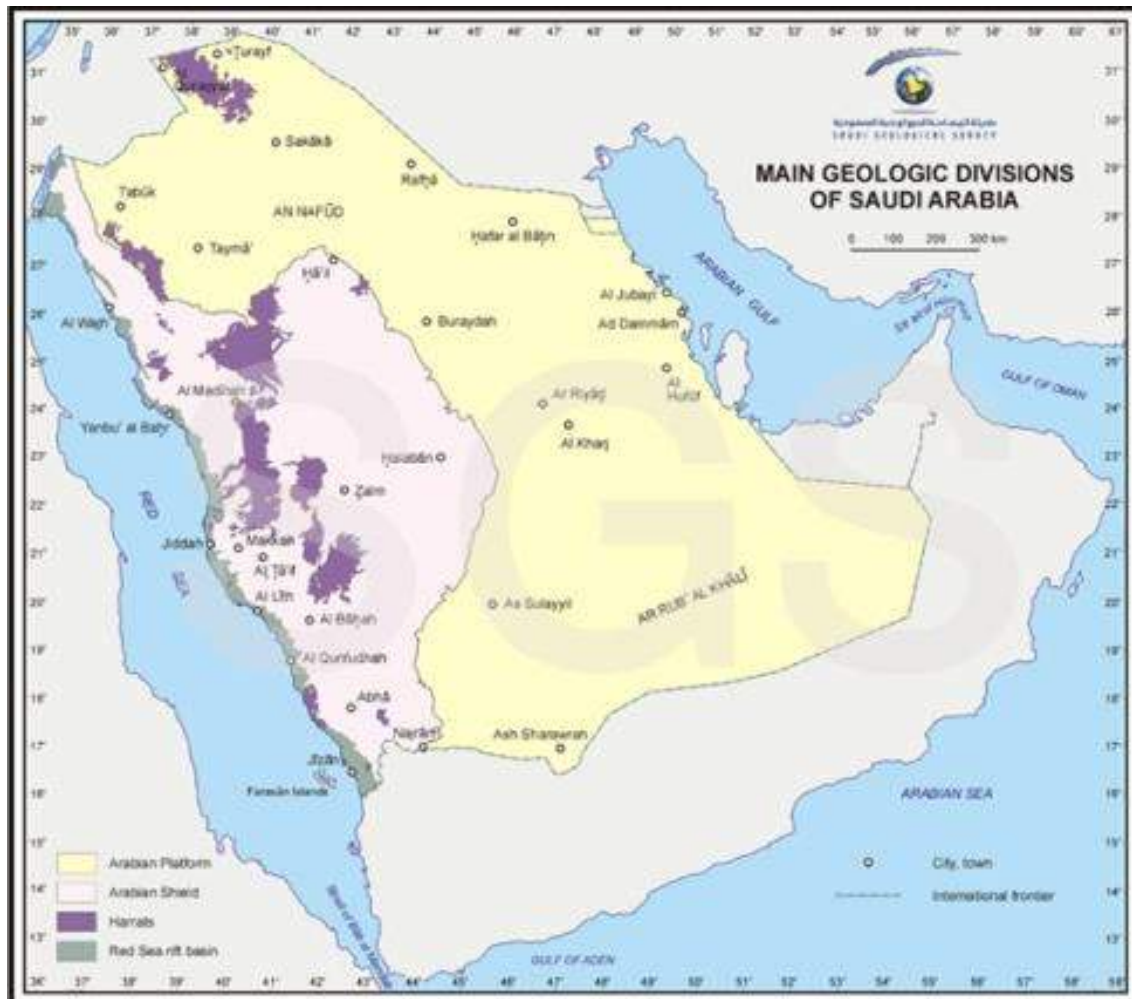


Figure 7-1: Geological Divisions of Saudi Arabia (Source: Saudi Geological Survey, 2016)

The development site is located on the Arabian Platform (Figure 7-1). The Phanerozoic Arabian platform is comprised of cover rocks of clastic, calcareous and evaporitic successions dipping gently eastward away from the Arabian shield (Figure 7-2- www.sgs.org.sa). These sedimentary successions cover almost two-thirds of the total area of Saudi Arabia (Vincent, 2008). The Phanerozoic cover rocks of the Arabian Shield belong to the Paleozoic (540-250 Ma), Mesozoic (250-65 Ma), and Cenozoic (65 Ma to Recent), and crop out as relatively flat lying beds of sedimentary rocks such as sandstone, siltstone, limestone, and evaporites (salt deposits), and volcanic rocks. The rocks were deposited uncomfortably on the underlying Precambrian basement, in riverbeds, in glacial valleys, and in shallow seas, or were extruded from subaerial volcanoes (www.sgs.org.sa).

The youngest deposits in the region include coral limestone and unconsolidated sand, silt, gravel, and sabkha, which accumulated in the sand seas of Ar Rub al Khali and An Nafud, filled dried-up lake beds and wadis.

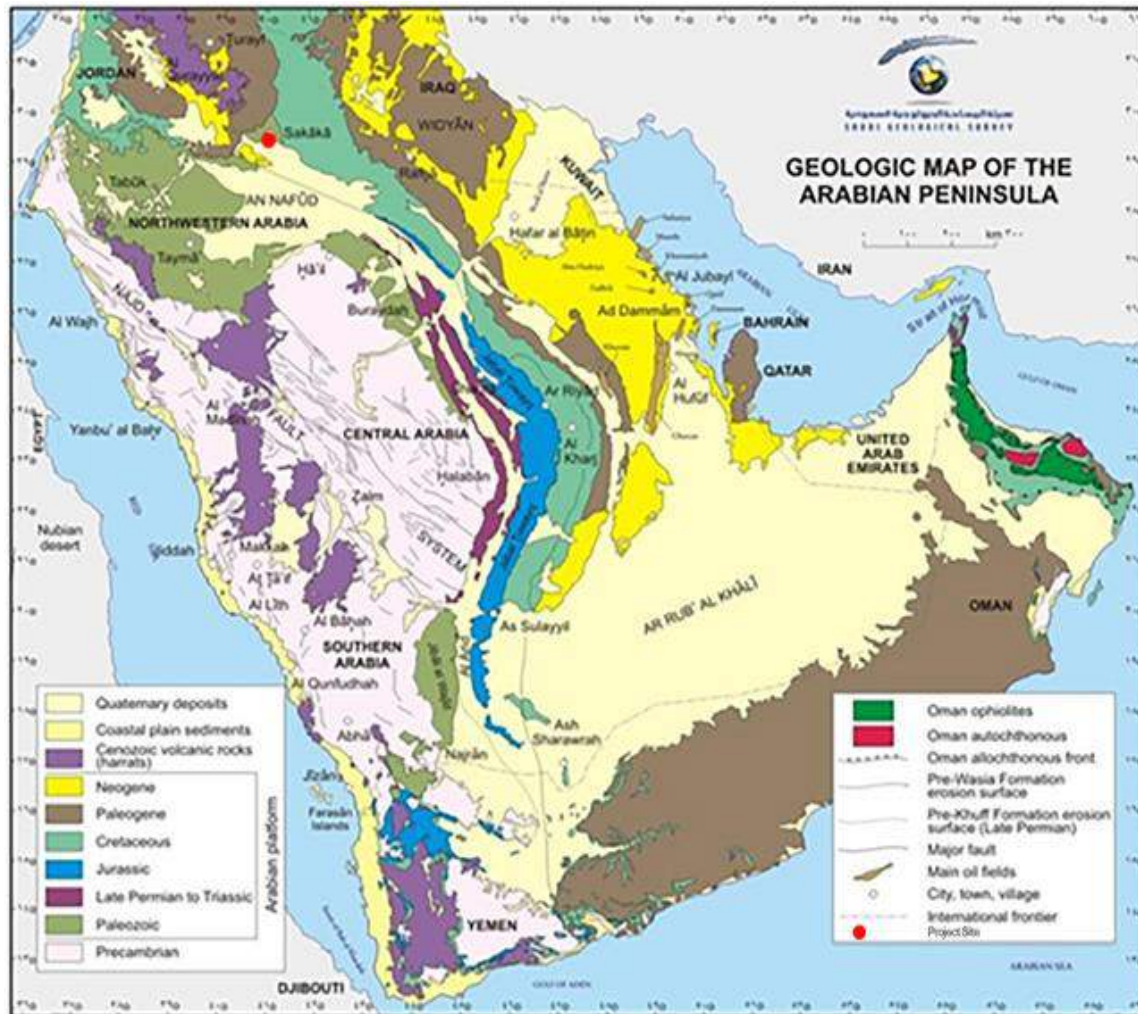


Figure 7-2: Geologic Map of the Arabian Peninsula (Source: www.sgs.org.sa)

7.3.1.2 Local Geology

The most prominent geological feature in the local area is the escarpments to the west of Sakaka and to the north of Dumat al Jandal. The Al Jayb, Quraymis, and Ar Rummantayn escarpments mark the south-eastern boundary of the Sirhan-Turayf basin, and fall within the Al Jouf Quadrangle. These escarpments are approximately 100m in height and demarcate the interface between the old Paleozoic sedimentary rocks to the north and the younger Mesozoic sedimentary rocks to the south (Al Ajmi, 2005).

The Paleozoic rocks in the local region are sub-divided into three formations: Tawil Formation, Jauf Formation and Jubah Formation. These three formations are composed mainly of sandstone and shale, except for Jauf Formation which includes limestone, siltstone and gypsum (Al Ajmi, 2005).

Al Ajmi (2005) investigated the successions of the Sakaka water well, located approximately 29km to the north of the development site. This well was drilled by the then Ministry of Water and Electricity and is positioned at an elevation of 671 m above sea level. The well has a total depth of 900 m and commences at the outcrop of the Wasi Formation and stops at the base of the Tawil Formation (Al Ajmi, 2005).

The succession of sediments within this water well is described in Table 7-1. The development site is located on the Devonian sandstones and so the geological investigation commissioned by Saudi Aramco should reveal an absence of the Wasia Formation. The soils are characterized by Entisols and in particular the sub-order of Torripsamments which are widespread in the An Nafud desert (Vincent 2008).

Table 7-1: Generalized Succession of Studied Sediments of Sakaka Water Well (source: Al-Ajmi, 2005)

Age		Formation		Thickness (m)	Depth (m)	Description
Mesozoic	Early Cretaceous	Wasia		20	(0)	Red to orange (dune sand) medium to fine, round to sub-round well sorted sandstone (Wasia Formation)
					(100)	
Paleozoic	Middle Devonian	Jubah		275	(200)	Medium and coarse grained sandstone composed of sub-round and rounded quartz grains (Judah Formation)
	Early Devonian	Jauf	Murayr	75	(300)	Black and blue, bulky shale with very fine sandstone
			Hamamiyat	130	(400) (500)	Black and blue shaly limestone and sandstone, hard aphanitic limestone with some dolomite and coarse grain, sub angular white crystalline sandstone
			Subbat	65		Black and dark blue, flaky limy shale
			Qasr	70	(600)	White creamy aphanitic and calcarinatic, hard limestone with dark green shale at the upper part
			Sha'iba			White creamy aphanitic and calcarinatic, hard limestone with dark green shale at the upper part
		Tawil		150	(800)	White, rounded, well sorted, fine to medium sandstone with some shale at the upper part
					(900)	

There is no evidence of soil contamination within the development site.

7.3.1.3 Regional Soils

The Saudi Geological Society has developed a series of surface geology maps for the Kingdom of Saudi Arabia, published by the former Ministry of Petroleum and Mineral Resources, now the Ministry of Energy, Industry and Mineral Resources. Sheet 29d covers the Al Juf Quadrangle, within which the development site is located. The development site is located in an area of sand and gravel deposits (Qdc) (Figure 7-3).



Figure 7-3: Extract from Geology Map Sheet 29d Al Jouf Quadrangle (Source: www.sgs.org.sa; Al-Ajmi, 2005)

Soil surveys undertaken by the Ministry of Agriculture and Water during the 1960s and 1980s characterize the soils in the region as Entisols. These soils are found on actively eroding slopes, the sand deserts and alluvial terraces. Specifically within the location of the development site, the soils are classified within the sub-orders of Torripsamments and Torriorthents. The former are mostly non-saline and deep and are widespread in the An Nafud desert which is located to the south of the development site. Torriorthents are mostly developed on colluvial and residual parent materials, often on actively eroding slopes and in material resistant to weathering (Vincent 2008).

7.3.2 Baseline Survey - Methodology

Ground Investigation was carried out at the development site by Riyadh Geotechnique & Foundations Co. during November and December 2016. Operations consisted of exploratory drilling and sampling of the subsurface soils and performance of field tests at designated locations.

A total of fifty boreholes were investigated across the development site. Locations of boreholes are shown in Figure 7-4 (boreholes highlighted in red indicate representative boreholes shown in section 7.3.3).

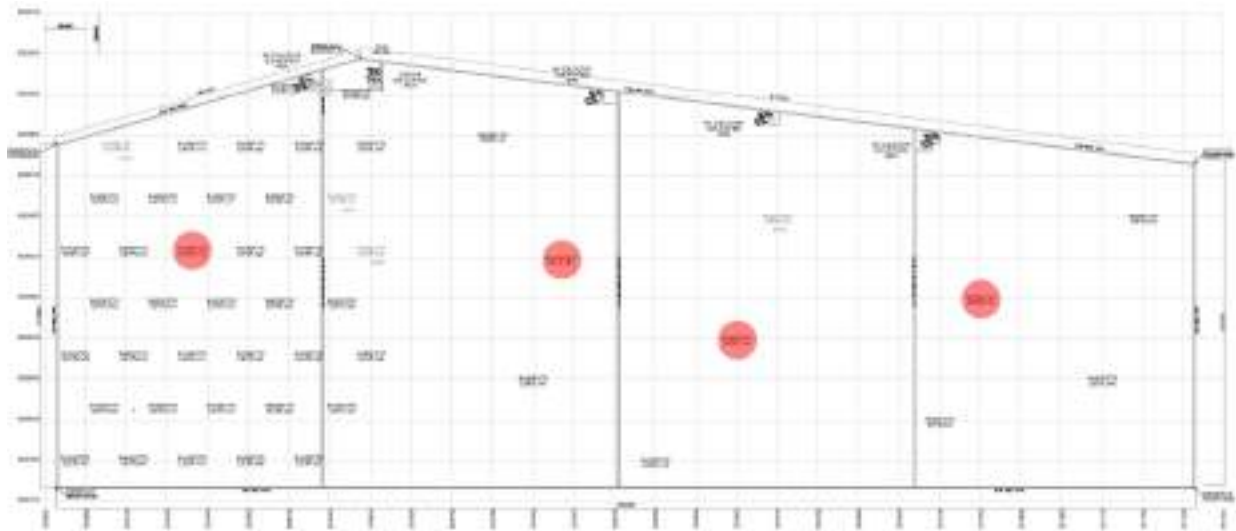


Figure 7-4: Locations of Boreholes

The drilling of boreholes was carried out using ACKER ADII drilling rigs equipped with automatic hammer. The subsurface stratum was penetrated through a rotary drilling method using wash boring technique. Bentonite slurry of suitable consistency was circulated as a drilling fluid to provide stability to borehole walls. After completion of the testing, boreholes were backfilled with a mixture of cement, bentonite, sand and water. The grout backfill materials were proportioned to a groutable / pourable consistency and the proportions varied as per the specific requirements of each borehole.

Field borehole logs were developed on the basis of the materials encountered at the site and were later confirmed / modified by the laboratory test results.

The samples recovered from the split spoon sampler were visually inspected and classified as per ASTM D-2488-09a. Standard penetration tests were carried out using an automatic standard penetration test hammer, and samples obtained from the boreholes were labelled, preserved in polythene bags and placed in plastic jars. All samples were transported to a laboratory for further evaluation and testing.

Laboratory tests carried out included:

- Grain size Analysis (ASTM D – 421-85 (Reapproved 2007);
- Grain size Analysis (ASTM D – 422-63 (Reapproved 2007);
- Atterberg Limits (ASTM D – 4318-10);
- Natural Moisture Content (ASTM D – 2216-10);
- Direct Shear Tests (ASTM D 3080-11);
- Unconfined Compression Strength (ASTM D 2938 - 95 (Reapproved 2002) / D 4543 - 08);
- Point Load Strength Index of Rock (ASTM D 5731);
- Sulphates Content (AASHTO T 290-94);

- Chloride Content (AASHTO T 291-94);
- pH (BS 1377 Part 3); and,
- Total Carbonate as Calcium Carbonate (ASTM D 4373).

Where rock or harder strata were encountered, the strata were penetrated through continuous coring using diamond core bit. The rock cores recovered were visually inspected and their percentage recovery (REC) and percentage Rock Quality Designation (RQD) values were determined. All the samples recovered from rock coring were preserved in rock core boxes and sent to a laboratory for further evaluation and testing.

Various other in situ tests were carried out, to determine the load bearing capacity of the ground. This information can be used to assess whether additional fill material is required to be transported to site in order to reinforce the subsurface strata in advance of installation of solar panels.

These tests included:

- Standard Penetration Tests;
- Piezo Cone Penetration Tests;
- Cross hole Seismic Tests;
- Surface Seismic Refraction Tests;
- Field Electrical Resistivity Tests;
- Field Thermal Resistivity Tests; and,
- Plate Load Tests.

7.3.3 Baseline Survey – Results

Representative examples of boreholes taken from a range of locations drilled at the development site are included in Table 7-2, Table 7-3, Table 7-4, Table 7-5. The locations of boreholes is shown in Figure 7-4

Table 7-2: Borehole 15 Results

Soil Symbol	Classification	DESCRIPTION	Depth (meters)
	SM	Brown, loose, silty SAND	0.3
	LIMESTONE	Light grey to brown moderately to highly weathered and fractured, hard, Marly/Siliceous LIMESTONE having vugs/voids at places	0.6
			0.9
			1.2
			1.5
			1.8
			2.1
			2.4
			2.7
			3
			3.4
			3.7
			4
			4.3
			4.6
			4.9
			5.2
			5.5
			5.8
			6.1
			6.4
			6.7
			7
			7.3
		End of borehole at 7.5m depth	7.6
			7.9

Table 7-3: Borehole 42 Results

Soil Symbol	Classification	DESCRIPTION	Depth (meters)
	LIMESTONE	Light grey to brown moderately to highly weathered and fractured, hard, Marly/Siliceous LIMESTONE having vugs/voids at places	0.3
			0.6
			0.9
			1.2
			1.5
			1.8
			2.1
			2.4
			2.7
			3
			3.4
			3.7
			4
			4.3
			4.6
			4.9
			5.2
			5.5
			5.8
			6.1
			6.4
			6.7
			7
			7.3
		End of borehole at 7.5m depth	7.6
			7.9

Table 7-4: Borehole 45 Results

Soil Symbol	Classification	DESCRIPTION	Depth (meters)
	SM	Brown, loose, silty SAND	0.3
	LIMESTONE	Light grey to brown moderately to highly weathered and fractured, hard, Marly/Siliceous LIMESTONE having vugs/voids at places	0.6
			0.9
			1.2
			1.5
			1.8
			2.1
			2.4
			2.7
			3
			3.4
			3.7
			4
			4.3
			4.6
			4.9
			5.2
			5.5
			5.8
			6.1
			6.4
			6.7
			7
			7.3
		End of borehole at 7.5m depth	7.6
			7.9

Table 7-5: Borehole 48 Results

Soil Symbol	Classification	DESCRIPTION	Depth (meters)
	SM	Brown, loose, silty SAND	0.3
	LIMESTONE	Light grey to brown moderately to highly weathered and fractured, hard, Marly/Siliceous LIMESTONE having vugs/voids at places	0.6
			0.9
			1.2
			1.5
			1.8
			2.1
			2.4
			2.7
			3
			3.4
			3.7
			4
			4.3
			4.6
			4.9
			5.2
			5.5
			5.8
			6.1
			6.4
			6.7
			7
			7.3
		End of borehole at 7.5m depth	7.6
			7.9

The borehole investigation revealed that under a very thin layer of brown, loose silty sand (0 - 30 cm), rocky soil of varied types is found. This finding was common across the site.

Anecdotal evidence gathered from the drilling crew responsible for the installation of the high voltage lines to the north of the development site confirmed that the following strata were found across the site:

- 0 – 8 m : calcareous (limestone or marl) rock; and,
- 8-30 m: loose but strong sands and gravels.

No groundwater was uncovered during the ground investigations or has been uncovered by the high voltage line ground investigation drilling crew.

7.3.4 Quality and Contamination

No evidence of contamination was found at the development site during the ground investigation works.

7.3.5 Load Bearing Capacity

The assessment did not reveal any requirement to import fill material to the site, above that which would be normally required to construct the foundations of the solar energy park.

7.4 Assessment Methodology

7.4.1 Approach

The development of the Park may result in potential impacts to the soils and geology of the development site during the construction, commissioning, operation and decommissioning/ closure phases of the Park. Accidental events may also result in potential impacts.

The significance of potential impacts on soils and geology has been assessed and where appropriate, mitigation measures identified and the resulting residual impacts evaluated. The assessment of impacts on quality of soil has been undertaken on the basis of a Source-Pathway-Receptor approach. In the context of the Park, soil is not considered to be a valuable resource determined from evaluation of the current land-uses, and the general lack of soils within the developable area.

The assessment of surface and ground water impacts is provided in Chapter 8 – *Hydrology and Hydrogeology*. Any groundwater input to surface water flows, during rainfall events, will be ephemeral and relate solely to the rainfall event. This is therefore considered part of the hydrology & hydrogeology assessment shown in chapter 8, and not discussed further in this chapter. Chapter 9 - *Terrestrial Biodiversity* provides the full ecology assessment and discusses impacts related to the ecological habitats of the development site.

The storage and handling of non-hazardous and hazardous materials and wastes generated during all phases of the Park may lead to spillages and releases which could impact the soils and geology of the development site if not adequately managed. A detailed assessment of waste management is presented in Chapter 16 - *Waste Management*. These aspects are not assessed in detail in this section.

The magnitude and significance of impacts are assessed and defined according to the criteria presented in chapter 5 of this report. Each impact is identified by a unique reference number (in the format “SG#”) in the impact assessment and mitigation sections.

7.5 Impact Assessment

7.5.1 Construction Phase

Construction phase impacts are those expected to occur during the construction of the Park. These include impacts resulting from dust damping, storage of hazardous and non-hazardous materials and leaks from poorly maintained equipment. Table 7-6 shows impacts expected to occur during the operational phase of the Park.

Table 7-6: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG1	Soil/Geology	Low	Potential contamination of soil resulting from inappropriate discharge of aqueous effluents from construction activities such as dust damping and sanitary wastewater from temporary welfare units.	Effect: Negative Action: Direct Likelihood: Likely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Low
SG2	Soil/Geology	Low	Loss of potential future land use	Effect: Negative Action: Direct Likelihood: Certain Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low
SG3	Soil/Geology	Low	Alteration of existing topography	Effect: Negative Action: Direct Likelihood: Certain Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG4	Soil/Geology	Low	Risk of leaks arising from the use of poorly maintained construction plant and equipment	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low
SG5	Soil /Geology	Low	Risk of erosion of soils through wind blow	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Low

7.5.1.1 Potential contamination of soil from aqueous discharges

The uncontrolled discharge of aqueous effluents from construction activities such as washing down of equipment, dust damping, or fugitive particles arising from unsealed roads, concrete work and the washout from the concrete mixing plant, or from cleaning ready-mix concrete trucks contaminated with cement (i.e. highly alkaline) has the potential to negatively impact upon soils at the development site. This also includes impacts related to leaks from construction sanitary tanks.

Where hard surfaces have the potential to collect fluids with the potential to impact upon soils or geological resources, (such as car parks or fuel storage areas), oil interceptors should be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through infiltration of any harmful fluids into groundwater and hydrological resources.

Water used for construction purposes (dust suppression etc.) will be supplied via connection to the municipal supply and will comply with relevant standards as specified in Chapter 4. This will prevent the accidental introduction of contaminants contained within untreated water, into the soils.

All areas where water is to be used on site or where, through the introduction of water (such as during a storm event) hazardous materials may enter the soils by way of translocation or infiltration, will be designed in compliance with the requirements of IFC EHS Guidelines 1.3. *Wastewater and Ambient Water Quality*. This will ensure that any potential impact upon soils through accidental discharge is prevented.

The impact would be temporary, and related only to the construction phase of the Park. Due to the proposed management of fluids at the construction site, this impact is considered to be of low significance.

Impact SG1 – Low Significance

7.5.1.2 Loss of potential future land use

The change in land-use has the potential to impact on future land use and the value of natural resources, for example the loss of soil resources and impairment of agricultural land. However the project site is not currently considered to be high value for grazing or agriculture and is therefore considered to be low sensitivity. Although the seasonal herders have been recorded in the locality, water and feed are typically brought onto the site. There is minimal natural grazing within the developable area, and the surface geology is rocky with no valuable soil resource.

Additionally, at closure and decommissioning, the land could be returned to its original use. The concrete foundations are pre-fabricated and will be placed atop the ground, rather than being installed into it, acting as an anchor for the solar infrastructure. Therefore, due to the reversible nature of this impact, it is assessed as being of low significance.

Impact SG2 – Low Significance

7.5.1.3 Alteration of existing topography

Construction activities will include pre-construction site clearance and grading prior to the installation of operational infrastructure. Based on the relatively uniform topography of the developable area, these activities are not anticipated to be extensive and this impact is assessed as being of low significance.

Impact SG3 – Low Significance

7.5.1.4 Risk of leaks arising from construction plant and equipment

Throughout the assessment, it is assumed that plant used by the contractor on site is within its design life, and has been properly maintained as per the manufacturer's instructions. Where plant is expired, or has not been properly maintained, there is a potential for uncontrolled leaks and spills arising from cracked fuel units, faulty pipes and other mechanical failures. The volumes of material which could potentially escape in this scenario are small, and the impact would be localized. Therefore, this impact is considered to be of low significance.

Vehicle fuels should be stored in accordance with the guidelines in Section 1.5 of the IFC General EHS Guidelines, including secondary containment systems. Vehicle refueling should be undertaken within an area of concrete hard-standing with spill containment and all stationary plant should have drip trays installed.

Impact SG4 – Low Significance

7.5.1.5 Risk of erosion of soils

There is a potential for the loss of soils through windblown disturbance. When soil is disturbed through construction activities such as vehicle movements, site grading and excavation, wind can displace this soil and carry it elsewhere on the site. Such activity can lead to a loss of nutrients within the soil.

Particles can be displaced and transported by wind in a number of ways, dependent on the size of the particles and the speed of the wind. Larger particles require greater wind speed to be displaced. Particles of ~100 µm are the most susceptible to 'wind drag' and can be moved by low wind speeds. These particles will typically 'hop' along the surface of the ground in what is known as 'saltation'. These 'saltators' can mobilize particles of a wide range of sizes. Dust particles are not normally directly lifted by wind because their inter particle cohesive forces are large compared to aerodynamic

forces. Small particles are elevated from the soil as a result of impact from the saltating particles. Following ejection, dust particles are susceptible to turbulent fluctuations and usually enter short-term (~ 20 - 70 mm diameter) or long-term (< ~20 mm diameter) suspension. Long-term suspended dust can remain in the atmosphere for several weeks and be transported thousands of kilometers from its source. The acceleration of particles with diameters in excess of ~500 µm is limited by their size and resultant inertia. These particles generally do not saltate, they usually settle into the soil after moving generally less than a centimeter (reptation). Larger particles can roll or slide along the surface, driven by saltating particles and wind drag forces in a mode of transport known as creep. Creep and reptation can account for a substantial fraction of the total wind-blown sand flux.

The transport of soil particles by wind can thus be crudely separated into several physical regimes: long-term suspension (< ~20 µm diameter), short-term suspension (~20 – 70 µm), saltation (~70–500 µm), and reptation and creep (> ~500 µm). Note that these four transport modes are not discrete: each mode morphs continuously into the next with changing wind speed, particle size, and soil size distribution.

The soil found on the site was classified as predominantly (91%) sand, having passed through a 4.75mm sieve, and been retained by a 75 µm sieve. This means that more than 90% of the sand will be subject only to saltation, with approximately 10% subject to suspension.

Based on the negligible soil resource across the development area, the potential for loss of soil through wind-blown disturbance is considered to be of low significance.

Impact SG5 – Low Significance

7.5.2 Operation Phase Impacts

Operational phase impacts are those expected to occur during the day to day operation of the Park. These include impacts resulting from improper storage of materials, discharges from vehicles and runoff from surfaces. Table 7-7 shows impacts expected to occur during the operational phase of the Park.

Table 7-7: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG6	Soil/Geology	Low	Degradation of soil quality due to continuous discharge of cleaning fluid from solar panels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Low
SG7	Soil/Geology	Low	Loss of soil due to storm water runoff and erosion	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG8	Soil/Geology	Low	Impact upon soil from release of stored chemicals / fluids on site	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low

7.5.2.1 Degradation of soil quality due to aqueous discharges

At this stage of the development, it is expected that scheduled 'spot' cleaning will be used alongside mechanized dry cleaning, in order to preserve the function of the solar modules. This approach will significantly reduce the demand for water, considered further in Chapter 15, and the volume of waste water run-off.

Furthermore, only biodegradable chemicals should be used to clean the solar panels. This will ensure that no damage to the panels is sustained through the use of harsh cleaning chemicals, and that no impact is sustained on soils at the development site. This is not only an environmental benefit, but also relates to optimal performance of the solar modules as chemical based cleaning products can leave a thin film of residue on the surface of the panels which can reduce performance.

Due to the nature of this impact, and the low impact expected to arise should it occur prior to the implementation of mitigation, this impact is considered to be of low significance.

Impact SG6 – Low Significance

7.5.2.2 Loss of soil due to storm water runoff and erosion

During storm events, there is potential risk for soil erosion and wash-out. Due to the infrequent and minor nature of storm events, the relatively uniform topography of the developable area, and the fact that measures are suggested as part of the hydrology and hydrogeology assessment which will be incorporated into the design of the Park (e.g. drainage channels and reinforcement of hard standing), this impact is considered to be of low significance.

Impact SG7 – Low Significance

7.5.2.3 Impact on soil from release of stored chemicals / fluids on site

Where chemicals / fluids are stored at the development site, there is a potential for infiltration into soils and geological resources through accidental and uncontrolled release.

It is proposed to use a septic tank stored on site during the operation of the Park, and there is a potential for uncontrolled releases. The design of the septic tank should comply with Section 1.3 of the IFC General EHS Guidelines and Saudi Aramco Engineering Standard-S-104; sanitary wastewater should be stored in a double bundled (to 110% capacity) tank. This will ensure that any potential impact upon soils through accidental discharge is mitigated through design.

There will be a back-up generator in case of a power failure, and a diesel tank will be installed to provide fuel supplies. This tank will again be designed in accordance with Section 1.3 of the IFC General EHS Guidelines and Saudi Aramco Engineering Standard-S-104.

The permanent design of the Park will include a workshop and storage building. All chemical will be stored under appropriate conditions within this building on hard-standing.

Where hard surfaces have the potential to collect fluids with the potential to impact upon hydrological or hydrogeological resources, (such as car parks or fuel storage areas), oil interceptors should be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through infiltration, of any harmful fluids into groundwater and hydrological resources.

Due to the proposed management of chemicals / fluids at the development site, this impact is considered to be of low significance.

Impact SG8 – Low Significance

7.5.3 Decommissioning Phase Impacts

The impacts associated with the decommissioning of the solar energy park are expected to be similar to those expected to occur during the construction phase. See section 7.5.1 for details.

Table 7-8 : Decommissioning Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
SG9	Soil/Geology	Low	Impacts upon soils and geology due to residual materials after breakout of concrete foundations and other demolition activities.	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low
SG10	Soil/Geology	Low	Impacts upon soils and geology due to leaks of fluids used during demolition	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low

7.5.3.1 Impacts on soils and geology due to residual materials

Following decommissioning and demolition of the Park, there is a potential for residual material to remain at the development site such as broken concrete or leftover marl. All demolition work will be carried out with reference to IFC EHS Guidelines 1.6 *Waste Management* and the GAME (PME) Environmental Standard 18 *Best Practicable Environment Option for Waste Disposal*. Due to the

intention to follow the guidance laid out in these documents, the significance of this impact is considered to be low.

Impact SG9 - Low Significance

7.5.3.2 Impacts on soils and geology due to leaks of fluids used during demolition

The uncontrolled discharge of aqueous effluents from demolition activities such as washing down of equipment, dust damping, or fugitive particles arising from unsealed roads and concrete work, has the potential to negatively impact upon soils at the development site. This also includes impacts related to leaks from sanitary tanks. Contamination should not be allowed to enter any watercourse/drainage channel and should be re-used or treated on site where possible.

Where hard surfaces have the potential to collect fluids with the potential to impact upon soils or geological resources, (such as car parks or fuel storage areas), oil interceptors should be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through infiltration of any harmful fluids into groundwater and hydrological resources.

Demand for water for dust suppression etc. will be supplied via connection to the municipal supply and will comply with relevant standards as specified in Chapter 4. This will prevent the accidental introduction of contaminants contained within untreated water, into the soils.

All areas where water is to be used on site or where, through the introduction of water (such as during a storm event) hazardous materials may enter the soils by way of translocation or infiltration, will be designed in compliance with the requirements of IFC EHS Guidelines 1.3. *Wastewater and Ambient Water Quality*. This will ensure that any potential impact upon soils through accidental discharge is prevented.

The impact would be temporary, and related only to the temporary decommissioning phase of the Park. Due to the proposed management of fluids at the construction site, this impact is considered to be of low significance.

Impact SG10 - Low Significance

7.6 Mitigation

7.6.1 Construction Phase

Impacts anticipated during the construction phase of the Park are expected to be of low significance. As per the

The EPC contractor must prepare a Construction Environmental Management Plan (CEMP) to manage environmental and social risk, as part of its Environmental and Social Management System (ESMS), in compliance with IFC Performance Standard 1. The purpose of the CEMP is to describe the environmental management and monitoring procedures to be implemented during the construction phase of the Park. The CEMP ensures that appropriate environmental management practices are followed during the construction phase.

Implementation of the CEMP will ensure:

- Compliance with conditions of authorizations, resource consents, and designations;
- Awareness of and adherence to environmental objectives;

- Proper management of environmental risks associated with the Park;
- Maintenance of competence and training requirements of staff with environmental responsibilities;
- Lines of communication in the event of an emergency;
- Construction waste management plan, designed to eliminate the risk of contamination entering the natural environment;
- Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices;
- Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties;
- Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases;
- Procedure to be implemented following the accidental release of hazardous substances during refueling of vehicles, including details of containment and recovery measures to be applied; and,
- Washout from the cleaning of ready-mix concrete trucks contaminated with cement is highly alkaline. This should not be allowed to enter any drainage channel and should be re-used on site where possible. Where this is not possible, the water should either be treated for pH and suspended solids and discharged off-site, or transported untreated, for disposal off site. Untreated disposal is the least favored options for waste water. On site treatment of washout should be undertaken within a hard standing area which is bunded and contained. Water must then be collected and disposed of in a closed loop system, as per the requirements of IFC EHS standards 1.3 *Wastewater and Ambient Water Quality*.

It is additionally advised that maintenance and lifespan requirements of plant and other vehicles to be used on site are laid out in advance of construction. This will allow the contractor sufficient time to perform proper maintenance and upkeep on required plant in advance of construction.

With regard to cleaning of solar modules, biodegradable cleaning fluids should be used only in order to minimize impacts upon soils resulting from runoff.

7.6.2 Operation Phase

Impacts anticipated during the operation phase of the Park are expected to be of low significance. The design has adopted recommendations related to proper drainage of cleaning fluids and excess water. Additionally, chemical based cleaning products which would likely impact upon soils through discharge should not be used, as these can create a microfilm on top of the panels which reduces efficiency. Therefore it is assumed that biodegradable cleaning fluids will be used and that these will have no impact upon soils at the development site through runoff. Provided these recommendations are followed, there is no reason that the impacts associated with the Park cannot be fully mitigated.

7.6.3 Decommissioning Phase

No impacts of moderate or high significance were identified in relation to the decommissioning of the Park. Best practice recommendations as shown in section 7.6.1 are suggested for the decommissioning phase of the Park.

7.7 Conclusion

This assessment of Soils and Geology has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the impact assessment should be reviewed with any updates and reported in an Addendum to this ESIA.

Notwithstanding, it is not anticipated that the Sakaka Solar Energy Park will have a significant impact upon the soil and geology resources of the development site, or that of the surrounding area. Where impacts are anticipated, they are expected to be of low significance, and are fully reversible upon decommissioning of the Park.

7.8 References

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8. Hydrology & Hydrogeology

8.1 Introduction

This chapter provides an overview of the existing hydrological and hydrogeological conditions present at the development site, and an evaluation and assessment of the potential impacts upon them which may arise as a result of the Park.

The assessment addresses regional and local hydrological and hydrogeological conditions, characterizes the surface and ground water resources and quality, and assesses potential impacts on receptors. Impacts related to the supply of water, municipal, potable and sanitary are addressed in Chapter 15 *Utilities and Infrastructure*.

8.2 International and National Standards and Guidance

8.2.1 IFC EHS Guidelines

Section 1.3 Wastewater and Ambient Water Quality of the IFC EHS Guidelines (2007) applies to projects that have either direct or indirect discharge of process wastewater, wastewater, wastewater from utility operations or storm water to the environment; and includes measures for water conservation and reuse. The standard states that projects with the potential to generate process wastewater, sanitary (domestic) sewage, or storm water should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety or the environment. As stated in Section 1.3 Wastewater and Ambient Water Quality of the IFC EHS Guidelines (2007), the receiving water use and assimilative capacity, taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality.

The IFC EHS Guidelines (2007) provide guidelines for the management of wastewater, liquid effluent quality (including the discharge to surface water and sanitary sewer systems, land application of treated effluent and septic systems), and storm water management.

8.2.2 IFC Performance Standard 3

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenant of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The objectives for this Performance Standard are as follows:

- To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities;
- To promote more sustainable use of resources, including energy and water; and,
- To reduce project-related Greenhouse Gas (GHG) emissions.

As stated in IFC Performance Standard 3, *“when the project is a potentially significant consumer of water, in addition to applying the resource efficiency requirements of this Performance Standard, the client shall adopt measures that avoid or reduce water usage so that the project’s water consumption*

does not have significant adverse impacts on others. These measures include, but are not limited to, the use of additional technically feasible water conservation measures within the client's operations, the use of alternative water supplies, water consumption offsets to reduce total demand for water resources to within the available supply, and evaluation of alternative project locations”.

8.2.3 National Legislation

The GAME has established ambient water quality standards. These standards introduce a baseline standard of water quality which aims to protect the Kingdom of Saudi Arabia's water supply and natural aquatic environment whilst allowing for sustainable economic and social development.

The ambient water quality standards for surface water and groundwater in the Kingdom of Saudi Arabia are listed in Table 8-1.

Table 8-1 : Ambient Water Quality Standards

Parameter	Unit	Surface Water	Groundwater
Temperature	oC	ABD	n/a
pH	pH Units	ABD	ABD
Salinity	%	ABD	ABD
TDS	mg/l	5,000	ABD
TSS	mg/l	5	ABD
Turbidity	NTU	30	ABD
Dissolved Oxygen	mg/l	>5	n/a
Biological Oxygen Demand	mg/l	10	n/a
Chemical Oxygen Demand	mg/l	25	n/a
Oil and Grease	mg/l	3	0
TKN	mg/l	3	ABD
TOC	mg/l	10	ABD
Phosphorus (total)	mg/l	0.5	0.3
Phosphorus (PO ₄ -P)	mg/l	0.1	ABD
Ammonia (Free as NH ₃)	mg/l	0.1	0.3
Chloride (as Cl)	mg/l	ABD	ABD
Calcium (CaCO ₃)	mg/l	ABD	ABD
Inorganic Nitrogen (as Nitrite and Nitrate)	mg/l	1	30
Sodium	mg/l	150	150
Sulfate	mg/l	200	250 (Guide)

Parameter	Unit	Surface Water	Groundwater
Sulfide	mg/l	0.002	0.002
Total Petroleum Hydrocarbon	mg/l	0.3	0.2
ABD – Above Background Levels			

8.3 Baseline Environmental Conditions

8.3.1 Groundwater

The groundwater resources within the Kingdom of Saudi Arabia are almost exclusively found within eight large tectonic basins of sedimentary rocks bordering the Arabian Shield (Vincent, 2008). The development site is located above two primary aquifers: the Saq Sandstone aquifer and the Wasio-Biyadh-Aruma aquifer (Figure 8-1 and Figure 8-2). The Tawil-Quaternary Aquifer is a further system associated with these primary aquifers (Figure 8-3).

Saudi Aramco has commissioned a hydrology and hydrogeology assessment, and a geotechnical investigation for the development site.

8.3.1.1 Saq Sandstone Aquifer

The development site is located to the east of the exploitable resource area of the Saq Sandstone aquifer. Figure 8-1 shows the extent of the Saq aquifer and the exploitable area. Groundwater is found in the Saq aquifer at depths of between 150m in the outcrops in Wadi Sirhan, to over 400m in central Jordan (UN, 2013)



Groundwater abstraction in the Tabuk area has increased drastically from approximately 29 Million Cubic Meters (MCM)/yr in 1983 to between 1,050-1,700 MCM/yr in 2004, mostly in the agricultural sector, while recharge remains at 3-10 MCM/yr. The heavy mining of the aquifer system has resulted in water level drops of up to 32 m/yr in the late 1980s in Saudi Arabia. There are indications that the

exploitable part of the resource may be exhausted within 30-40 years, unless abstraction can be controlled on both sides of the border (UN, 2013).

8.3.1.2 Wasia-Biyadh-Aruma Aquifer

The exploitable area of the Wasia-Biyadh-Aruma aquifer, also known as the Sakaka-Rutba aquifer, lies to the east of the development site. The Wasia-Biyadh-Aruma aquifer is of lower and middle cretaceous sandstones and is located in the Northern Interior Homocline and the Widyan Basin margin. The Wasia formation is the single most important lithostratigraphic unit for water resources in the Kingdom of Saudi Arabia (Vincent, 2008).

The reserves in this aquifer are estimated to be $590,000 \times 10^6 \text{ m}^3$, although recharge rates are estimated to be $480 \times 10^6 \text{ m}^3$ and the exploitation depth ranges between 200 and 400 m below ground level (UN, 2013). The use of this aquifer system is currently limited due to its remoteness and the harsh environment in the area but the towns of Ar'ar and Sakaka in Saudi Arabia presumably rely on the aquifer system for their water supply (UN, 2013). Figure 8-2 shows the Wasia-Biyadh Aruma Aquifer.

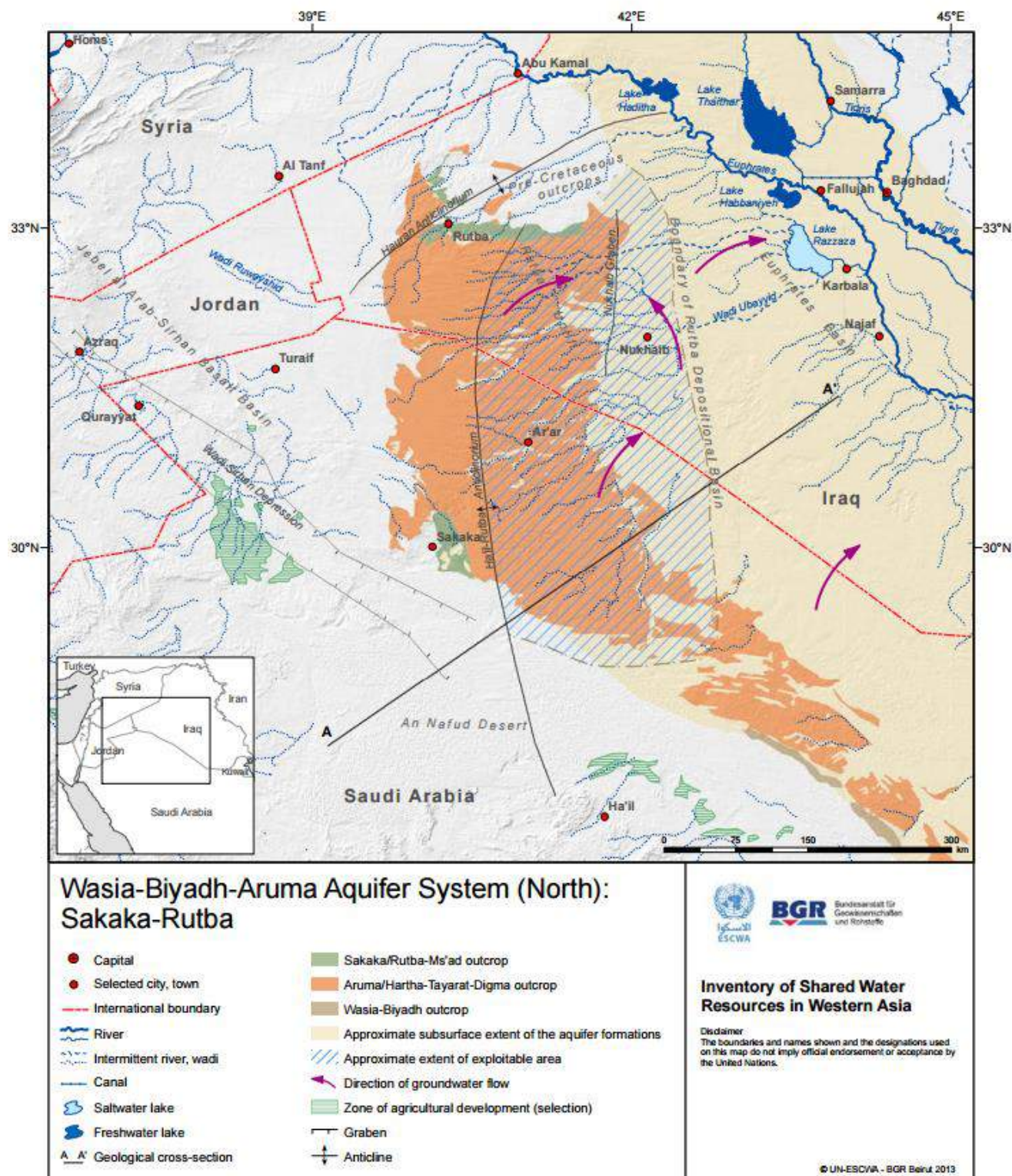


Figure 8-2: Wasia-Biyadh-Aruma Aquifer System (North): Sakaka-Rutba

8.3.1.3 Tawil-Quaternary Aquifer: Wadi Sirhan Basin

The Tawil-Quaternary Aquifer System, also referred to as the Wadi Sirhan Basin, extends from the eastern boundaries of the Basalt Aquifer towards the Sakaka - Al Jouf area. The Wadi Sirhan Basin is comprised of sedimentary water-bearing formations in a zone of subsidence shaped by subsurface faults associated with major crustal movements (UN, 2013). These water-bearing formations were subjected to deep and significant fracturing with large vertical displacement (50-1,500 m) and this tectonic setting resulted in the deposition of thick sediments since the late Cretaceous time, which dip towards the center of the depression (UN, 2013).

Before heavy abstraction from the aquifer system started in the 1990s, depth to water was reported at less than 10 m below ground level. Today, exploitable reserves are located at a water level as far as 250m below ground level. The present day recharge of the aquifer is limited. (UN, 2013)

The formations of the Tawil-Quaternary Aquifer System are comprised of an upper part (Upper Cretaceous to Quaternary) and a lower part (mainly Silurian- Early Devonian). There has been significant abstraction from this aquifer and subsequent depletion of resource. The exploitable reserves in this formation are estimated to be about 22 BCM (UN, 2013). Natural recharge to this aquifer is assessed as negligible and this aquifer has limited renewability. Figure 8-3 shows the Tawil-Quaternary Aquifer System.

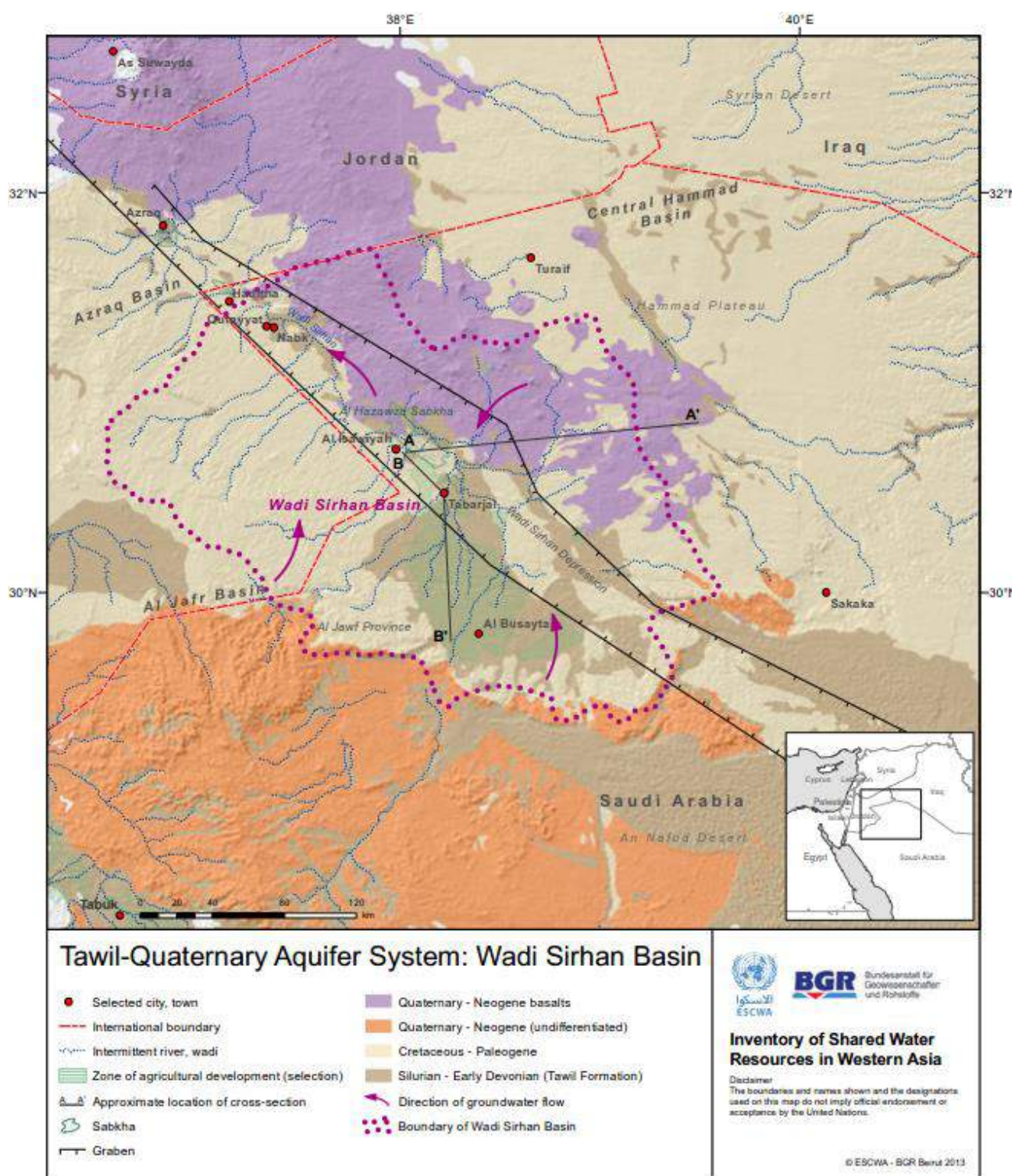


Figure 8-3: Tawil-Quaternary Aquifer System: Sakaka-Rutba

8.3.2 Groundwater Abstraction

A study commissioned by the then Ministry of Water and Electricity inventoried the groundwater abstraction boreholes within the exploitable area of the Saq Sandstone Aquifer. As part of the study, a total of 5,969 water points were inventoried, which included wells for domestic water supply, and agricultural irrigation. As can be seen in Figure 8-4, there is a concentration of boreholes in the vicinity of Sakaka and Dumat al Jandal which support agricultural irrigation. In total, 4972 of the wells are for irrigation, whilst 573 are for domestic water supplies.

Data presented in the report “Groundwater Management in Saudi Arabia” (FAO, 2009) indicates a gradual decline in major aquifer water levels in the Kingdom of Saudi Arabia since the start of the data in 1980. A declining trend in aquifer water levels in the development area may also be expected (FAO, 2009).

Agriculture is a primary source of economic activity within Al Jouf province and groundwater abstraction supplies the majority of irrigation demand. Historic and ongoing abstraction from aquifers in this region is contributing towards the depletion of this natural resource with limited renewability. These resources are precious as they are not the product of an ongoing hydrological cycle (FAO, 2009).

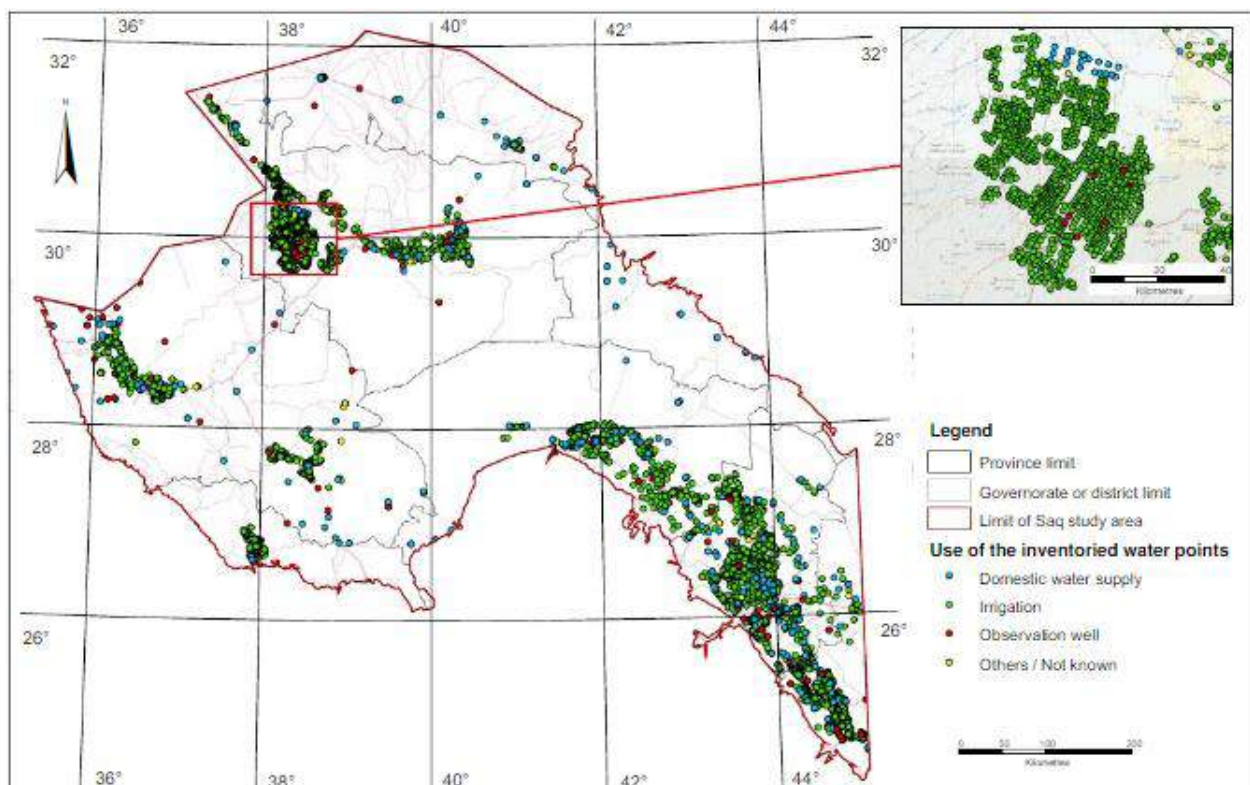


Figure 8-4: Location Map of the Inventoried Water Points of Saq Aquifer (source: MOWE, 2008)

A cross-chapter of the aquifers in the region has been developed by the Ministry of Water and Electricity (2008) and is illustrated in Figure 8-5.

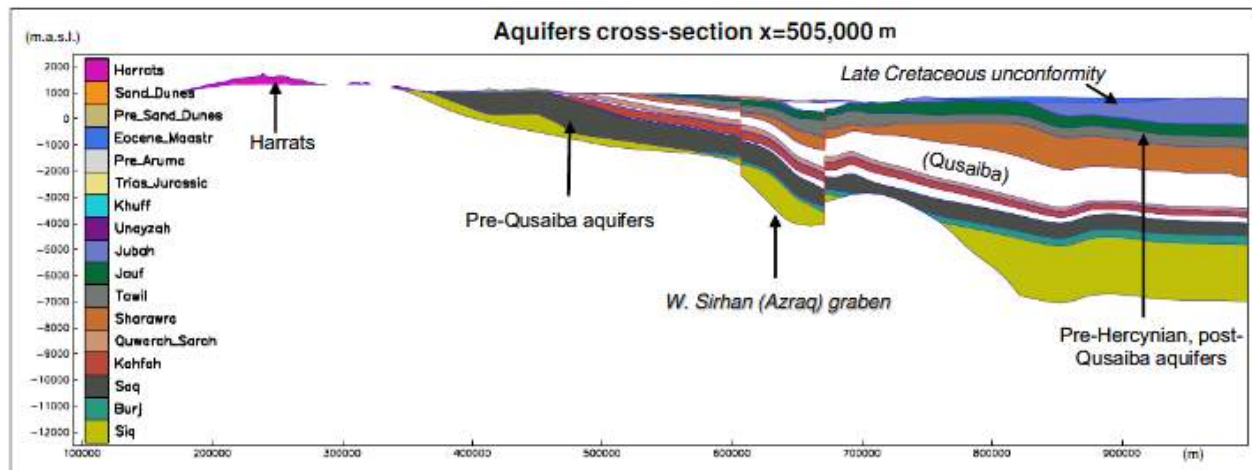


Figure 8-5: North-south Cross-section Along the 40°E Meridian (longitude of Sakaka) (Source: MOWE, 2008)

8.3.3 Surface Water

There are no permanent surface water bodies either on the site, or within the Study Area. However there are two surface water bodies in the wider region.

There is a lake to the north-east side of Dumat al Jandal and it is one of the few remaining wetland habitats in the northern desert of the Kingdom of Saudi Arabia. Until 1983-1984 it was a medium-sized natural lake surrounded by a large marsh of reeds and sedges (900 ha overall), but this has now been drained and converted to agricultural smallholdings; the water is pumped to an elevated basin in the hills overlooking the former marsh, forming a reservoir (150 ha). From here water flows through a number of irrigation channels back to the agricultural areas, where there are some very small, scattered remains of marshland.

The reservoir is used for recreation in summer, and Tilapia fish have been introduced (Birdlife International, 2016). The site has been designated as an Important Bird and Biodiversity Area (IBA) by Birdlife International. Dumat al Jandal Lake is located approximately 18km north-west of the development site.

There is also a lake to the east of Sakaka, approximately 22km north-east of the development site. The lake is fed by treated waste water and unlike Dumat al Jandal, it is a man-made feature. The lake is surrounded by dunes and a dense fringe of reeds *Phragmites* spp.

8.3.4 Local Hydrology

8.3.4.1 Annual Rainfall

Rainfall data was collected at meteorological monitoring stations within 50km of the development site. The data showed variability between the different stations. The locations of the meteorological monitoring stations is shown in Figure 8-6 and the mean rainfall recorded at each station is shown in Table 8-2.



Figure 8-6: Location of Meteorological Monitoring Stations

Table 8-2: Mean Annual Rainfall at Meteorological Monitoring Stations

Station	Period of measurement	Mean Annual Rainfall (mm)	Highest Rainfall Year	Highest Amount of Rain
592	1964-2013	46.71	1967	152.3
598	1965-2013	42.20	1967	149.8
606	1983-2003	26.40	1985	54.0

There is significant variability in the recorded data, despite the proximity of the meteorological monitoring stations. This can be explained broadly through the absence of data for certain years within the measurement period, especially at station 606. When data from station 606 is excluded as

anomalous, a mean average level for local rainfall in proximity to the development site can be taken as 44.45mm per year, which is considered to be low.

8.3.4.2 Rainfall Intensity

Rainfall intensity is a measure of how frequently, and at what intensity, rainfall events in a given area are expected to occur. It is measured in mm/h and is given for 'return periods' which represent the frequency (in years) and duration (in minutes and hours) of events at a given intensity.

Table 8-3 shows rainfall intensity data which was extrapolated from data provided at the three monitoring stations.

Table 8-3: Intensity Duration Data

Return Period (years)	Intensity (mm/h)							
	10 minute	20 minute	30 minute	One Hour	Two Hour	Three Hour	Six Hour	Twelve Hour
10	59.91	42.94	30.14	16.96	9.69	6.96	3.59	2.02
20	72.91	53.04	37.07	20.52	11.68	8.40	4.28	2.43
50	89.74	66.12	46.04	25.13	14.25	10.27	5.18	2.96
100	102.36	75.92	52.76	28.59	16.18	11.66	5.85	3.35

The most intense rainfall at the area for which data was provided was experienced for ten minute duration in the 100 year return period and was 102.36mm/h. This is considered broadly representative of conditions at the development site, however, it is noted that they are not perfectly suitable for the site region.

8.3.5 Baseline Survey

A baseline site walkover survey was carried out as part of the hydrogeological survey. No further observations were made in the field above what was included in the data provided.

8.4 Assessment Methodology

8.4.1 Aquifer Vulnerability

Assessment of groundwater vulnerability was carried out with reference to the GOD method as described in the GAME (PME) environmental standard 17, *Industrial & Municipal Wastewater Discharges* Appendix C '*Determining the pollution vulnerability of an aquifer*'. This method involves identifying the degree of confinement of the aquifer groundwater, the lithological characterization of the horizon above the saturated zone of the aquifer and an estimation of the depth of the groundwater. These characteristics are quantified using a 0.0-1.0 scale. These numbers are indexed to produce a number which represents the Ground water occurrence (G), the overall lithology of the aquifer or aquitard (O) and the depth of the groundwater table (D) These GOD values are compared against a qualitative scale of vulnerability as shown in Figure 8-7.

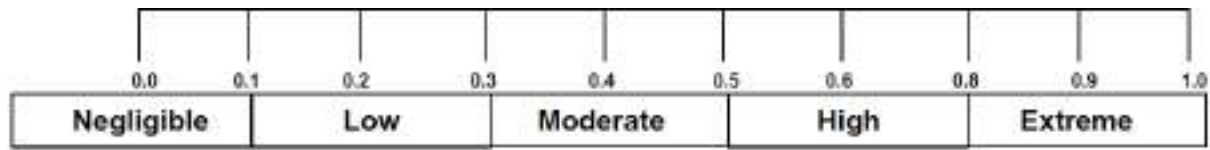


Figure 8-7: GOD Index of Groundwater Vulnerability

The degree of confinement for groundwater encountered at the development site is considered to be 'confined' (0.2). This is due to the fact that there is sand and limestone at ground level above it.

According to the boring logs from the ground investigation, the strata overlaying the groundwater at locations where it was encountered, are described as; *"brown, loose, silty SAND Light grey to brown, moderately to highly weathered and fractured hard, Marly/Siliceous LIMESTONE having vugs/voids at places."* Therefore, the lithological characterization of the aquifer is considered to be 'Calcrete + karst limestones' (0.9).

No groundwater was discovered at the development site. Boreholes were drilled to a depth of 30m, therefore, the depth of the aquifer is known to be greater than that value, alongside this, it is known that the minimum depth of groundwater within the aquifer is 150m. However, due to the fact that the characterization of the rock, is Calcretes + karst limestones, the depth of aquifer must be classified as (1.0).

The overall categorization of groundwater encountered at the development site, according to the GOD scale, is therefore considered to be 0.72, which is considered to be High. ($GOD = CI \times Ca \times Cd$).

Despite the high sensitivity of the groundwater at the development site, due to the benign nature of impacts upon groundwater expected to be associated with the Park, further groundwater / spill modelling was considered of limited value.

8.4.2 Flood Risk Assessment

The baseline data for the development site was extrapolated using data provided. Calculations were used to model the likely frequency and duration of storm events. The modelling was carried out for both pre-development, and post-development scenarios in order to draw a comparison between the two and therefore understand the impact of the Park upon the flood regime of the development site.

The same calculations were used in order to understand the impact of the Park upon the drainage regime of the development site, carried out with a 'with site' scenario as opposed to a 'baseline' scenario.

8.4.3 Prediction of Flood Risk

Modelling was carried out to predict flood events at the development site. The modelling utilized the Storm Water Management Model, developed by the Environmental Protection Agency (EPA) in 2010, which is used to evaluate the runoff quantities from the site area and compare the situations before and after development.

For this project, the Soil Conservation Service (SCS) Curve Number (CN) Method was used (United States Department of Agriculture, 1986).

The approach is based on the following relations: $R = (P - Ia)^2 P - Ia + S$

$$\text{Where: } R = \frac{(P - 1a)^2}{P - 1a + S}$$

With:

- R = Cumulative runoff (mm)
- P = Rainfall depth (mm)
- Ia = Initial abstraction (mm)
- S = Volume of total storage (mm)
- CN = curve number.

Storage includes both initial abstraction and total infiltration. The initial abstraction is a function of land use, infiltration, detentions storage and antecedent soil moisture. The initial abstraction and the total storage are commonly related by the following empirical relation.

$$Ia=0.2 S$$

CN₁₁ is the curve number that can be obtained from standard tables for different combinations of land-use, land cover and hydrologic soil groups.

From dry conditions, assumed here, an additional conversion is required following:

$$CN_1 = \frac{4.2CN_{11}}{10 - 0.058CN_{11}}$$

The following assumptions were made in the modelling:

- Soil Group A: Low runoff potential with high infiltration rates (Infiltration rate > 1.14 mm/h). This choice is in agreement with the visual findings from the site visits and the results of the geotechnical investigations (RGF Geotechnical and Materials Testing Laboratories, 2016). The thickness is deemed sufficient to categorize the soil into the group A and the local and limited occurrences of surface rocks (0-0.5 cm) do not change the categorization significantly.
- CNII: 63 (Natural desert landscaping, pervious areas)
- CNI: 41.7 (according to previous)

8.4.4 Pre Development Flood Risk

The conclusion of modelling exercise was that due to the very mild slope (less than 0.1 %) of the topography even for an important flood event (10 years return period), the flow velocities are very low (Max around 0.5 m/s).

8.4.5 Post Development Flood Risk

The runoff simulations of the existing situation and of the Park development have been carried out and compared. A small discharge growth is expected due to the increase of the impervious surfaces and the light reduction of the concentration time.

The solutions for road crossings and the need of more infiltration areas will have to be defined in regard of the existing constraints and building possibilities.

8.5 Impact Assessment

8.5.1 Basis of Design

The management of storm water has been considered as part of the preliminary design and this has been accounted for in the assessment of impact. The hydrology and storm water management report has recommended the construction of rip rap and other protection measures to manage storm water run-off. This includes rip rap around tracks and hard surfaces, and an outfall to manage the discharge of storm water.

8.5.1.1 Ditches

The estimated velocities in ditches are between 0.20 and 0.65 m/s at the peak of the flood for the 10 year event.

On the other hand, maximum velocities found in the literature for fine sand canals vary globally between 0.45 and 0.60 m/s (1.5 and 2.0 fps) (Ven Te Chow, 1979, USACE, 1991).

In those circumstances, it seems probable that during certain storms and at certain locations, some erosion and sediment movement will occur.

Two approaches may be considered:

Option A

- Design erosion protection measures for all the ditches, such as rock or gravel riprap (the pervious nature of the drainage system must be maintained).

Option B

- Schedule maintenance and ditches rehabilitation after severe events.

Option B is recommended for the following reasons:

- The additional costs of construction and maintenance difficulties imposed with installing riprap;
- The limited expected volumes of sediment transported (only some phases of the Park are concerned);
- The infrequent nature and conservative characteristics of the design storm (10 year return period), velocities and erosion for more common storms will be lower;
- The fact that velocities do not change significantly between the pre and post development simulations; no sign of sediment movement is currently detected on site;
- The calculated velocities correspond to the case where road crossings with culverts are considered. If fording structures are included, some storage will occur upstream of the ford and the flow velocities will be reduced significantly.
- Additional maintenance works will be required after important storms to rehabilitate the ditches if sediment movements or deposits are observed and risk to impact the flow.

8.5.1.2 At the outlet of the pipe or culvert

Riprap protection will be required at the outlet of the culvert or pipe crossings in order to dissipate the energy and avoid erosion caused by high velocities and turbulences at the outlet.

A typical riprap apron would be composed of a well graded mixture of stones where 50 percent of the pieces, by weight, are larger than the median stone diameter (d50). The diameter of the largest stone will not exceed $1.5 \times d50$.

Normally the minimal tail-water condition will be observed because of the large width of the ditches and the small water depth of the flow.

The minimum thickness of the riprap layer will be 1.5 times the maximum stone diameter for $d50 \leq 15$ inches (38.1 cm); and, 1.2 times the maximum stone size for $d50 > 15$ inches.

The stones will be placed on a geotextile in order to prevent migration of the fine soil particles through voids and distribute the weight of the protection.

8.5.1.3 Areas of hard standing

Where hard surfaces have the potential to collect fluids with the potential to impact upon hydrological or hydrogeological resources (e.g. car parks or vehicle maintenance areas), oil interceptors will be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through interception of any harmful fluids into groundwater and hydrological resources. The management of storm water must also be in compliance with the recommendations in Section 1.3 Wastewater and Ambient Water Quality of the IFC EHS Guidelines (2007).

8.5.2 Construction Phase

Limited impacts are expected to occur during the construction phase of the Park except in the event that a storm should occur during that period. As the severity of storms below the 100 year return period is minor, it is not anticipated that the Park would impact upon this regime during the construction phase.

Water sources for construction will be supplied from off site, via connection to local municipal supply infrastructure, no on site abstraction of ground water will occur.

Vulnerability of the aquifer located beneath the development site is classified as high according to the GOD index, however minimal runoff is expected and recommended procedures for fluid storage and disposal are to be followed at the development site, therefore the Park is not expected to impact upon the ground water at the development site.

All wastewater will be temporarily stored on site and then taken by tanker off-site for treatment prior to discharge or re-use.

Table 8-4: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH1	Groundwater Stored in Aquifer	High	Changes to groundwater as a result of leaks and spills during construction phase and washout from concrete cleaning	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Long Local permanent	Low	Low

8.5.2.1 Changes to groundwater quality

Water for construction will be supplied through a connection to the local municipal supply located adjacent to Road 80.

Where water or any construction fluids are required to be stored or utilized on site (including sanitary waste, diesel fuel and other fluids), this will be carried out in accordance with the IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality* and GAME Environmental Standard 6: *Storage and Material Reclaim Facilities Design and Operation*. Materials with the potential to adversely impact the environment will be stored with secondary containment systems in accordance with Section 1.5 of the IFC General EHS Guidelines. Through design, the potential for groundwater quality to be impacted will be minimized.

Washout from the cleaning of concrete trucks will be managed in accordance with the same guidelines, which will require the use of a hard standing, double-bunded area and a closed disposal system.

Water used for dust damping, will be supplied via connection to municipal water supply adjacent to Road 80 the town of Sakaka. Water supplied will be in compliance with the requirements of SAES-A-104 - *Wastewater Treatment, Reuse and Disposal and Section 1.3 of the IFC EHS Guidelines, including the WHO Guidelines for the Safe Use of Wastewater, Excreta and Greywater*. This will avoid the potential for impacts upon water as a result of untreated water being used for dust damping and other construction activities where exposure to the ground is unavoidable.

Due to the proposed management of fluids at the development site, and the absence of groundwater above 30m below ground level, this impact is assessed as being of low significance.

Impact HH1 – Low Significance

8.5.3 Operation Phase

Impacts experienced during the operation phase of the Park are expected to be related to the runoff of cleaning solutions from surfaces, and leaks and spills of sanitary waste during operation of the Park.

Table 8-5: Operation Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH2	Flood Regime of Development Site	Low	Alteration of flood drainage pattern on development site due to introduction of hard surfacing	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Short Local Reversible	Low	Low
HH3	Drainage Regime of Development Site	Low	Infiltration of water from cleaning of panels	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Low	Low
HH4	Groundwater at development site	Low	Changes to groundwater as a result of leaks of stored fluids at the development site.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Rare Short Local Reversible	Low	Low

8.5.3.1 Alteration of flood drainage pattern

During the operational phase of the Park, the hydrogeological regime of the site will be temporarily altered as a consequence of areas of hard surfacing. The areas of hard surfacing will reduce the rate of natural infiltration and contribute towards increased volumes of surface water run-off. Due to the absence of fluvial flows, the infrequent occurrence and short duration of pluvial flooding, and the small surface area of hard surfacing in comparison to the developable area of the Park, it is not anticipated that impacts related to this would be significant. This impact is therefore assessed as being of low significance.

Impact HH2 – Low Significance

8.5.3.2 Infiltration of water from cleaning of panels

Solar PV panels will be cleaned using dry cleaning technology, supplemented by regular 'spot' cleaning utilizing cleaning fluids. A small amount of run-off will be associated with this spot cleaning process. A drainage system is included within the design of the Park in order to collect and disperse the runoff from this process. The design of the drainage system will take account of the mitigation measures suggested in the hydrological and hydrogeological assessment (Tractebel, 2016).

Furthermore, only biodegradable chemicals should be used to clean the solar panels. This will ensure that no damage to the panels is sustained through the use of harsh cleaning chemicals, and that no

impact is sustained on soils at the development site. This is not only an environmental benefit, but also relates to optimal performance of the solar modules as chemical based cleaning products can leave a thin film of residue on the surface of the panels which can reduce performance.

Therefore, this impact is assessed as being of low significance.

Impact HH3 – Low Significance

8.5.3.3 Changes to groundwater as a result of leaks

It is proposed to use a septic tank stored on site during the operation of the Park, and there is a potential for uncontrolled releases. The design of the septic tank should comply with Section 1.3 of the IFC General EHS Guidelines and Saudi Aramco Engineering Standard-S-104; sanitary wastewater should be stored in a double bundled (to 110% capacity) tank. This will ensure that any potential impact upon groundwater through accidental discharge is mitigated through design.

There will be a back-up generator in case of a power failure, and a diesel tank will be installed to provide fuel supplies. This tank will again be designed in accordance with Section 1.3 of the IFC General EHS Guidelines and Saudi Aramco Engineering Standard-S-104.

The permanent design of the Park will include a workshop and storage building. All chemical will be stored under appropriate conditions within this building on hard-standing.

Where hard surfaces have the potential to collect fluids with the potential to impact upon hydrological or hydrogeological resources, (such as car parks or fuel storage areas), oil interceptors should be utilized as per the requirements of GAME Environmental Standard 6 - *Storage and Material Reclaim Facilities Design and Operation*. This will prevent the introduction, through infiltration, of any harmful fluids into groundwater and hydrological resources.

Due to the proposed management of chemicals / fluids at the development site, and the absence of groundwater above 30m below ground level, this impact is assessed as being of low significance.

Impact HH4 – Low Significance

8.5.4 Decommissioning Phase

Impacts experienced during the decommissioning phase of the Park, are expected to be similar to those experienced during the construction phase. These include leaks of stored materials, runoff, and infiltration from accidental discharges.

Table 8-6: Decommissioning Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH5	Groundwater	Low	Changes to groundwater as a result of leaks of fluids stored at the development site during decommissioning.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HH6	Flood regime of development site	Low	Changes to flood regime during decommissioning of the Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	Low	Low

8.5.4.1 Changes to Groundwater as a Result of Leaks

Where water or any fluids are required to be stored or utilized on site (including sanitary waste, diesel fuel and other fluids). This will be carried out in accordance with the IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality*. This will ensure that wherever fluids with the potential to impact upon groundwater through leaks or spills are to be utilized on the development site, they are managed in a way that would minimize the potential for impact. Similarly all tanks will have secondary containment systems in accordance with Section 1.3 of the IFC General EHS Guidelines and Saudi Aramco Engineering Standard-S-104.

Water used for dust damping, will be supplied via connection to municipal water supply adjacent to Road 80 the town of Sakaka. Water supplied will be in compliance with the requirements of SAES-A-104 - *Wastewater Treatment, Reuse and Disposal*. This will avoid the potential for contamination of water resources through the use of untreated water for activities such as dust damping.

Due to the proposed management of fluids at the development site, and the absence of groundwater above 30m below ground level, this impact is assessed as being of low significance.

Impact HH5 – Low Significance

8.5.4.2 Alteration of flood drainage pattern

Should a storm event occur during the decommissioning period of the Park, there is potential for impacts upon the drainage regime of the development site. As the severity of storms below the 100 year return period is low, it is not anticipated that the Park would impact upon this regime during the decommissioning phase. This impact is therefore assessed as being of low significance.

Impact HH6 - Low Significance

8.6 Mitigation

No impacts of moderate or high significance were identified. No specific mitigation measures for managing impacts on hydrology or hydrogeology receptors are recommended.

8.7 Conclusion

This Hydrological and Hydrogeological assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the impact assessment should be reviewed with any updates and reported in an Addendum to this ESIA.

The Park is located on a site without critical flooding problems. Rainfall events are scarce and runoff episodes infrequent due to the low increment of the site, and the pervious properties of the sandy soil / highly porous bedrock. No traces of flooding were observed during site visits.

Despite this, possible runoff must be managed in order to protect the infrastructure of the Park (mainly the roads).

The runoff simulations of the existing situation and of the Park development have been carried out and compared. A small discharge growth is expected due to the increase of the impervious surfaces and the light reduction of the concentration time.

The potential for leaks of harmful fluids into the environment is low, due to the proposed application of the relevant standards outlined in previous sections within the design of the Park and the management of its construction.

Boreholes were drilled to a depth of 30m and no groundwater was encountered. Groundwater is not to be extracted in relation to the Park, therefore no impacts are expected upon it.

8.8 References

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9. Noise & Vibration

9.1 Introduction

This chapter provides an overview of the existing noise conditions present at the proposed Sakaka Solar Energy Park, and an assessment of the potential adverse noise and vibration impacts that may arise as a result of the proposed development. The assessment considers typical construction and decommissioning activities, along with typical operational activities (including (1) general site management, delivery and maintenance, emptying of sanitation and domestic waste facilities, and (2) the operation of the transformers located across the site). The assessment of emergency transient conditions are not covered by this assessment.

9.2 Definitions

This section is intended to aid the understanding of some of the terms and parameters used within this chapter of the document.

A sound wave travelling through the air is a regular disturbance in ambient atmospheric pressure. These pressure fluctuations, when occurring at frequencies within the audible range, are detected by the human ear and produce the sensation of hearing. Noise has been defined in a variety of ways and is very much dependent on factors such as the listener's attitude to the source of the sound and their environment, but is essentially any sound that is unwanted by the recipient.

The human ear is sensitive to a wide range of sound levels; the sound pressure level of the threshold of pain is over a million times that of the quietest audible sound. In order to reduce the relative magnitude of the numbers involved, a logarithmic scale of decibels (dB) based on a reference level of the lowest audible sound is used. Also, the response of the human ear is not constant over all frequencies. It is therefore usual to weight the measured frequency to approximate human response. This is achieved by using filters to vary the contribution of different frequencies to the measured level. The "A" weighting network is the most commonly used and has been shown to correlate closely to the non-linear and subjective response of humans to sound. The use of this weighting is denoted by a capital A in the unit abbreviation (i.e. L_{Amax} , L_{Aeq} , L_{A90} etc.) or a capital A in brackets after a dB level (i.e. 3 dB(A)).

Sound Pressure Level: The sound pressure level (L_P or SPL) is the instantaneous acoustic pressure and is measured in decibels (dB). Since the ear is sensitive to variations in pressure, rather than source power or intensity, the measurement of this parameter gives an indication of the impact on people. The SPL is defined as:

$$SPL = 10 \log_{10} \left(\frac{p^2}{p_{ref}^2} \right)$$

Where p is the rms⁵ pressure of the sound in question (in Pascals, Pa) and p_{ref} is the reference sound pressure, defined as the limit of human audibility (2×10^{-5} Pa).

L_{eq} : The L_{eq} is defined as the equivalent continuous sound level and is the most widely used parameter for assessing environmental noise. Since this descriptor is a type of average level, it must

⁵ Root mean square sound pressure: the value obtained when squaring multiple instantaneous sound pressure level measurements at a given point, averaging these over the time of a complete cycle, and taking the square root of this average.

by definition have an associated time period over which the measurement is referring to. This is often included in the abbreviation in the form $L_{eq,T}$, where T is the time period (i.e. $L_{Aeq, 5-min}$). The formula for calculating the L_{eq} is:

$$L_{eq} = 10 \log_{10} \left(\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} \frac{p^2}{p_{ref}^2} . dt \right)$$

In practice, since most modern sound level meters are digital and hence take periodic samples of the sound pressure level, the L_{eq} will be the logarithmic average of all the SPL samples taken in the measurement period.

L_{max} : The L_{max} is defined as the maximum rms level recorded during a measurement period.

L_n : The L_n is a statistical descriptor and refers to the level that is exceeded for $n\%$ of the time during a particular measurement period. Again, the measurement period that the descriptor refers to is often included in the abbreviation in the format $L_{n,T}$. Two of the most commonly used statistical descriptors used for environmental noise assessments are the L_{90} and the L_{10} .

L_{10} : The L_{10} refers to the level exceeded for 10% of the measurement period and is commonly used in assessing road traffic noise as it has been found to give a good indication of the subjective human response to this type of noise.

L_{90} : The L_{90} refers to the level exceeded for 90% of the measurement period and is widely considered to represent background noise, or the underlying noise in an area between noisy events.

Free-field Noise Level: The term “free-field” refers to noise levels that have been measured or predicted in the absence of any influence of reflections from nearby surfaces. In practice, a measurement is considered to be free-field if it was taken at a distance of over 3.5 m from any reflecting surfaces.

Façade Noise Level: This is the noise level measured or predicted at the façade of a building, typically at a distance of one meter, containing a contribution of reflections from the façade itself.

Peak Particle Velocity (PPV): is the instantaneous maximum velocity reached by a vibrating element as it oscillates about its rest position.

9.3 International and National Standards and Guidance

The potential noise emissions from the Sakaka Solar Energy Park are subject to a number of design criteria and standards. Information relevant to noise emissions and management is identified in the following documentation:

- International Finance Corporation (IFC), General Environmental, Health, and Safety (EHS) Guidelines, April 30, 2007 (IFC, 2007);
 - o Environmental, Noise (Guideline 1.7); and
 - o Occupational Health and Safety, Physical Hazards, Noise (Guideline 2.3).
- GAME General Environmental Regulations and Rules for Implementation (2001), Article Thirteen, 13.3 (PME, 2001).
- GAME Environmental Standard 3 - Environmental Noise (2012).

Additional Standards and guidance that has been considered in this assessment includes:

- British Standard 5228, Code of practice for noise and vibration control on construction and open sites, 2014:
 - o Part 1, Noise (BSI, 2014); and
 - o Part 2, Vibration (BSI, 2014a).
- International Organization for Standardization (ISO) 9613, Acoustics – attenuation of sound propagation outdoors:
 - o Part 1, Calculation of the absorption of sound by the atmosphere (ISO, 1993); and
 - o Part 2, General method of calculation (ISO, 1996).

Ground-borne vibration has the potential to be generated during the construction and, to a lesser extent, operational phases of the Project. However due to the separation distances (>1 km) between the proposed development site and receivers (see Figure 9-2) it is considered unlikely that any significant adverse environmental vibration impacts would result from the Project, and, as such, no further consideration has been given to environmental ground-borne vibration impacts, with the exception of those resulting from the movement of heavy vehicles (during construction and decommissioning) along the access routes to the development site.

9.3.1 IFC (World Bank Group) EHS Guidelines (2012)

The IFC guidelines (IFC, 2007) present both environmental and occupational health and safety noise and vibration limit values.

Operational Noise (environmental): Section 9.7: Noise Management presents noise level guidelines for environmental noise, providing both one hour ambient noise limits, as reproduced in Table 9-1, and a noise limit of no more than 3 dB above existing background sound levels. Although not explicit within the guidelines, it is common practice to apply a lower absolute noise threshold before considering night change at a receptor location. To this end, the levels quoted below in Table 9-1 shall be considered representative of such thresholds.

Table 9-1: Noise level guidelines, free field

Receptor	Hourly ambient noise limit $L_{Aeq,1h}$	
	Daytime 07:00 – 22:00	Night time 22:00 – 07:00
Residential; institutional; educational	55	45
Industrial; commercial	70	70

Operational Noise (workplace exposure): Section 2.3: Physical Hazards presents noise level guidelines for occupational (workplace) noise as both daily average doses and maximum noise levels. These noise limit values shall be adopted during the construction (decommissioning) and operational phases of the development

9.3.2 GAME General Environmental Standards: Environmental Noise (2012)

Operational Noise: Article IV – ‘Community Noise’ details noise limit values for all noise sources, with the exception of transportation sources. It defines areas into three categories according to their noise sensitivity:

A = Sensitive – These areas are designated quiet areas as they hold value in terms of them being places of worship , important tourist attractions, recreational park land and those areas surrounding hospitals, schools and noise sensitive natural habitats.

B = Mixed – Areas designated in this category will typically be dominated by residential properties (including hostels and hotels) and may range from sparse population densities to suburban districts of cities.

C = Non-sensitive – This designation applies to mixed area, often within cities where there is a mix of residential and commercial activities. This designation will also apply to retail and financial districts.

The permitted free field external noise limits for each area designation are reproduced in Table 9-2. It is considered that the surrounding area and potentially sensitive receptors would fall into category B.

Table 9-2: Permitted free field external noise limits for community noise, measured at any noise sensitive property within the appropriate area designation

Designation	Daytime $L_{Aeq,12-hr}$ 07:00 – 19:00	Evening $L_{Aeq,4-hr}$ 19:00 – 23:00	Night-time $L_{Aeq,8-hr}$ 23:00 – 07:00
A	50	45	40
B	55	50	45
C	60	55	50

It is noted that the Designation B noise limits (i.e. 55, 50 and 45 $L_{Aeq,T}$ for day, evening and night periods, respectively) correspond with the noise limits presented within Article V of the GAME Standard: *maximum permissible free field noise levels from industrial units in area set aside primarily for industrial facilities* for A3 classification sites, which are described as ‘*Light industrial, refers to those areas which may be mixed with or adjacent to residential properties where minor manufacturing processes take place*’.

Construction Noise: Article VI ‘*Noise from construction activities*’ presents construction noise limits. Table 9-3 details the general construction maximum permissible façade noise limits contained within the GAME document. For the purposes of this assessment the noise levels presented for area classifications A, B and C are deemed appropriate.

Table 9-3: General construction maximum permissible façade noise limits

Area classification	Daytime $L_{Aeq,12-hr}$ (07:00 – 19:00)	Evening $L_{Aeq,4-hr}$ (19:00 – 23:00)	Night-time $L_{Aeq,8-hr}$ (23:00 – 07:00)
A, B, C	75	65	45
D	80	80	80

Note: It should be noted that the table in the GAME Standard details “Evening $L_{Aeq,12-hr}$ (dB) and Night time $L_{Aeq,12-hr}$ (dB)”. It has been assumed that this should be detailed instead as “Evening $L_{Aeq,4-hr}$ (dB) and Night-time $L_{Aeq,8-hr}$ (dB)” within the GAME Standard.

Receptors are classified as:

A = Quiet areas – These are areas are designated quiet areas as they hold value in terms of them being places of worship , important tourist attractions , recreational park land and those areas surrounding hospitals, schools and noise sensitive natural habitats.

B = Sensitive – Areas designated in this category will typically be dominated by residential properties (including hostels and hotels) and may range from sparse population densities to suburban districts of cities.

C = Mixed – This designation applies to mixed areas often within cities where there is a mix of residential and commercial activities. This designation will also apply to retail and financial districts.

D = Non-sensitive – The final classification of district is a predominantly industrial area where there are few residential properties and commercial premises. This classification also applies to industrial cities and land that is generally unpopulated.

The document also provides guidance on the permissible maximum sound power levels for equipment for use outdoors and can be used as guidance for assessing construction noise levels from construction activities.

9.3.3 British Standard (BS) 5228: 2009+A1: 2014

Construction noise: BS 5228-1: 2009+A1: 2014 'Code of practice for noise and vibration control on construction and open sites' (BSI, 2014) provides a database on the noise emissions from individual items of plant and equipment to predict noise from demolition and construction methods. This database of noise sources has been used in the prediction of construction noise levels for the Project. The standard also suggests practical ways to mitigate excessive noise.

In addition to providing noise source data, the Standard also provides two methodologies for the prediction of significance of noise effects during typical construction works, based upon noise change and existing measured ambient noise levels. The evaluation criteria in the methodology used are applicable for residential housing, hotels, buildings in religious use, schools and health or community facilities. However, the assessment of construction noise impacts during construction shall be assessment against the guidance provided within the Saudi Arabian GAME General Environmental Standard, BS 5228-1 has been used in identifying noise emission source terms and the prediction of construction (and decommissioning) noise levels only.

Construction vibration: with regard to construction vibration, BS 5228-2 (BSI, 2014a) contains guidance on vibration levels in structures from construction works. BS 5228-2 presents guidance for the control of vibration from construction works.

BS 5228-2 provides guidance on the human response to vibration and for predicting human response to vibration in buildings. For construction works, the guidance contained in Table 9-4 is provided:

Table 9-4: Guidance on the human response to vibration levels from BS 5228-2

Vibration Level (PPV)	Effect
0.14 mms-1	Vibration might just be perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3 mms-1	Vibration might just be perceptible in residential environments.
1.0 mms-1	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.0 mms-1	Vibration is likely to be intolerable for any more than very brief exposure to this level.

For building structure response, BS 5228-2 reproduces the advice on vibration levels that could potentially result in building damage given in BS 7385-2:1993 '*Evaluation and Measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Groundborne Vibration*'⁶. The response of a building to ground-borne vibration is affected by the type of foundation, underlying ground conditions, the building construction and the state of repair of the building. Table 9-5 reproduces the guidance detailed in BS 5228-2 on building classification and guideline values for cosmetic building damage.

Minor damage is possible at vibration magnitudes greater than twice those given in Table 9-4, with major damage at values greater than four times the values in the table. BS 7385-2 also notes that the probability of cosmetic damage tends towards zero at 12.5 mms⁻¹ peak component particle velocity.

Table 9-5: Guidance on the effects of vibration levels on building structures from BS 5228-2

Type Of Building	PPV in Frequency Range of Predominant Pulse	
	4 Hz to 15 Hz	15 Hz and Above
Reinforced or framed structures	50 mms ⁻¹	50 mms ⁻¹
Industrial and heavy commercial buildings		
Un-reinforced or light framed structures	15 mms ⁻¹ at 4 Hz increasing to 20 mms ⁻¹ at 15 Hz	20 mms ⁻¹ at 15 Hz increasing to 50 mms ⁻¹ at 40 Hz and above
Residential or light commercial buildings		

Based on the above criteria, a vibration level of 10 mms⁻¹ at the nearest sensitive receptor location as a result of construction would be intolerable for residents for any more than a brief exposure, whilst vibration levels above 12.5 mms⁻¹ would represent a risk of cosmetic building damage occurring. Therefore, it was considered that vibration levels in excess of 10 mms⁻¹ as a result of construction works should be avoided.

In a residential environment, vibration levels of 1.0 mms⁻¹ may cause complaints from residents, but can be tolerated if prior warning and explanation has been given. Where vibration levels as a result of construction works exceed 1.0 mms⁻¹ at the nearest sensitive receptor locations, consideration would be given to mitigation options to reduce vibration levels where possible.

Figure 3 from '*Transport and Road Research Laboratory (TRRL) Report No RR53 – Ground Vibration Caused by Civil Engineering Works*' (British Steel, 1986) provides a summary of measurements taken by the TRRL which indicates the relative effects of various construction related sources. This figure indicates that, for a heavy lorry on a poor road surface at 4 m, a PPV of 0.3 mms⁻¹ is expected, reducing to approximately 0.1 mms⁻¹ at a distance of 8 m.

Additionally, the guidance contained within HD213/11 (Highways England, 2011) advises that should the level of vibration at a receptor be predicted to rise to above a level of 0.3 mms⁻¹, or an existing level above 0.3 mms⁻¹ is predicted to increase, then this should be classed as an adverse impact from vibration. It should be noted however that this guidance relates to permanent road traffic noise impacts.

9.3.4 Summary and assessment method

Table 9-6 summarizes the absolute noise thresholds that have been used in the assessment of construction, operational and decommissioning noise and vibration effects.

⁶ British Standard 7385-2: 1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from groundborne vibration

Table 9-6: Noise and vibration threshold values from applicable Standards and guidance

Standard or guidance	Noise limit value	Comment
GAME (operation)	Daytime: 55 dB LAeq,T Night time: 45 dB LAeq,T	Free-field noise limit at nearby sensitive receptors.
GAME (construction)	Daytime: 75 dB LAeq,T Night time: 45 dB LAeq,T	Facade noise limit, as appropriate, at nearby sensitive receptors.
IFC (operation)	Daytime: 55 dB LAeq,T Night time: 45 dB LAeq,T	Free-field. Receptor: residential; institutional; educational.
BS 5228-2 and HD213/11 (construction)	0.3 mms-1	Vibration might just be perceptible in residential environments

9.4 Baseline Environmental Conditions

9.4.1 Baseline Review

No previous studies were identified related to noise at the development site and therefore the baseline review of noise data at the development site was carried out using desktop analysis exclusively.

9.4.2 Baseline Survey - Methodology

Noise Monitoring at one location was carried out at a location representative of receptors identified during the desktop study that are likely to experience impacts as a result of the Park. This will provide an understanding of the baseline noise levels at these points, against which, an assessment can be made, following the execution of noise modelling.

Table 9-7: Noise Monitoring Info

Survey Date/Time	Location	Data Anomalies Reported (removed from data set)
10.12.2016	West of development site	Car horn Pickup truck driving past Plane flying over Plane flying over
11.12.2016	West of development site	Car engine starting Plane flying overhead Plane flying over
11.12.2016 (spot sample)	West of development site	None recorded

Baseline noise data was measured using a Rion NL-32 Sound Level Meter (SLM). The instrument had received a full manufacturer calibration within 12 months of the survey, in addition to the field calibration undertaken at the start of every survey. No drift in calibration was noted at the end of any of the surveys. Appendix B presents the manufacturer calibration certificate for the SLM.

The instrument microphone was placed on a tripod, at a height of 1.5 m above ground level in free-field conditions in proximity to the identified receptors. The survey collected continuous noise data at 15 minute intervals during one morning and one afternoon period to gain a realistic understanding of baseline noise on the development site and capture any anomalous events. Spot data (20 minute recordings) was also taken at random point within the development site to corroborate the data and ensure accuracy. Figure 9-1 shows the location of the noise monitoring survey points. Meteorological conditions were recorded for each 15 minute interval of recording (i.e. wind speed, wind direction, temperature).

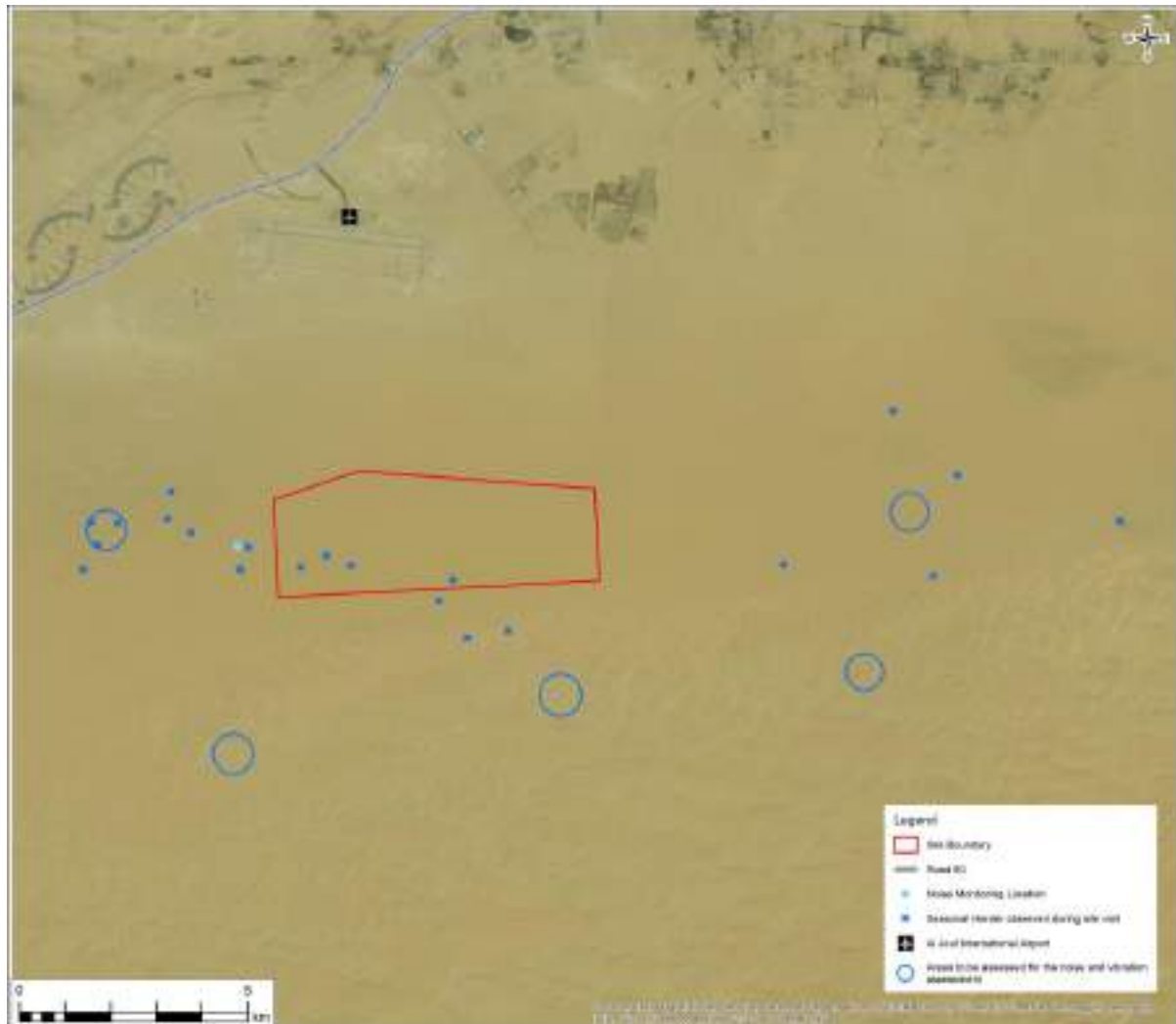


Figure 9-1: Noise Monitoring Survey Points

9.4.3 Baseline Survey - Results

Noise data gathered at the development site indicated that noise levels are consistent throughout the development site, with a maximum recorded (L_{max}) level of 73 dB, which was recorded in the afternoon survey period when an airplane flew over the survey location. This atypical noise event has been removed from the data set presented below. Aside from this atypical noise event, recordings were generally between 25 and 35 $L_{Aeq,T}$, which indicates a very quiet site, where the main source of background sound is goats being herded and distant vehicle (traffic) noise (Table 9-8). Full details of the noise levels recorded and anomalies reported are included in Appendix C.

Table 9-8: Measured baseline sound levels, free-field

Location	Averaged Noise Levels				
	L _{Aeq} (dB)	L _{Amax} (dB)	L _{A5} (dB)	L _{A10} (dB)	L _{A90} (dB)
Location 1 (pm - 12:00-16:00)	28	53	32	29	18
Location 1 (am - 08:00-12:40)	34	64	37	35	30
Location 1 (spot sample)	34	53	37	35	30

9.5 Assessment Methodology

The noise and vibration criterion presented in Table 9-6 shall be used in determining the significance of noise and vibration effects through the use of the matrix presented below.

9.5.1 Significance matrix

Defined criteria for assessing magnitude are shown in Table 9-9 (noise) and Table 9-10 (vibration). Table 9-11 shows the decision making matrix for assessing the significance of impacts associated with environmental noise.

Table 9-9: Magnitude definitions for environmental noise impacts

Noise Level at Location of Receptor	Magnitude of Impact
Below or up to applicable noise limits	Low
1 to 5 dBA above applicable noise limits	Medium
6 to 10 dBA above the applicable noise limits	High
> 10 dBA above the applicable noise limits	Very High

Table 9-10: Magnitude definitions for environmental vibration impacts

Vibration Level at Location of Receptor	Magnitude of Impact
≤ 0.3 mms ⁻¹ PPV	Low
> 0.3 to 1 mms ⁻¹ PPV	Medium
> 1 to 9 mms ⁻¹ PPV	High
> 10 mms ⁻¹ PPV	Very High

Table 9-11: Decision matrix for significance assessment of environmental noise

Receptor Sensitivity	Magnitude			
	Low	Medium	High	Very High
Very High	Low	Medium	Very High	Very High
High	Low	Medium	High	Very High
Medium	Low	Low	Medium	Medium

Receptor Sensitivity	Magnitude			
	Low	Medium	High	Very High
Low	Low	Low	Low	Medium

9.5.2 Sensitive Receptors

Sample receptors surrounding the proposed solar site were chosen during the desktop review exercise. Table 9-12 shows sample noise receptors identified surrounding the development site. These receptor locations are also illustrated on Figure 9-2.

Table 9-12: Noise receptors

No.	Description	Northing	Easting	Approximate distance from (m)	
				Site boundary	Centre of development site
1	West of development site	29°43'55.19" N	40°2'41.32" E	3500	4800
2	South-west of development site	29°41'24.22" N	40°4'18.61" E	3000	4500
3	South of development site	29°41'33.45" N	40°8'31.84" E	2500	5900
4	South-east of development site	29°41'41.70" N	40°12'43.76" E	6100	11900
5	East of development site	29°43'23.29" N	40°13'32.21" E	6900	12700

9.5.3 Assessment Approach

This section discusses the pertinent noise modelling configurations settings and conditions.

9.5.3.1 Noise Model Set-up and Configuration

Noise modelling has been undertaken to predict noise levels radiating from the development site. Noise modelling predictions have been made using the CadnaA noise modelling software package, developed by Datakustik. This software package has been configured to utilize the noise propagation algorithm within BS 5228 part 1 (BSI, 2014) for the prediction of construction and decommissioning noise levels, while ISO 9613 parts 1 (ISO, 1993) and 2 (ISO, 1996) have been used in predicting noise levels resulting from the two operational scenarios that have been considered.

The following settings were selected and assumptions were made within the noise model.

General model conditions

- No reflection or reflective surfaces have been included within the model.

Meteorological and ground conditions

- Flat ground has been assumed through the noise model.

- Acoustically mixed ground has been assumed throughout the noise model ($\alpha=0.5$).
- Noise predictions have been made with an assumed mean ambient air temperature of 20 °C and an assumed mean relative humidity of 50 %.

Sensitive receptors

- All noise predictions have been made under free-field conditions with receiver points located 1.5 m above ground.

Noise sources

Ten construction scenarios, two operational scenarios and single decommissioning scenario have been considered. Each scenario includes a single point source noise source to represent the plant and machinery that will be operational during the scenario. Noise sources have been assigned a height of 1 m above ground. It is assumed that all construction activities shall be undertaken during daytime periods only.

The assessment of noise impacts due to the movement of heavy vehicles on access roads to and from the facility involves the prediction of noise levels using the haul route calculation method detailed within BS 5228-1 (BSI, 2014). It is assumed that deliveries, as with other construction activities, would be during daytime periods only.

Appendix D presents the sound power levels for each of the scenarios considered in the assessment while Appendix E presents the data pertaining to the assessment of vehicle movements.

The contractors compound is likely to be located in the north-west corner of the site. At this time the location of the six proposed 500 kV power supply generators are not known, and as such the assessment considers noise levels resulting from the operation of six generators at varying distances from the generators with recommendations made based on the findings.

A total of 75 2,000 kVA transformers are proposed to be located throughout the development site. No further details, including noise emission data, are available at this time. The assessment of transformer noise makes a series of conservative assumptions and assumes that none of the transformers will not be operational during the construction phase of the development.

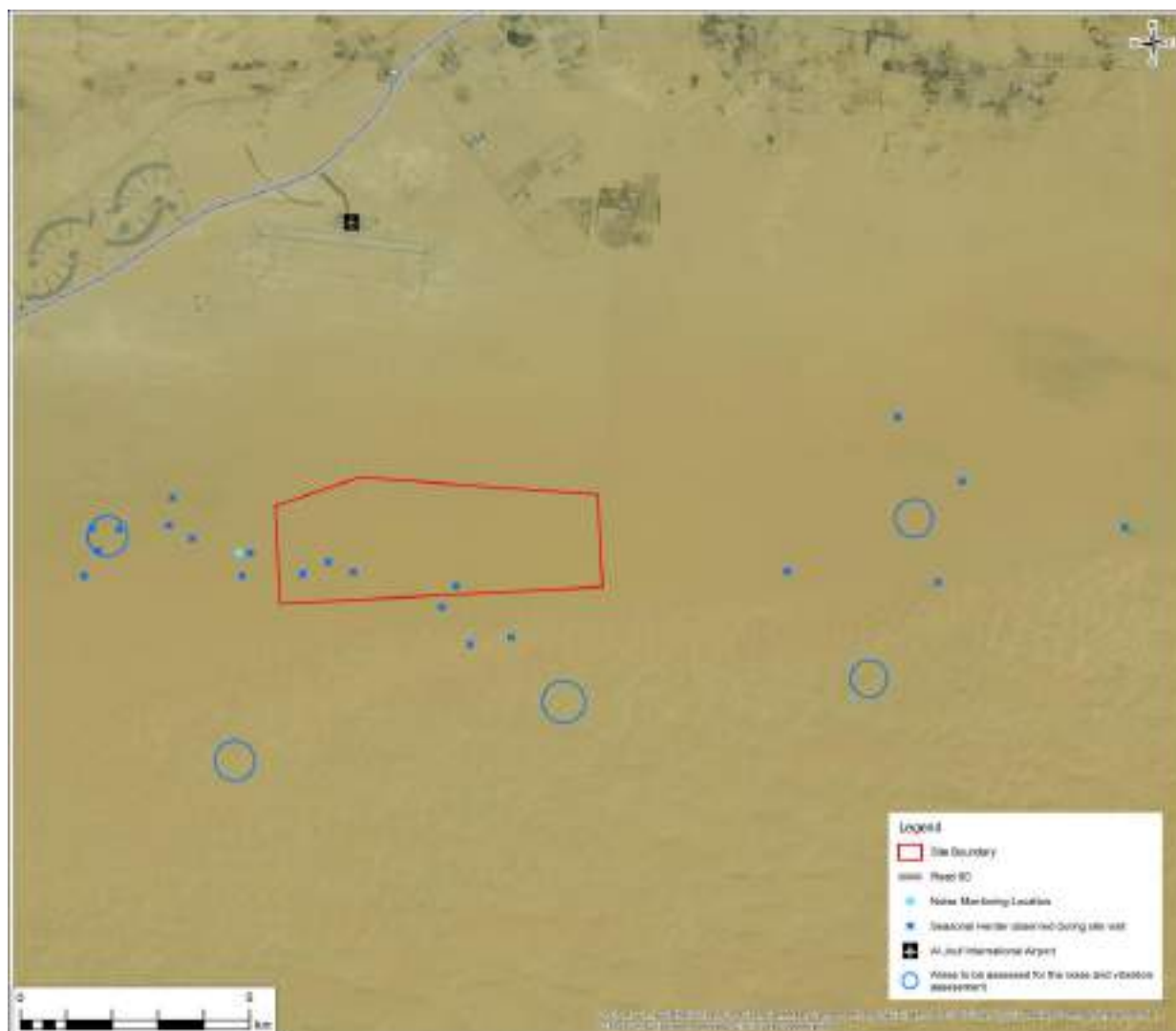


Figure 9-2: Noise receptors, including noise prediction locations to represent assumed location of seasonal herders during construction, operation and decommissioning of scheme

9.6 Impact Assessment

Table 9-13 presents the indicative noise levels at varying distances from roads due to the movement of heavy vehicles during the construction (and decommissioning) phases of the Project. Table 9-14 presents the predicted noise levels at varying distances around the proposed generator sets that shall be in use during construction, while Table 9-15 presents the pre-construction, construction, operational and decommissioning noise levels predicted at each of the sample receptor locations considered within this assessment as a result of activities within the proposed development site.

The assessment of impact assumes that the contractor will undertake construction works during daytime periods only, avoiding the potential for adverse impacts at night and weekends.

Table 9-13: Predicted construction noise levels due to vehicle movements on access roads to and from site, free field

Distance (m)	Noise Level ($L_{Aeq,T}$)	
	Pre-construction	Construction
4	68	64
5	67	63
10	64	60
20	61	57
50	57	53
100	54	50
200	51	47
500	47	43

Table 9-14: Predicted noise levels due to the six 500 kV generators, free field

Distance (m)	Noise Level ($L_{Aeq,T}$)
20	76
50	67
100	60
200	53
500	44
650	42
1000	38

Table 9-15: Predicted construction noise levels due to on-site activities, free field

Receptor	Source Location	Activity noise level ($L_{Aeq,T}$), free-field												
		Pre-construction (BS 5228)				Construction (BS 5228)						Operation (ISO9613)		Decommissioning (BS 5228)
		Installation of Access Roads	Site Grading	Install Construction Compound	Installation of Fencing/lighting	Install Foundations for panels	Pre-Fabrication (Installing Mounting Structures)	Installing Solar Modules	Installing Cabling	Power Supply at Construction Site	Building Developers Compound	site management delivery & maintenance, emptying of waste	transformers	
1	Site boundary	36	41	45	43	40	50	49	37	25	31	25	8	55
	Centre	33	38	42	40	37	47	46	34	22	28	21	<5	52
2	Site boundary	38	42	46	44	42	52	51	38	27	32	28	10	57
	Centre	34	38	42	40	38	48	47	34	23	28	22	<5	53
3	Site boundary	40	44	48	46	44	54	52	40	29	34	31	12	58
	Centre	31	35	40	38	35	45	44	32	20	26	18	<5	50
4	Site boundary	31	35	39	37	35	45	44	31	20	25	18	<5	50
	Centre	24	29	33	31	28	38	37	25	13	19	10	<5	43
5	Site boundary	30	34	38	36	34	44	43	30	19	24	16	<5	49
	Centre	24	28	32	30	28	38	37	24	13	18	9	<5	43

9.6.1 Construction Phase Impacts

Impacts expected to be experienced during the construction phase of the Park include increased ambient noise and vibration at various receptors due to an increase in activity at the development site. This relates to construction plant and other construction activities (Table 9-16).

Table 9-16: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
NO1	Seasonal herders	Low	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low
NO2	Seasonal herders	Low	Increased ambient vibration levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low
NO3	Workers at construction compound (night-time sleeping)	High	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous (Night-time) Duration: Short Extent: Local Permanence: Reversible	Low if generators are located at least 650 m from worker accommodation	Low
NO4	Workers at construction compound (night-time sleeping)	High	Increased ambient vibration levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous (Night-time) Duration: Short Extent: Local Permanence: Reversible	Low. The vibration emissions from the generators are not known, however, based on professional judgement, emissions are unlikely to be significant at a distance of 650 m or greater.	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
N05	Sensitive receptors along access roads to site	High	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low, at a distance of 4 m	Low
N06	Sensitive receptors along access roads to site	High	Increased ambient vibration levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low, at a distance of 4 m	Low

9.6.1.1 Increased ambient noise levels (Receptor Seasonal Herders)

Ambient noise levels are expected to increase during the construction phase of the Park. Seasonal herders are located in various locations surrounding the development site. During the construction, operation and decommissioning of the Park, these receptors would be excluded from the development site by security fencing. Due to the transient nature of these receptors, and based on the assessment location selected in the assessment, this effect is assessed as Low significance.

Impact NO1 – Low Significance

9.6.1.2 Increased ambient vibration levels (Receptor Seasonal Herders)

Ground-borne vibration effects are anticipated to be no greater than noise effects at the sensitive receptor locations and as such this effect is assessed as Low significance.

Impact NO2 – Low Significance

9.6.1.3 Increased ambient noise levels (Construction Workforce)

There is the potential for significant adverse effects as a result of noise emissions from the proposed generators at the workers compound. The assessment (see Table 9-14) demonstrates that a minimum offset distance between the generators and worker accommodation of 650 m should be maintained to ensure that façade noise levels do not exceed 45 dB $L_{Aeq,T}$ at night. The effect is assessed as Low significance if the minimum offset distance of 650 m is maintained.

Impact NO3 – Low Significance

9.6.1.4 Increased ambient vibration levels (Construction Workforce)

Ground-borne vibration levels as a result of the generators are anticipated to be negligible at the minimum offset distance discussed above and any potential adverse effects at this distance are assessed as Low significance.

Impact NO4 – Low Significance

9.6.1.5 Increased ambient noise levels (Receptor Community)

Ambient noise levels are expected to increase during the construction phase of the Park, as a result of vehicle movements to and from the development site. However the assessment (see Table 9-13) demonstrates that construction noise levels resulting from heavy vehicle movements are below the daytime construction noise limit, even at very small source to receiver offset distances, and the effect is therefore assessed as Low significance.

Impact NO5 – Low Significance

9.6.1.6 Increased ambient vibration levels (Receptor Community)

Ground-borne vibration levels are expected to increase during the construction phase of the Park, as a result of vehicle movements to and from the development site. However as discussed within Section 9.3.3, vibration effects beyond 4m from a road are assessed as being of Low magnitude and significance in this context.

Impact NO6 – Low Significance

9.6.2 Operation Phase Impacts

Impacts expected to be experienced during the operational phase of the Park relate to the increase in noise and vibration associated with the general operation of the Park. Due to the limited amount of mechanical equipment involved in the daily operation of the Park, these impacts are not expected to be significant (Table 9-17).

Table 9-17: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
NO7	Seasonal Herders	Low	Increased ambient noise levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Occasional Duration: Long Extent: Local Permanence: Reversible	Negligible	Low
NO8	Seasonal Herders	Low	Increased ambient vibration levels	Effect: Negative Action: Direct Likelihood: Likely Frequency: Continuous Duration: Long Extent: Local Permanence: Reversible	Negligible	Low

9.6.2.1 Increased ambient noise levels (Seasonal Herders)

During the operation of the Park, occasional maintenance and inspection visits will require staff to visit the development site via trucks. This will result in a very slight increase in ambient noise levels at the development site. Due to the infrequent and minor change associated with this effect, it is assessed as being of Low significance. Additionally, the noise emissions generated by the transformers located throughout the facility are predicted to be well below the relevant off-site limit values and are also assessed as being of Low significance. It is further noted that sensitive receptors such as seasonal herders would be excluded from the Park itself by the security fencing and therefore would be unable to gain access to the areas where this impact would be most noticeable.

Impact NO7 – Low Significance**9.6.2.2 Increased ambient vibration levels (Seasonal Herders)**

Ground-borne vibration levels may increase as a result of the operational activities outlined above, however the magnitude of any impact is considered to be negligible and any adverse effects are assessed as being of Low significance. Furthermore, sensitive receptors such as seasonal herders would be excluded from the Park by the security fencing, and therefore would be unable to access the areas where this impact would be most apparent.

Impact NO8 – Low Significance**9.6.3 Decommissioning Phase**

Decommissioning phase impacts are expected to be broadly similar to those experienced during the construction phase of the Park. The assessment has considered a large scale decommissioning phase that sees many activities taking place concurrently. This is considered to represent very much a worst-case condition; nevertheless the assessment of effect outcome for this scenario is again Low significance.

9.7 Mitigation**9.7.1 Construction Phase**

The assessment demonstrates that the likelihood of significant adverse effects during construction is low, based on the IPP complying with the GAME and IFC standards. In particular Article VII – *Noise from vehicles*, and article VIII – *Noise from equipment used outdoors* detail permissible noise levels from plant and equipment (GAME, 2012).

Furthermore, the good practice guidance measures stated within the IFC Guidelines are presented below.

“Noise reduction options that should be considered include:

- selecting equipment with lower sound power levels;
- installing silencers for fans;
- installing suitable mufflers on engine exhausts and compressor components;
- installing acoustic enclosures for equipment casing radiating noise;
- improving the acoustic performance of constructed buildings, apply sound insulation;
- installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective;
- installing vibration isolation for mechanical equipment;
- limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas;
- re-locating noise sources to less sensitive areas to take advantage of distance and shielding;
- siting permanent facilities away from community areas if possible;
- taking advantage of the natural topography as a noise buffer during facility design;

- reducing project traffic routing through community areas wherever possible;
- planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas;
- developing a mechanism to record and respond to complaints”;

In addition to the example of good practice presented above, BS 5228: 2009 + A1: 2014 - Parts 1 and 2 provide further guidance on effective methods for controlling noise and vibration emissions. It is anticipated that the following mitigation measures would be employed on site to ensure that noise and vibration levels are adequately controlled (all of which are considered to be examples of Best Practicable Means (BPM)):

- appropriate selection of plant and equipment, construction methods and programming. Only plant conforming with or better than relevant national or international standards, directives or recommendations on noise or vibration emissions will be used. Construction plant will be maintained in good condition with regards to minimizing noise and vibration emission;
- plant will be operated and maintained appropriately, with due regard for manufacturer recommendations.
- all vehicles, plant and equipment will be switched off when not in use;
- use of appropriate noise abatement site hoardings and screens, where appropriate. Where practicable, gates will not be located opposite noise sensitive receptors;
- careful selection of routes and programming for the transport of construction materials, spoil and personnel so as to reduce the risk of increased noise and vibration impacts during construction;
- vehicle and mechanical plant/ equipment used for the purpose of the works should be fitted with effective exhaust silencers, to be maintained in good working order and operated in such a manner so as to minimize noise emissions;
- the positioning of construction plant and activities to minimize noise at sensitive locations;
- equipment that breaks concrete by munching or similar, rather than by percussion, will be used where practicable;
- mufflers shall be used on pneumatic tools;
- the use, where necessary, of effective sound reducing enclosures.
- programming works so that the requirement for working outside normal working hours is avoided;
- Minimize the potential for higher vibration levels from the vibratory roller (used within the installation of access roads scenario), by taking into account the guidance within TRL report 429 (ensure that the vibratory roller is not started, stopped, or the direction of travel reversed close to sensitive receptors). TRL report 429^[7] states that:

“...it should be remembered that for vibrating rollers there are likely to be transients at starting and stopping which may generate particle velocities which can be twice as large as for steady state operation. Significantly lower speeds than the 1.5 to 2.5 kph specified will also result in higher particle velocities. The implications of this are that rollers should not be started, stopped, or the direction of travel reversed near to sensitive structures.”

⁷ Hillier, DM and Crabb, GI. (2000), *Groundborne vibration caused by mechanized construction works*, TRL 429.

It is anticipated that a schedule of noise and vibration monitoring will be agreed by the IPP with the regulatory body and noise and vibration limits be included within the Construction Environmental Management Plan (CEMP).

The assessment that has been undertaken is considered to be generally conservative in its approach. The assessment assumed that all plant and equipment included within a discrete construction scenario shall be in operation at the same time and with an operating time of 90% during the assessment period.

9.7.2 Operation Phase

The examples of good practice presented within the IFC Guidelines, as outlined above, shall be adopted where reasonably practicable.

9.7.3 Decommissioning Phase

The control of noise and vibration effects during the decommissioning phase of the development will follow the examples of good practice adopted during the construction phase of the scheme.

9.7.4 Workplace noise and vibration

Workplace noise exposure during construction and decommissioning, and to a lesser extent operation, of the Project will be controlled through the adoption of good practice, some examples of which are presented within the Occupational Health And Safety section of the IFC guidelines (IFC, 2007).

The noise limits for working environments, see Table 2.3.1 of the IFC guidelines, shall be adopted and this aspect is considered further in Chapter 18 Health and Safety Aspects.

9.8 Conclusion

The assessment of construction, operational and decommissioning noise and vibration effects associated with the proposed development demonstrate that the likelihood of significant effects at nearby noise and vibration sensitive receptors is low. Despite this, it is recommended that the examples of good practice with regard to noise and vibration control be adopted throughout the various stages of the scheme.

The most significant potential source of adverse noise and vibration effect is likely to result from the operation of the generators during the construction phase, and as such it is recommended that these are located as far as reasonably practicable from sensitive receptors, and at least 650 from the proposed contractor's workers compound in the north-western corner of the facility.

9.9 References

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PME. (2012). *Environmental Standards: Environmental Noise*. Presidency of Meteorology and Environment.

10. Landscape and Visual

10.1 Introduction

Landscape and Visual Impact Assessment (LVIA) can be described as ‘a tool used to identify and assess the significance of the effects of changes resulting from development on both the landscape as an environmental resource in its own right and on people’s views and visual amenity’ (Landscape Institute, 2014).

The baseline review of the landscape resources and visual amenity which would be potentially impacted upon by the Sakaka Solar Energy Park (the Park,) and their subsequent assessment has been carried out using information provided by Saudi Aramco, existing publically available digital mapping and topographical information including Google Earth and fieldwork. The assessment, following the baseline review, has been undertaken in accordance with good practice guidance and addressed impacts associated with both the construction and operational phases of the Park.

The LVIA chapter has been set out in the following sections:

- Section 10.1 Introduction;
- Section 10.2 International and National Standards and Guidance;
- Section 10.3 Baseline Environmental Conditions;
- Section 10.4 Assessment Methodology;
- Section 10.5 Impact Assessment; and,
- Section 10.6 Conclusion.

10.2 International and National Standards and Guidance

No national guidance is available regarding the assessment of landscape and visual impact within Saudi Arabia.

The IFC Good International Industry Practice (GIIP) recommendation is for the use of the *Guidelines for Landscape and Visual Impact Assessment* for the assessment of the landscape and visual impact of international projects. In preparing this assessment, reference has been made to the following guidance:

- *Guidelines for Landscape and Visual Impact Assessment (3rd Edition)* – Landscape Institute and the Institute of Environmental Assessment and Management (2013) (GLVIA 3).
- *Landscape Character Assessment, Guidance for England and Scotland* - The Countryside Agency and Scottish Natural Heritage (2002); and
- *Photography and Photomontage in Landscape and Visual Impact Assessment* - The Landscape Institute, Advice Note 01/11 (March 2011).

These pieces of guidance (originating from the United Kingdom) are commonly adopted in the assessment of renewable energy projects such as the Sakaka Solar Energy Park.

10.3 Baseline Environmental Conditions

10.3.1 The Site

The proposed site of the Sakaka Solar Energy Park is located within a non-classified area with the approved Saudi Aramco Land Use Permit (LUP) No. 41641, approximately 4.5km to the south of Al Jouf International

airport in Al Jouf Province in northern Saudi Arabia. The permitted development area is approximately 16.38km² in area. The landscape of the development site comprises an open, rough desert landscape.

The nearest settlement to the Park is the town of Sakaka, which lies approximately 14km to the north-east of the development site. The nearest road to the Park is Road 80, which runs in an east to west direction, 6.5km to the north of the development site.

10.3.2 The Study Area

The Study Area comprises land that falls within a 15km radius from the boundary of the development site.

The landform of the Study Area is flat and sweeping, and is typical of much of the desert landscape, rising gently to the south, with a maximum elevation of 700m AOD at the southern boundary, and 600m AOD at the northern boundary. Road 80 crosses the northern section of the Study Area, which also includes Al Jouf International Airport and parts of the Al Jouf University campus. In addition, the south-western region of the town of Sakaka is found in the northern half of the Study Area. In the south, the Study Area is dominated by desert landscapes. The extent of the Study Area is shown in

Figure 10-1.



Figure 10-1: the Study Area

10.3.2.1 Landscape Elements and Land cover

The Study Area comprises a simple composition of very sparsely vegetated desert plain with occasional very low rise, sweeping dune features. Additional landscape elements are very sparse and include only occasional shrubs and bushes.

10.3.2.2 Geology and Landform

The geology of the development site is comprised of limestone, overlain with brown, loose silty sand. For full geological details please refer to Chapter 7 (*Soils & Geology*).

The landform of the Study Area is generally flat, rising gently from six hundred meters AOD in the north, to seven hundred in the south. The town of Sakaka to the north of the development site sits in a slight depression at approximately 550 meters above sea level. Road 80 follows this slight depression through the northern sector of the Study Area.

10.3.2.3 Land Use

A variety of land uses are found within the Study Area. To the north of the development site, land use is predominantly residential and light commercial/educational usage. This includes housing, gas stations and forecourt shops, as well as Al Jof International Airport and Al Jof University. Across the southern portion of

the Study Area, nomadic herding, temporary pre-fabricated accommodation and animal pens are the predominant land uses across the desert plain.

10.3.2.4 Existing Infrastructure

Existing infrastructure within the Study Area includes the Al Jouf Bulk Plant which is located approximately 11km north-east of the development site. This development consists of gas holders, and other petrochemical storage infrastructure. The site is operational during normal day time hours during which trucks transport petrochemicals in and out of the site.

Al Jouf Power Station is located 7km north-west of the development site. This development consists of power generation and distribution infrastructure, transformers, generators and transmission masts. Overhead electricity transmission lines of various kV ratings convene at the Al Jouf Power Station. A transmission corridor runs east – west approximately 400m north of the development site, within this corridor are two 132kV lines, and one 13.8kV line.

10.3.2.5 Landscape Designations

There is no recognized system of landscape designation within Saudi Arabia. As such the development site is not subject to any form of protection or designation at a national level. Furthermore there are no international designations (such as UNESCO World Heritage Sites) placed upon the development site.

10.3.3 Landscape Character

The landscape within the Study Area can be broadly categorized into three different landscape character types (LCTs). These were mapped during the desk based assessment, and confirmed during the site visit, and are as follows:

- Settled Desert Plain LCT;
- Desert Plain LCT; and
- Desert Plateau LCT.

A description of these character types are provided below. The location and extent of the character types within the Study Area are provided in Figure 10-2.

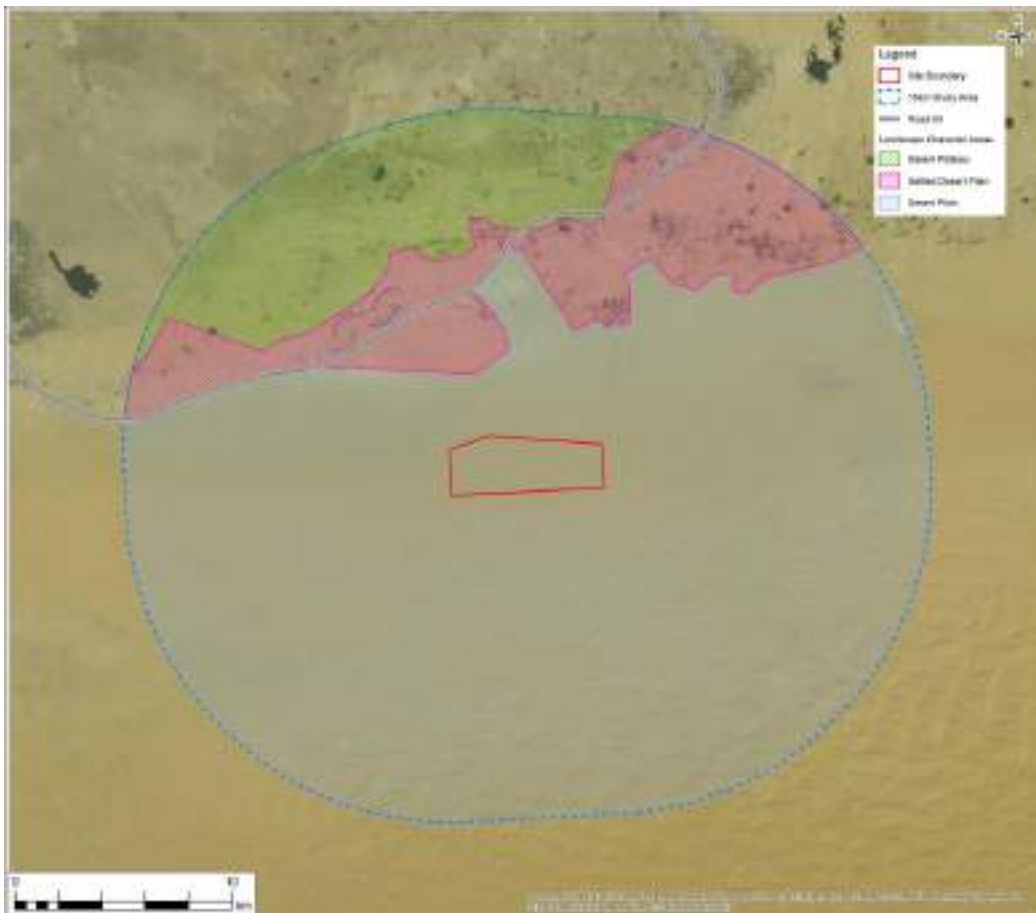


Figure 10-2: Landscape Character Types

10.3.3.1 Settled Desert Plain LCT

The Settled Desert Plain LCT is located in the valley like depression which the town of Sakaka and its associated development along road 80 is sited within. The LCT boundary is defined to the south by the edge of the settled area, where it abuts the undeveloped Desert Plain LCT. To the north, the character type extends as far as the foot of the wadi channels which define the boundary of the Desert Plateau LCT.

Land use within this LCT is a mixture of residential, commercial and industrial developments. Residential areas typically comprise medium density low rise properties (typically of a g+2 configuration). Commercial properties are typically located on the ground floor of residential blocks or along strips beside roads. Sprawling farming settlements with center pivot irrigation systems are located on the periphery of the residential areas, particularly to the north in the more fertile areas.

The land cover within this landscape character type is simple. Where vegetation exists, it is generally associated with residential or commercial property and is intensively maintained. Natural vegetation is sparse and of low quality.

Key Characteristics of this landscape character type, observed during the site visit include:

- Mixed land use, footprint size and density;
- Settled and simple structure; and
- Intensively maintained ornamental vegetation and agriculture.

Illustrative views of the feature and character of this LCT are provided in Figure 10-3 to Figure 10-7.

10.3.3.1.1 Sensitivity to Change:

The LCT is defined by the presence of development within it and, to a lesser extent, by the range of types and scales of this development. It is these elements which differentiate this LCT from the adjacent undeveloped desert plain, and desert plateau landscape character types.

A key defining element of the character of this LCT is the robust diversity of scale among the built elements present within it, this range of scale suggests that a development with a large footprint such as a solar energy park would be well received, and would not alter the balance of defining elements within the LCT.

The addition of a solar energy park to this LCT would represent a new form of infrastructure. In the context of the existing Al Jouf Bulk plant, and Saudi Electrical Company Power Station however, it is not considered that additional infrastructure would alter the contribution that infrastructure broadly plays in the definition of the LCT.

No formal designation is placed upon this landscape, nor are there any features which are considered to be unique to this area. In this regard, this landscape character type is considered to be of low susceptibility to change and of low landscape value. As such, this landscape character type is considered to be of low sensitivity in relation to solar energy developments.



Figure 10-3: Typical Settlement within the Settled Desert Plain LCT



Figure 10-4: Industrial Land Use within the Settled Desert Plain LCT (Al Jouf Power Station)



Figure 10-5: Typical Settlement within the Settled Desert Plain LCT (New Worker Accommodation)



Figure 10-6: Farming Settlements within the Settled Desert Plain LCT



Figure 10-7: Centre Pivot Irrigation System within the Settled Desert Plain LCT

10.3.3.2 Desert Plain LCT

The Desert Plain LCT comprises the rough sandy desert area to the south of the Settled Desert Plain LCT extending into the An Nafud desert to the south. This is a very large scale, open LCT with long range views over sweeping desert and very harsh exposed conditions.

Due to the harsh conditions within this LCT, land use is limited to nomadic seasonal grazing, herding of animals and power distribution. The topography of this LCT is flat, and land cover is sparse, with only very occasional scrub.

It is within the Desert Plain LCT that the Park would be sited.

Key Characteristics

- Very large scale;
- Open long range views;
- Exposed conditions; and
- Lack of development and very little evidence of human activity.

10.3.3.2.1 Sensitivity to Change

The LCT is defined largely by its very large scale and the general absence of development. There is a lack of human activity within this LCT, and this simple, undeveloped nature is a key characteristic of the landscape. The introduction of any form of development would alter the character of this LCT to some extent but the very large scale of the LCT and the commonality of desert landscapes throughout the Kingdom infer a low susceptibility to change. Furthermore, while it is recognized that the An Nafud Desert is located within this landscape character type there is currently no formal designation placed upon this landscape resource. In consideration of this, the LCT has been assessed as being of low value and low sensitivity to change associated with the Park.

Illustrative views of the feature and character of this LCT are provided in Figure 10-8 and Figure 10-9.



Figure 10-8: View South across the Desert Plain LCT and the An Nafud Desert



Figure 10-9: View North across the Desert Plain LCT towards Sakaka

10.3.3.3 Desert Plateau LCT

The Desert Plateau LCT comprises an area of high plateau to the north of the Settled Desert Plain LCT. The landscape is characterized by an exposed sweeping plateau landscape with rocky ground and very little vegetation. Wadi channels are typically deep and littered with rock debris.

Key Characteristics

- Very Large scale;
- High plateau and long range views over Dumat Al Jandal;
- Deep Wadi channels and rock formations influenced by hydrology; and
- Rough, rocky landscape surface.

An Illustrative view of the wadi channels is provided in Figure 10-10. An illustrative view of the character and features of the plateau landscape is provided in Figure 10-11.

10.3.3.3.1 Sensitivity to Change

This LCT is defined by its elevation, its large scale and the dramatic wadi channels and rock formations as well as the long range views from the high plateau over nearby settlements which are afforded by the LCTS openness and elevation. Human activity is rare although communication masts are visible in most views within the LCT and there are rough tracks throughout. The commonality of desert landscapes and the distinct separation of the LCT from the development site infer a low susceptibility to change associated with the Park. Furthermore, there is no formal designation placed upon this landscape resource. In this regard, the LCT has been assessed as being of low value and low sensitivity to change associated with the Park.

No formal designations are placed upon this landscape. In consideration of this, the LCT has been assessed as being of low value and a low sensitivity to change associated with the Park.

Illustrative views of this LCT are provided in Figure 10-10 and Figure 10-11.



Figure 10-10: Illustrative View of a Wadi Channel within the Desert Plateau LCT



Figure 10-11: Illustrative View of the Desert Plateau LCT

10.3.4 Viewpoint Locations

The location of viewpoints selected is shown in Figure 10-12 and the coordinates and basis for inclusion are shown in Table 10-1. The viewpoints have been selected in order to provide assessment from a range of receptor types and provide a representative sample of predicted visibility from locations within the Study Area.

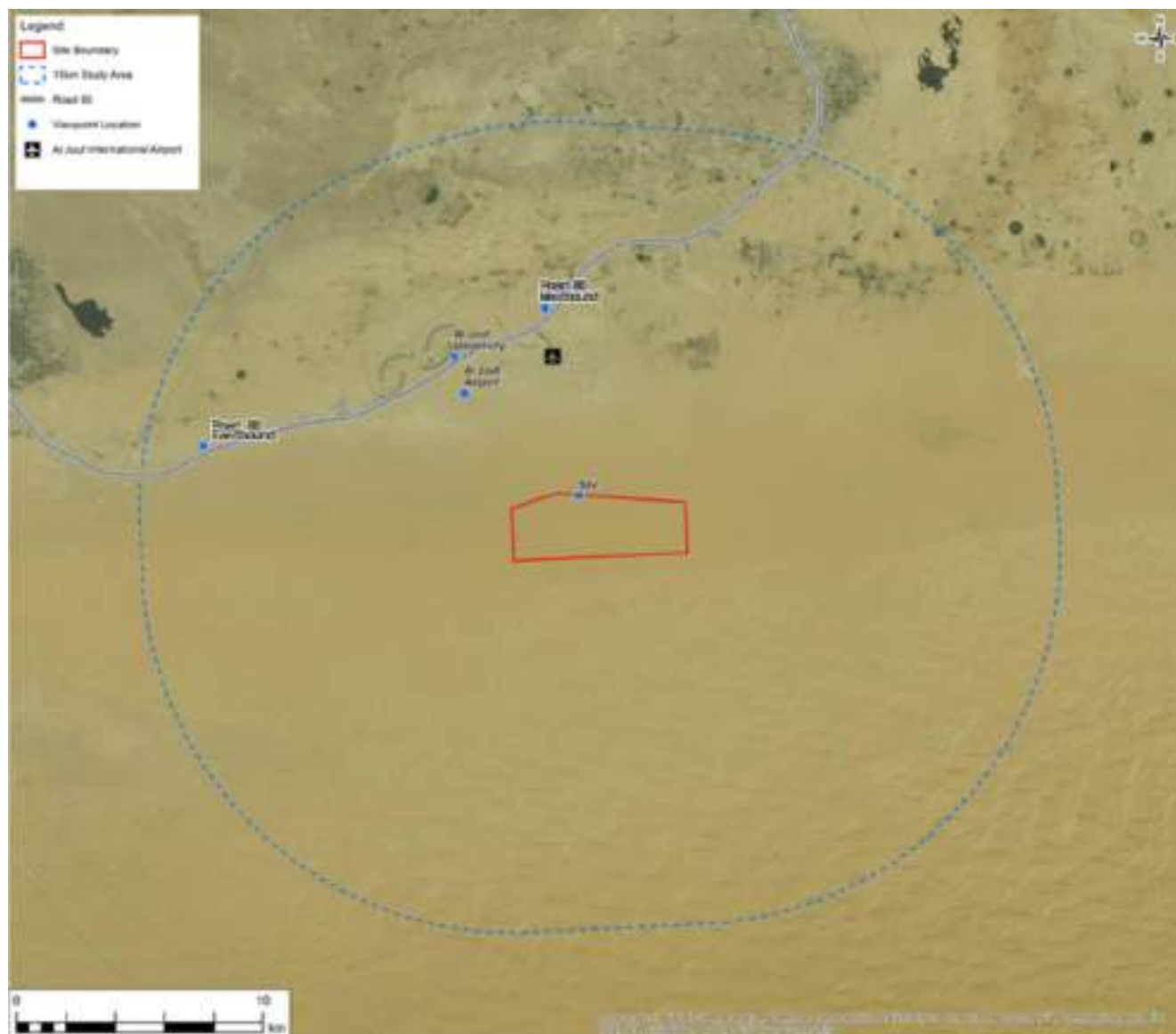


Figure 10-12: Viewpoint Locations

Table 10-1: Viewpoint Locations and Basis for Inclusion

Viewpoint Location		Coordinates	Reason for Inclusion
Viewpoint 1	Road 80 (eastbound)	29°48'45.32"N, 40° 6'41.09"E	Representative of the view experienced by drivers travelling eastbound along Road 80.
Viewpoint 2	Road 80 (westbound)	29°45'57.32"N, 39°58'20.35"E	Representative of the view experienced by drivers travelling westbound along Road 80.
Viewpoint 3	Al Jouf University	29°47'28.58"N, 40° 3'58.21"E	Representative of the view experienced by students and workers at Al Jouf University.
Viewpoint 4	Al Jouf Airport	29°44'40.73"N, 40° 3'36.48"E	Representative of the view experienced by passengers and workers at Al Jouf Airport.
Viewpoint 5	Site	29°44'1.00"N, 40° 6'41.51"E	Representative of the view experienced by nomadic herders and seasonal herders at the

Viewpoint Location		Coordinates	Reason for Inclusion
			development site.

10.4 Assessment Methodology

10.4.1 Baseline Landscape Assessment

The baseline landscape assessment is a description, classification and evaluation of the landscape of the Study Area, from which the potential landscape impacts of the Park can be assessed. This assessment forms the basis against which the magnitude and significance of the predicted landscape and visual impacts arising from the Park are predicted.

The baseline assessment involves three stages:

- Description – the systematic collection and presentation of information about landscape and visual resources;
- Classification – the analytical activity of refining landscape elements into units of distinct and recognizable character; and,
- Evaluation – the process of attributing a value to a given landscape / or visual resource, by reference to specified criteria.

Preliminary visual analysis plans were plotted to inform the early stages of the assessment process.

The process of baseline assessment comprises three main stages, desk study, field survey and analysis. The methods for these three stages are described below.

10.4.1.1 Desk Study

Existing available maps and written data related to the development site and its surrounding 15km Study Area were reviewed.

The desk study identified the general landscape characteristics of the Study Area and the likely extents of landscape character types. Furthermore, the desk study helped define the likely zone of theoretical visibility of the Park in addition to baseline visual resources such as the key viewpoints and features as well as the likely visual receptors. The location of a range of potential visual receptors was identified, and they were classified according to their associated use (settlements, footpaths, roads etc.). The aim of the baseline assessment of visual resources was to ensure that an appropriate range of viewpoints is included in the visual assessment. These locations were chosen to ensure that the viewpoint assessment included a representative range of the following:

- type of receptor – based on the range outlined above;
- a range of different landscapes and character types;
- viewpoint altitude;
- distance of receptor from Development; and,
- direction of receptor from Development.

The desk study provided the basis for the subsequent field survey work, during which the baseline landscape and visual resources, in addition to potential visual receptors were refined and confirmed.

10.4.1.2 Field Survey

A field walkover survey was carried out by Jacobs Landscape Architects in November 2016. The aim of the survey was as follows:

- To evaluate and confirm the desk based interpretation of landscape character;
- To evaluate and confirm the nature of visual amenity;
- To make an assessment of the view at each sensitive receptor, in order to understand the potential impact of the Park upon it; and,
- To record imagery to support the interpretations of character and view at each receptor.

10.4.1.2.1 Photography

Images were recorded using a full frame digital Single Lens Reflex (SLR) camera. The camera was mounted on a tripod in order to obtain a stable platform for the single frame and panoramic views. The position of the tripod was recorded with a handheld GPS device. In addition to recording the location of the viewpoint, observations such as time of day, weather, cloud cover, and visibility were recorded using a standard landscape survey sheet.

10.4.1.2.2 Zone of Theoretical Visibility

The Zone of Theoretical Visibility (ZTV) has been informed by the field survey in addition to the production of visibility mapping through the use of GIS data and software. It should be noted that due to limitations in the accuracy of the digital elevation data used in the production of the visibility mapping professional interpretation of the results (and the likely visibility at each receptor) has been required. Figure 10-13 shows the Zone of Theoretical Visibility.

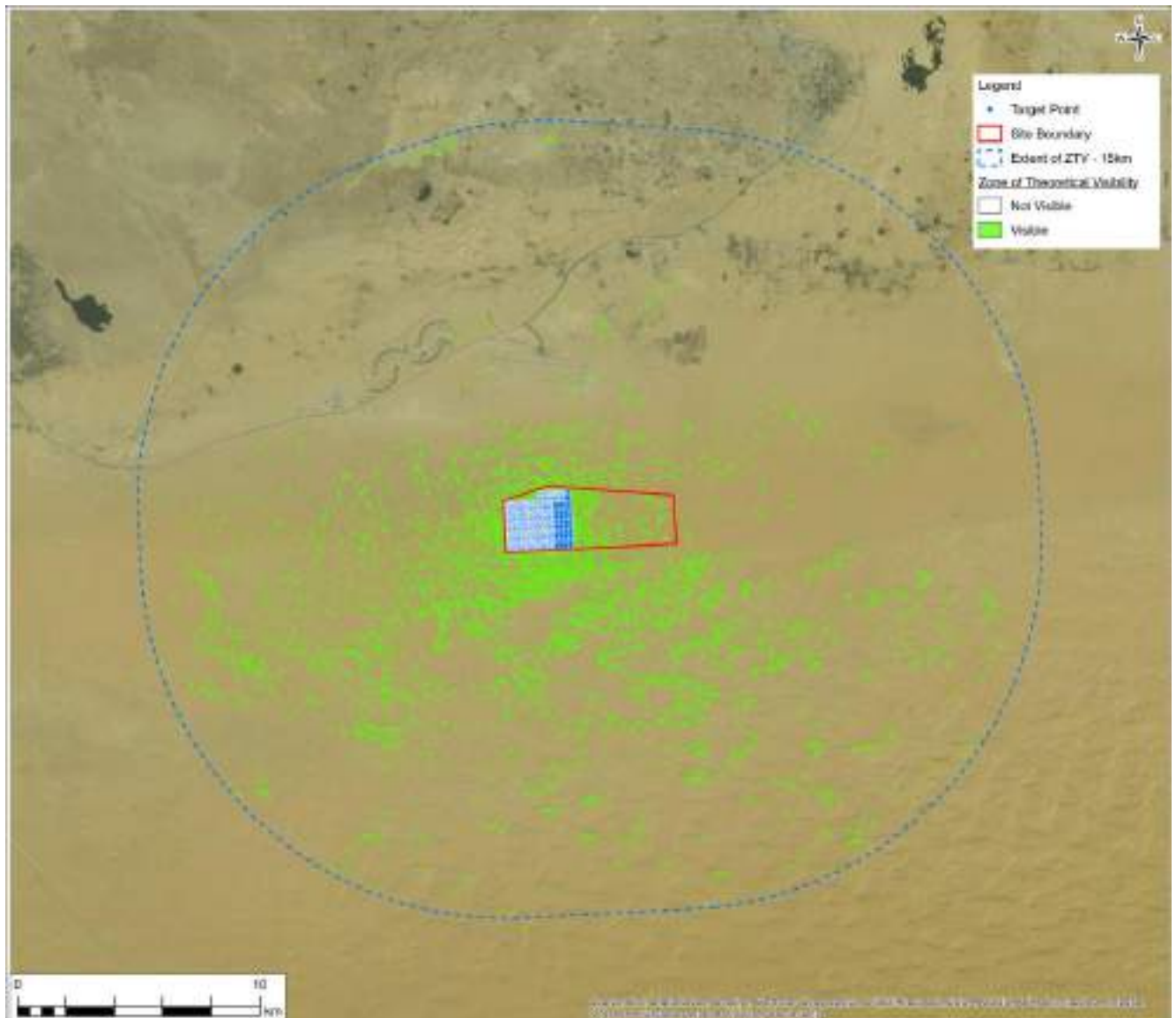


Figure 10-13: Zone of Theoretical Visibility

10.4.1.3 Analysis and Reporting

Analysis and reporting of the baseline assessment took place following the completion of the desk and field surveys. The findings of the baseline assessment are reported in Section 10.3.

10.4.2 Assessment of Residual Landscape and Visual Impacts

The aim of an environmental assessment is to identify, predict and evaluate potential key impacts arising from a proposed development. Wherever possible, identified impacts are quantified. However, the nature of LVIA requires an element of interpretation using professional judgement. In order to provide a level of consistency to the assessment, the prediction of magnitude and assessment of significance of the residual landscape and visual impacts have been based on pre-defined criteria, as discussed below.

10.4.3 Landscape Impacts

Landscape impacts can be defined as the changes to the physical form, structure and fabric of a landscape. Different types of landscape are typically identified as 'character types' which are defined areas, categorized by similarities in form, structure and fabric.

Landscape impacts are assessed with regard to the sensitivity of the landscape (derived from its susceptibility to change and value), and the magnitude of change expected to be experienced.

The following sections set out the methodology specific to the type of impact being considered, and describe how the sensitivity and the magnitude of change ('nature of the impact', considering size/scale/extent, duration and reversibility) on each receptor were identified, and used to judge the significance of impact.

The scale and geographical extent of landscape impacts are measures of the extent of existing landscape elements that would be lost, the proportion of the resource that this represents, the contribution of such elements to the character of the landscape, and the size of the geographical area across which the impacts would be felt. In terms of landscape character, this reflects the degree to which the character of the landscape would change by removal or addition of landscape components, and how the changes would affect key characteristics.

10.4.3.1 Assessing Landscape Sensitivity

The sensitivity of the landscape is not absolute and varies according to the existing landscape, the nature of the proposed development and the type of change being considered. The determination of the sensitivity of the landscape resource to changes associated with the proposed development is defined as high, medium, low or negligible – or intermediate bands between these. It is developed from guidance within GLVIA 3, and based on professional interpretation of a combination of parameters as follows:

- Key landscape characteristics – a professional evaluation based on the key characteristics of the landscape and existing landscape character assessments describing the elements that make up the landscape including:
 - o Physical influences – geology, soils, landform, drainage and water bodies;
 - o Land cover, including different types of vegetation and patterns and types of tree cover;
 - o The influence of human activity, including land use and management, the character of settlements and buildings, and pattern and types of fields and enclosure;
- The aesthetic and perceptual aspects of the landscape – such as its scale, complexity, openness, tranquility or wildness; and,
- The nature of views – whether open, closed, long or short distance, simple or diverse.

GLVIA 3 advises that the two components of landscape value and susceptibility to change are taken into account in assigning sensitivity to change from the proposed development to landscape and visual receptors. The two factors are described and explained in greater detail below.

10.4.3.1.1 Value Attached to Landscape

Establishing landscape value forms part of establishing the baseline description. Understanding how society values different landscapes informs judgements in the assessment phase about significance of impacts. Value is most often expressed through designation – as reflected by local, regional or national landscape designation; however, undesignated landscapes and components of individual landscapes also need to be considered. As part of the baseline the following factors are considered when developing an understanding of landscape value:

- landscape quality / condition – the physical state of the landscape;
- scenic quality – aspects of the landscape that appeal to the senses;
- rarity – presence of unusual or rare features;
- representativeness – the landscape may be representative of a typical landscape;

- conservation interests – wildlife, earth science or archaeological importance;
- recreation values – particularly where landscape experience is important;
- perceptual aspects – value for particular experience such as tranquility or wildness; and,
- cultural associations – with people such as writers or artists, events such as battles, etc.

Information on landscape value is included in the baseline descriptions of landscape character/ landscape receptor, described in the process of setting out baseline landscape designations, and added to where appropriate through additional baseline reporting.

10.4.3.1.2 Susceptibility to Change

GLVIA 3 defines susceptibility to change as *“the ability of the landscape...to accommodate the proposed development without undue consequences for the maintenance of the baseline situation and/or the achievement of landscape planning policies and strategies.”*

The degree to which a particular landscape type or area can accommodate change will vary with:

- existing land use;
- the pattern and scale of the landscape;
- visual enclosure / openness of views, and distribution of visual receptors; and,
- the scope for mitigation, which will be in character with the existing landscape

Key characteristics likely to be affected by the development are evaluated, taking into account *“quality, value, contribution to landscape character, and the degree to which the particular element or characteristic can be replaced or substituted”*.

In order to evaluate the sensitivity of the landscape / landscape receptor, the criteria outlined in Table 10-2 have been used, combining an understanding of the landscape value and susceptibility to change based on GLVIA 3.

Table 10-2: Definition of Landscape Sensitivity

Description	Sensitivity
Landscape with important components, usually of particularly distinctive character and high quality, susceptible to relatively small changes and for which mitigation will be difficult or not possible. Some less distinctive or lower quality landscapes may also fall into this category where characteristics are such that mitigation of negative changes will be difficult. Landscape is often recognized through designation at international / national / regional level.	High Sensitivity
Landscape with characteristics reasonably tolerant of changes or for which mitigation is likely to be possible. These landscapes may be of high quality or of distinctive character but will usually be relatively ordinary and moderately valued.	Medium Sensitivity
A less distinctive or relatively poor landscape with few features of quality or interest, potentially tolerant of substantial change and with scope for mitigation of any negative changes.	Low Sensitivity
Considerably degraded landscape, with few / no features of quality or interest, e.g. heavily industrialized landscapes	Negligible Sensitivity

In some instances a landscape with important components and high quality may be of a lower sensitivity as a result of its potential tolerance to change and opportunities for mitigation, e.g. a variable landform or high levels of tree cover. Conversely a landscape with few features of interest may be of a higher sensitivity because it is vulnerable to change, e.g. a flat landscape with an open character providing little opportunity to mitigate against adverse change.

Having described the landscape resource and the key components that contribute to the character of the landscape type, and having categorized the sensitivity of each landscape type or landscape receptor to change, the probable magnitude of change that would be sustained as a result of the proposed development is then assessed. This change could be adverse, neutral or beneficial. The assessment of the magnitude of change is described below.

10.4.3.2 Magnitude of Change on Landscape/Landscape Receptors

Each impact on landscape/landscape receptors needs to be assessed in terms of its size or scale, the geographical extent of the area influenced, and its duration and reversibility, i.e. its magnitude of change. The scale and geographical extent of landscape impacts are measures of the extent of existing landscape elements that would be lost, the proportion of the resource that this represents, the contribution of such elements to the character of the landscape, and the size of the geographical area across which the impacts would be felt. In terms of landscape character, this reflects the degree to which the character of the landscape would change by removal or addition of landscape components, and how the changes would affect key characteristics.

Judgements are made about the size or scale of the change in the landscape that are likely to be experienced as a result of the Park. The judgements take account of:

- the extent to which landscape elements will be lost, the proportion of the total extent that this represents and the contribution of that element to the character of the landscape;
- the degree to which aesthetic or perceptual aspects of the landscape are altered either by removal of existing components of the landscape or by addition of new ones; and
- whether the impact changes the key characteristics of the landscape, which are critical to its distinctive character.

10.4.3.2.1 Geographical Extent (of influence within the Landscape Character Area/Type)

The geographical extent over which landscape impacts occur will be considered. Distinct from size or scale, the extent of impacts will vary according to the nature of the proposal. The impact of a development may have an influence at the following scales:

- at site level, within the development site itself;
- at the level of the immediate setting of the site;
- at the scale of the landscape type or character area within which the proposal lies; or,
- at a larger scale influencing several landscape types or character areas.

10.4.3.2.2 Duration and Reversibility of Landscape Impacts

The impacts on the landscape will continue for the permitted life of the Park.

10.4.3.2.3 Judgement on Magnitude of Change

Magnitude of change on landscape/landscape receptors is categorized as major, moderate, slight, or negligible – or intermediate categories – as set out in Table 10-3. There may also be no magnitude of change, where further analysis of potential impacts upon landscape receptors reveals that there will be no alteration as a result of the Park.

Table 10-3: Definition of Magnitude

Level of Magnitude	Definition of Magnitude
Substantial	Total loss or major alteration to key elements / features / characteristics of the baseline (pre-development) conditions, such that post-development character / composition of baseline will be fundamentally changed.
Moderate	Partial loss or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions, such that post-development character / composition / attributes of baseline will be partially changed.
Slight	Minor loss of or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions. Change arising from the loss / alteration will be discernible, but underlying character / composition of the baseline condition will be similar to pre-development circumstances / patterns.
Negligible	Very minor loss or alteration to one or more key elements / features / characteristics of the baseline (pre-development) conditions. Change barely distinguishable, approximating to the 'no change' situation.

10.4.3.3 Visual Receptor Sensitivity

The sensitivity of visual receptors depends upon:

- the location of the viewpoint, and its position relative to the Park;
- the context of the view;
- the activity of the receptor at the viewpoint location; and,
- frequency and duration of the view.

10.4.3.3.1 Value attached to Views

Judgements are also made about the value attached to views experienced taking account of:

- Recognition of the value attached to particular views, for example in relation to heritage assets, or through planning designations.
- Indication of value attached to particular locations as a distinctive view through appearance in guide books, provision of formal facilities such as a car park and sign board, references in art and literature.

10.4.3.3.2 Susceptibility of Visual Receptors to Change

The susceptibility of different visual receptors to changes in views is a function of:

- the occupation or activity of people experiencing the view at particular locations; and
- the extent to which their attention or interest may therefore be focused on the views and visual amenity they experience at particular locations.

Visual receptor susceptibility is defined as high, medium, low or negligible, or bands in-between, as set out in

Table 10-4: Definition of Visual Receptor Susceptibility

Visual Receptor Susceptibility	Definition
High	Users of outdoor recreational facilities including strategic recreational footpaths, promoted cycle routes or rights of way, whose attention may be focused on the landscape; important landscape features with physical, cultural or historic attributes; views from principal settlements; visitors to scenic areas and picnic areas.
Medium	Other footpaths; people travelling through or past the landscape on most roads, train lines or other transport routes, views from minor settlements.
Low	People engaged in outdoor sports or recreation (other than appreciation of the landscape); those whose attention may be focused on their work or activity rather than the wider landscape; travelers on highways.
Negligible	Views from heavily industrialized areas.

10.4.3.4 Magnitude of Change on Visual Receptors

The magnitude of visual change arising from the Park is described as substantial, moderate, slight, or negligible based on size or scale, the overall geographical extent of visibility, and the duration and reversibility. It may also be the case that analysis reveals that there will be no change. For individual viewpoints it will depend upon:

- distance of the viewpoint from the proposed development;
- duration of impact;
- angle of view in relation to main receptor activity;
- proportion of the field of view occupied by the proposed development;
- background to the proposed development, and;
- extent of other built development visible, particularly vertical elements.

10.4.3.4.1 Size or Scale

Judging magnitude of visual impacts identified needs to take account of:

- the scale of change in the view with respect to the loss or addition of features in the view and changes in its composition, including the proportion of the view occupied by the proposed development;
- the degree of contrast or integration of any new features or changes in the landscape with the existing or remaining landscape elements and characteristics in terms of form, scale and mass, line, height, color and texture, and;
- the nature of the proposed development, in terms of the relative amount of time over which it will be experienced and whether views will be full, partial or glimpses.

10.4.3.4.2 Geographical Extent

The geographical extent of a visual impact will vary with different viewpoints and is likely to reflect:

- the angle of the view in relation to the main activity of the receptor;
- the distance of the viewpoint from the proposed development, and;

- the extent of the area over which the changes would be visible.

10.4.3.4.3 Duration and Reversibility of Visual Impacts

The impact on views will continue for the permitted life of the Park. All impacts are reversible following decommissioning of the Park.

10.4.4 Level and Significance of Impacts

Overall significance of each impact is assessed according to the magnitude of the impact and the sensitivity of the receptor, with regard to the criteria shown in Chapter 5 – Impact Assessment Methodology. All impacts are adverse unless otherwise stated.

10.5 Impact Assessment

10.5.1 Construction Phase

10.5.1.1 Landscape Impacts

The sensitivity to change of the landscape within the development site has been assessed as low. Table 10-5 provides the assessment of impacts upon the landscape expected to arise as a result of the Park during the construction phase.

Table 10-5: Construction Phase Landscape Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA01	Development site (Desert Plain LCT)	Low	Alteration of landscape during construction phase due to construction of access tracks and the Park	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Certain		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		

10.5.1.2 Alteration of landscape

By virtue of there being no major earthworks, it is anticipated that the introduction of vehicle access tracks and the construction of the Park would not result in any fundamental change to the overall character of the landscape. This is due to the fact that significant numbers of both formal and informal vehicle tracks exist on the site already and the proximity of the Park to the settled landscapes associated with Sakaka.

Impact LA01 - Low significance

10.5.1.3 Visual Impacts

The impact upon specific visual receptors has been assessed within the operational phase impact assessment. It is not anticipated that construction impacts would differ significantly from operational impacts in this regard.

10.5.2 Operation Phase

The following section provides an assessment of impacts on LCTs during the operational phase of the Park. It should be noted that the solar panels would be arranged to face to the south and that it is likely that there would

be no impacts associated with glare and glint for receptors located to the north of the Park. To the south, the landscape is comprised of the Ad Dahna desert and there are no landscape or visual receptors in this location.

10.5.2.1 Landscape Impacts

Table 10-6 shows the assessment of Impacts upon the Settled Desert Plain LCT.

Table 10-6: Operation Phase Landscape Impacts (Settled Desert Plain LCT)

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA02	Settled Desert Plain LCT	Low	No direct impact Perceived indirect impact associated with the alteration of landscape character as a result of the Sakaka Solar Energy Park in the adjacent landscape character type	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Infrequent Medium Local Reversible	Low	Low
LA03	Desert Plain LCT	Low	Direct impact associated with the alteration of landscape character due to the introduction of Sakaka Solar Energy Park	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Infrequent Medium Local Reversible	Low	Low
LA04	Desert Plateau LCT	Low	No direct impact Perceived indirect impact associated with the alteration of landscape character as a result of the Sakaka Solar Energy Park in the adjacent landscape character type	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Infrequent Medium Local Reversible	Low	Low

10.5.2.2 Alteration of landscape (Settled Desert Plain LCT)

There would be no direct impacts on the defining characteristics of the Settled Desert Plain LCT as a result of the Park. However the implementation of the Park would result in Low, indirect impacts on the character of the Settled Desert Plain LCT as a result of the extension of the Settled Desert Plain into the Desert Plain LCT to the south of Al Jouf International Airport and a perceived increase in the presence of industrial development within the local area.

Impact LA02 - Low Significance

10.5.2.3 Alteration of landscape (Desert Plain LCT)

The Park would introduce a new industrial development and alter the character of a relatively small area of desert from Desert Plain LCT to Settled Desert Plain LCT. However in consideration of the very large scale of the Desert Plain LCT, its abundance within the Study Area (and the wider region) it is not considered that the

fundamental character of the Desert Plain LCT would not change as a result of the introduction of the Park. This impact is therefore assessed as being of Low significance.

Impact LA03 - Low Significance

10.5.2.4 Alteration of landscape (Desert Plateau LCT)

There would be no direct impacts on the defining characteristics of the Desert Plateau LCT as a result of the Park, and impacts would be indirect in nature only and associated with the perception of an increase in industrial development and an increase in the extent of Settled Desert Plain LCT albeit to the south, away from the Desert Plateau LCT

Impact LA04 - Low Significance

10.5.2.5 Visual Impacts

The following section provides an assessment of the impacts resulting from the Park on the visual amenity of nearby receptors (such as road users and residents). It should be noted that during the summer months, when the temperature is higher, views at a distance of greater than 200m will be affected by the presence of heat haze across the horizon which will effectively limit longer distance views across the desert landscape towards the development site (Table 10-7).

Table 10-7: Operational Phase Visual Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA05	Road 80 (westbound)	Low	Alteration of the view from the receptor. Introduction of Sakaka Solar Energy Park within desert landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Low	Low
LA06	Road 80 (eastbound)	Low	Alteration of the view from the receptor. Introduction of Sakaka Solar Energy Park within desert landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Indirect Certain Continuous Medium Local Reversible	Low	Low
LA07	Al Jouf University	Low	Alteration of the view from the receptor. Introduction of Sakaka Solar Energy Park within desert landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Low	Low
LA08	Al Jouf Airport	Low	Alteration of the view from the receptor Introduction of Sakaka Solar Energy Park within desert landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
LA09	Site	Moderate	Alteration of the view from the receptor Introduction of Sakaka Solar Energy Park within desert landscape	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Local Reversible	Low	Moderate/Low

10.5.2.6 Alteration of view (Receptor Road 80 - Westbound)

This viewpoint is representative of the view experienced by road users travelling along Road 80 in an eastbound direction.

For the purposes of this assessment, receptors at this location are assessed as low sensitivity due to the low value of the nature of the view available from Road 80 in views towards the development site and the medium susceptibility to change of road users. Existing views from this receptor compromise the very large, broad expanse of desert to the south

The Park would be viewed intermittently at long range, in oblique views to the south from this receptor, the views interrupted by landform and intervening features such as Al Jouf Airport.

Due to the low sensitivity of the receptor, and the intermittent nature of the view, the magnitude of change would be low and the resulting impact of Low significance.

Impact LA05 - Low Significance

10.5.2.7 Alteration of view (Receptor Road 80 - Eastbound)

This viewpoint is representative of the view experienced by road users travelling along Road 80 in a westbound direction.

For the purposes of this assessment, receptors at this location are assessed as low sensitivity due to low value of the nature of the view available from Road 80 in views towards the development site and the medium susceptibility to change of road users. Existing views from this receptor compromise the very large, broad expanse of desert to the south

The Park would be viewed intermittently at long range, in oblique views to the south from this receptor, the views interrupted by landform and intervening features such as Al Jouf International Airport.

Due to the low sensitivity of the receptor, and the intermittent nature of the view, the magnitude of change would be low and the resulting impact of Low significance.

Impact LA06 - Low Significance

10.5.2.8 Alteration of view (Receptor Al Jouf University)

This viewpoint is representative of the view experienced by workers, students and visitors to Al Jouf University. The boundary of the University includes a security fence, which provides a significant amount of screening of views from this location. The grounds of the University itself are landscaped and maintained.

The users at this site are primarily engaged in education and activities associated with the University. The sensitivity of users at this location has been assessed as being low due to the fact that none of the activities

carried out at the University are engaged with the landscape or directly relate to visual amenity, i.e. views are of a low value, and the susceptibility to change of the students, staff and workers on the campus is low.

The Park would be viewed in long range views from this location, typically from the upper floors of buildings as opposed to ground level vantage points, views from ground level locations being curtailed by landscaping within the campus in addition to the perimeter security fencing.

Due to the fact that the site is at a long distance from this receptor, the limited nature of visibility, and the low sensitivity of the receptor, the magnitude of change would be low and the resulting impact of Low significance.

Impact LA07 - Low Significance

10.5.2.9 Alteration of view (Receptor Al Jouf Airport)

This viewpoint is representative of the view experienced by staff and passengers at Al Jouf Airport. The boundary of the airport lies 3.4km north of the development site boundary and includes a security fence which provides a limited amount of screening.

The passenger terminal building includes various internal objects which provide screening, such as plants and other units. The view from the runway is unobstructed but is only relevant as passengers walk from the terminal building to the airplane. The control tower is 13.5m high and faces towards the Park.

The users of this building are primarily engaged in travelling or working. The sensitivity of users at this location has been assessed as being low due to the fact that activities carried out at this location are not related to the landscape (i.e. the susceptibility to change is low) and appreciation of the landscape does not form a critical element related to the enjoyment of the location, i.e. the value of the view is low. The Park would be visible in medium range views from this location.

It should be noted that due to security concerns related to the military base to the north of the development site, it was not possible to make the assessment from the airport itself, therefore assessment was made at the nearest possible receptor.

Users at this site are primarily engaged in transport or work, and are therefore assessed as low sensitivity.

Due to the low sensitivity of the receptor, this impact is assessed as Low significance.

Impact LA08 - Low significance

10.5.2.10 Alteration of view (Receptor Site)

This viewpoint is representative of the view experienced by nomadic herders in proximity to the development site. Receptors at this location are primarily involved with working, although there is evidence of temporary accommodation within the Study Area. The sensitivity of this receptor has been assessed as being moderate in relation to the medium value that these receptors might attribute to views of the wider landscape in relation to their lifestyle and medium susceptibility.

The Park would be viewed over a short distance and would constitute a new feature within the desert landscape within a localized area. In consideration of the transient nature of the nomads, uninterrupted, wider views of the desert landscapes would however be appreciable from locations close to this viewpoint, and views would be impacted upon for a short duration only.

Due to the short visual range but consideration of the nature of views, and the moderate sensitivity of the receptor, the magnitude of change would be low and the resulting impact of moderate/low significance.

Impact LA09 - Moderate significance

10.5.3 Decommissioning Phase

Decommissioning phase impacts are considered to be identical to those experienced during the construction phase.

10.6 Mitigation

Impact LA09 is assessed as being of moderate significance. This impact is associated with the alteration to the view experienced by nomadic herders using the area surrounding the development site. It is noted that security fencing would exclude herders from accessing the development site itself.

Stakeholder consultation will confirm the significance of this impact and from this exercise, mitigation measures will be developed and incorporated into the Addendum to the ESIA.

10.7 Conclusion

In conclusion, an assessment of the likely impacts on landscape and visual receptors within a 15km radius of the site of the proposed Sakaka Solar Park has been undertaken as part of a Landscape and Visual Impact Assessment. This LVIA has been undertaken in accordance with GLVIA 3 (prepared by the United Kingdom's Landscape Institute) and followed a stage approach including identification of the baseline environmental conditions and impact assessment. The assessment found that there would be no significant impacts on the desert landscape character types identified within the Study Area, and that there would be no significant impacts on visual receptors within the Study Area.

10.8 References

Guidelines for Landscape and Visual Impact Assessment (3rd Edition) – Landscape Institute and the Institute of Environmental Assessment and Management (2013);

Landscape Character Assessment, Guidance for England and Scotland - The Countryside Agency and Scottish Natural Heritage (2002); and

Photography and Photomontage in Landscape and Visual Impact Assessment - The Landscape Institute, Advice Note 01/11 (March 2011).

11. Terrestrial Biodiversity

11.1 Overview

This chapter aims to determine the terrestrial biodiversity resources within the development site and the wider region through desktop review of available resources and literature. This baseline review has been used to inform the design and approach to targeted baseline surveys for terrestrial biodiversity resources.

With respect to ornithology, the desktop study focuses on determining the level and importance of bird migration in the vicinity of the Sakaka Solar Energy Parke (wintering and resident birds will be assessed through site-based surveys). To achieve this, designated sites and known bottleneck sites on the associated East Asian/East African Flyway have been assessed along with related literature in an attempt to identify key species, peak migration periods and defined routes of migration in the region. Important Bird and Biodiversity Areas (IBAs) as identified by BirdLife International are discussed separately and these are a key source of information in the region.

11.2 International and National Standards and Guidance

11.2.1 International Conventions

11.2.1.1 Convention on Biological Diversity

Saudi Arabia ratified the Convention on Biological Diversity in 2001. The Convention on Biological Diversity is *“dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and micro-organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live”* (www.cbd.int/convention).

The Convention on Biological diversity is composed of 24 Articles and those which are considered most relevant to the development of the Park are listed in Table 11-1. As a party to the Convention, the Kingdom of Saudi Arabia has to report on the progress of its obligations under the Convention.

Table 11-1 : Most Relevant Articles of the Convention on Biological Diversity

Article	Description
Article 1 [States the Principal Objectives]	i. conservation of biological diversity ii. sustainable use of its biological components and iii. fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
Article 6 [Obligation on all Parties]	i. to develop national biodiversity strategies and action plans ii. to integrate the conservation of biodiversity into all the relevant sectors of the government as well as the national plans of the country.
Article 8 [Devoted to in-situ conservation and obligation on all contracting Parties]	i. to establish a national system of protected areas ii. to create economic incentives to encourage conservation and sustainable use of biodiversity iii. to adopt procedures to assess the impacts of proposed projects on biodiversity iv. to protect rights of indigenous and local communities
Article 9 [Devoted to ex-situ conservation and obligation on all contracting Parties]	i. to establish gene banks such as seed banks, field banks (botanical gardens) and sperm and ova banks ii. to establish in-vitro plant tissue cultures and microbial culture collections iii. to establish captive breeding of animals and artificial propagation of plants and

Article	Description
	reintroduce them into their natural habitats iv. to collect living organisms for zoos, aquaria and botanic gardens
Article 10 [Deals with the sustainable use of components of biological diversity]	i. integrating conservation and sustainable use into national decision making process ii. adopting measures to avoid or minimize adverse impacts on biological diversity iii. protecting and encouraging traditional use of biological resources iv. supporting local populations to develop and implement remedial action in degraded areas where biological diversity has been notably reduced v. encouraging cooperation between governmental authorities and private sector in developing methods for sustainable uses of biological resources.

11.2.1.2 Convention on the Conservation of Migratory Species of Wild Animals

The Convention on the Conservation of Migratory Species of Wild Animals (CMS) is an environmental treaty implemented under the United Nations Environment Program (UNEP). It provides a global platform for the conservation and sustainable use of migratory animals and their habitats. The Convention brings together the States through which migratory animals pass, the Range States, and lays the legal foundation for internationally coordinated conservation measures throughout a migratory range (www.cms.int).

Migratory species threatened with extinction are listed on Appendix I of the Convention. CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. Besides establishing obligations for each State joining the Convention, CMS promotes concerted action among the Range States of many of these species (www.cms.int).

Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this reason, the Convention encourages the Range States to conclude global or regional agreements (www.cms.int).

Saudi Arabia is a party to the Convention, ratified in 1991. As a party to the Convention, the Kingdom of Saudi Arabia has to report on the progress of its obligations under the Convention.

11.2.2 Regional Conventions

11.2.2.1 Convention on the Conservation of Wildlife and their Natural Habitats in the Countries of the Gulf Cooperation Council (GCC)

The Convention is the first legal instrument binding the six member States of the Gulf Cooperation Council (GCC) to coordinate their activities toward the conservation of wildlife and natural habitats. This Convention, which was signed on 30 December 2001 in Muscat, came into force in April 2003. The Convention consists of thirteen Articles and three Appendices broadly dealing with Conservation of biodiversity and the natural environment within the member States through a number of agreed measures. The articles most relevant to the development of the Park are listed in Table 11-2.

Table 11-2 : Articles of the Convention on the Conservation of Wildlife and their Habitats in the GCC

Article	Description
Article 2 [Protection of Habitats]	1. Enact the necessary legislative laws to ensure conservation, and where necessary, rehabilitation and sound management of enough areas of natural habitats suitable for wildlife, particularly the species (or sub-species which are geographically isolated) or endemic species in any state that is party to this Convention. 2. Give priority to verification that the natural habitats being conserved are managed in a way that safeguards the realization of the objective of such conservation. This shall include the following:

Article	Description
	a) Banning or restricting human activities which lead to the: (i) distortion of the nature of such habitats; (ii) pollution or poisoning them or; (iii) deterioration, or threatening with deterioration, of the biodiversity of such habitats or their environmental productivity. b) Adopting appropriate measures to restore the biodiversity and productivity of the habitats which have been subjected to deterioration. 3. Co-ordinate and exert efforts, with other parties, to conserve the natural habitats in a proper way, particularly when: a) Such conservation is on a common border area. b) These habitats are important for the migratory species included in Appendix (II) and Appendix (III) of this Convention.
Article 3 [Protection of Wildlife Species]	1. Each party to this Convention shall enact the necessary legislation to conserve the species of wildlife included in the three appendices attached to this Convention, as follows: A) Flora species included in Appendix (I). (i) conserving such species, wherever they exist in natural habitats or whenever it is necessary to re-distribute them; and (ii) banning or regulating the uprooting or felling any parts thereof or collecting their seeds except save for authorized scientific or research purposes. B) The fauna species included in Appendix (II): (i) conserving such species, wherever they exist in natural habitats or whenever it is necessary to settle them; and (ii) banning all forms of hunting or deliberate killing, destruction or collecting of eggs or causing their disturbance, particularly during seasons of propagation and breeding of their young. C) The fauna species included in Appendix (III): Verifying that any exploitation of such species is done in a rationalized way ensuring that the survival or existence of any of such species in nature is not threatened, by adopting appropriate measures, such as: (i) banning hunting or designating seasons when hunting is allowed, and introducing systems ensuring the rationalization of the levels of such exploitation; and (ii) banning and/or regulating the exploitation of such groups for the purpose of affording the opportunity to them to recover their numbers in a satisfactory manner. 2. Each party to this Convention shall adopt all the necessary legislative and administrative measures in order to: A) Register all the species included in Appendix (I), Appendix (II) and Appendix (III), which are allowed to be owned in a legitimate way. B) Regulate the method of breeding such species and enhance their breeding in captivity. C) Ban or regulate the release of such species to the wild. D) Ban or regulate all forms of trading, locally, regionally or internationally, in the species included in Appendix (I), Appendix (II) and Appendix (III) or in their products or parts. 3. Ban the owning of the animals species included in Appendix (III) or killing them, by any means, which may lead to their extinction, or through the use of any of the permitted tools without obtaining a permit specifying the conditions whereby their ownership is regulated or specifying such tool. Such permits and licenses shall be issued by the concerned authorities in the states which are parties to the Convention. 4. The party states shall, in addition to the measures provided for in this Convention, coordinate their efforts to conserve the migratory populations from those included under Appendix (II) and Appendix (III).

11.2.3 IFC Performance Standard 6

IFC Performance Standard 6 concerning Biodiversity Conservation and Sustainable Management of Living Natural Resources recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development (IFC, 2012). The standard is guided by the Convention on Biological Diversity in addition to setting out guidelines for the preservation of ecosystem services.

Performance Standard 6 describes ecosystem services as the benefits that people, including businesses, derive from ecosystems. Ecosystem services are organized into four types:

- **Provisioning Services:** the products people obtain from ecosystems (e.g. food, water, timbers, fibers, medicinal plants);
- **Regulating Services:** which are the benefits people obtain from the regulation of ecosystem processes (surface water purification, carbon storage and sequestration, climate regulation, protection from natural hazards);
- **Cultural Services:** which are the non-material benefits people obtain from ecosystems (e.g. natural areas that are sacred sites and areas of importance for recreation and aesthetic enjoyment); and,
- **Supporting Services:** which are the natural processes that maintain other services (e.g. soil formation, nutrient recycling, primary production).

Informed by the risks and impacts identification process, this Performance Standard should be applied to projects:

- Located in modified, natural and critical habitats;
- That potentially impact on or are dependent on ecosystem services over which the project proponent has direct management control or significant influence; or,
- That include the production of living natural resources (e.g. agriculture, animal husbandry, fisheries, forestry).

It states that the impact identification process should consider direct and indirect project-related impacts on biodiversity and ecosystem services and identify any significant residual impacts. The project proponent should seek to avoid impacts on biodiversity and ecosystem services, and, where avoidance is not possible, measures to minimize impacts and restore biodiversity and ecosystem services should be implemented.

The risks and impacts identification process should take account for the differing values attached to biodiversity and ecosystem services by Affected Communities, and where appropriate other stakeholders.

11.2.4 National Legislation

11.2.4.1 The Wildlife Protected Areas Act (1995)

The Protected Areas Act was established under Royal Decree No. M / 66 in 1995. The primary objectives of this Act are to conserve and develop wildlife in the Kingdom of Saudi Arabia. The principal provisions of the act relate to:

- Protected areas declaration procedures (Articles 3, 4 and 5).
- Protected areas management (Articles 6 and 7).
- Establishment of the guard force (rangers) (Article 8).

- Acts prohibited in the protected areas (Article 13).

11.2.4.2 The Wild Animals and Birds Hunting Act

The Wild Animals and Birds Hunting Act was implemented in 1999. The primary objectives of this Act are to regulate hunting of wild animals and birds; and to ensure the preservation of the nation's fauna by providing opportunities for wild animals and birds to breed.

The principal provisions of the act relate to:

- Issuing of hunting permits (Article 2).
- Acts prohibited by the Act (Article 4).
- Species that are protected from hunting (Article 5).

The Ministry of Interior, which is the authority responsible for regulating hunting activities, has in cooperation with the Saudi Wildlife Authority (SWA), specifies the periods and locations for hunting annually. Under this act, there is currently a ban on hunting migratory birds, due to concerns of avian bird flu. Hunting is also banned within the 16 designated protected areas of the Kingdom of Saudi Arabia.

Engaging in hunting activities without obtaining a license is contrary to the system of wild animals and bird hunting, and is considered as a violation of the agricultural land use purposes.

The falcon hunting season in the Kingdom of Saudi Arabia is from October to March.

11.2.4.3 The Act on Trade in Endangered Wildlife Species and their Products

The Act on Trade in Endangered Wildlife Species and their Products was implemented in 2000. The primary objectives of this act are to regulate the trade in wildlife and wildlife products by the system of import/export permits according to the rules of the Convention on International Trade of Species (CITES).

The principal provisions of the act relate to:

- Trade in wildlife and its products is prohibited without the appropriate permit from the National Commission for Wildlife Conservation and Development (NCWCD) (Article 3).
- The NCWCD should issue a list of endangered species with the agreement of the Ministry of Agriculture (Article 4).
- A fee of SAR 50 should be collected, for the Treasury, for each permit issued (Article 5).

11.2.4.4 The Forest and Rangeland Act

The Forest and Rangeland Act was implemented in 1979. The primary objectives of this act are to ensure the conservation and rational exploitation of the forests and rangelands.

The principal provisions of the act relate to:

- Afforestation in public and village forest lands (Articles 6, 7 and 8).
- Rational exploitation of the forest products (Articles 9, 10 and 11).
- Acts prohibited in the forests (Article 12).

11.3 Baseline Environmental Conditions

11.3.1 Baseline Review

11.3.1.1 Protected Areas

IUCN Protected Areas (International)

The IUCN has listed 16 Protected Areas within the Kingdom of Saudi Arabia. An IUCN Protected Area is defined as: *'an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means'*.

The nearest IUCN Protected Areas to the Sakaka Solar Energy Park are At Tubayq, Al Khunfah and Harrat Al Harrah Protected Areas (Figure 11-1).

- **At Tubayq Protected Area (Located approximately 180km west of the development site):** This is an IUCN Category III site and covers an area of c.12,200km² south of Harrat Al Harrah. The site consists primarily of desert and sandstone rocky plateaus and is one of the last remaining strongholds for the Nubian Ibex *Capra nubiana*.

The definition for IUCN Category III Natural Monument or Feature sites is:

"These are comparatively smaller areas that are specifically allocated to protect a natural monument and its surrounding habitats. Natural Monuments or Features can be natural in the wholest sense, or include elements that have been influenced or introduced by humans. The latter should hold biodiversity associations or could otherwise be classified as a historical or spiritual site, though this distinction can be quite difficult to ascertain. As such, the classification then falls into two subcategories, those in which the biodiversity is uniquely related to the conditions of the natural feature, and those in which the current levels of biodiversity are dependent on the presence of the sacred sites that have created an essentially modified ecosystem. Natural Monuments or Features have a high cultural or spiritual value which can be utilized to gain support for conservation challenges." (IUCN, 2012)

- **Al Khunfah Protected Area (located approximately 121km south-west of the development site):** This is an IUCN Category VI site. The Al Khunfah protected area was declared in 1988 to protect the then largest population of sand gazelle in Saudi Arabia, and to conserve a large tract of sandy gravel plain bordering the western edge of the Great Nafud (Child and Grainger 1990).

The definition for IUCN Category VI Protected area with sustainable use of natural resources is to:

"Conserve ecosystems and habitats, together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area" (IUCN, 2012).

- **Harrat Al Harrah Protected Area (located approximately 86km north-west of the development site):** This is an IUCN Category IV site and covers an area of 12,150km² the landscape is dominated by numerous uplifted extinct volcanic cones and black basaltic boulders of the middle Miocene, making vehicle access mostly impossible. The Harrat al Harrah Protected Area was one of the initial biodiversity reserves established in Saudi Arabia (Child & Grainger, 1990; Seddon et al., 1997). The reserve provides habitat to over 250 species of plants, 50 species of birds and 22 species of mammals (Nader 1995; Seddon et al. 1997). It is located approximately 26km south of the development area

The definition for IUCN Category IV Habitat/Species Management Area sites is:

"Habitat/Species Management Areas focus on more specific areas of conservation in correlation to an identifiable species or habitat that requires continuous protection. These protected areas will be sufficiently controlled to ensure the maintenance, conservation and restoration of particular species and habitats - possibly through traditional means - and public education of such areas is widely encouraged as part of the management objectives. Habitat or Species Management Areas may exist as a fraction of a wider ecosystem or protected area and may require varying levels of active intervention including - but not limited to - the prevention of poaching, creation of artificial habitats, halting natural succession and supplementary feeding practices" (IUCN, 2012).

- This site was in part designated to afford protection to the Houbara bustard *Chlamydotis (undulata) macqueenii*.

The development site is also located in proximity to the **Northern Wildlife Management Zone** which is designated as a Category VI Protected area with sustainable use of natural resources.

Category VI protected areas do conserve biodiversity, particularly at ecosystem and landscape scale, but the aim would not be to protect them strictly from human interference. Although scientific research may be important, it would be considered a priority only when applied to sustainable uses of natural resources, either in order to improve them, or to understand how to minimize the risks to ecological sustainability (IUCN, 2012). Therefore a key objective of this category of Protected Area is to promote the sustainable use of natural resources ensuring consideration is given to the ecological, economic and social dimensions.



Figure 11-1: IUCN Protected Areas in the Sakaka Region of Saudi Arabia.

Important Bird and Biodiversity Areas (International)

Important Bird and Biodiversity Areas (IBAs) are key conservation areas which have been identified using internationally agreed criteria applied locally by BirdLife Partners and experts (BirdLife International, 2016). There are over 12,000 recognized sites which make up the largest global network of significant biodiverse sites.

Four sites within 300km of Sakaka have been summarized in Table 11-3 and Appendix F. The IBAs are arranged by their distance from Sakaka; all of the IBAs listed are in KSA. Each qualifying bird species has been listed by its presence within the designated site under four headings; resident (year-round), breeding-only, non-breeding-only or on passage. The nearest IBA site is 16km from Sakaka, Dumat al Jandal Wetland.

Table 11-3: Summary of IBAs in relation to Sakaka (BirdLife, 2016).

IBA	Country	Description	Habitat	Size (ha)	Distance from Sakaka (km)	Number of Qualifying Species			
						Resident	Breeding	Winter	Passage
Dumat al Jandal Wetland	Saudi Arabia	Historically one of the few remaining wetlands in the northern desert surrounded by marshland. Now a man-made reservoir surrounded by agricultural holdings and the town of Dumat al Jandal.	Open raised permanent reservoir basin with irrigation channels running to agricultural areas punctuated by very small, scattered remains of marshland.	2,500	16	-	-	-	-
Harrat al-Harrah	Saudi Arabia	Large desert with basalt boulder fields and volcanic cones.	Silt flats, salt flats, shallow wadis, permanent reservoir and small scrub.	1,377,500	110	9	2	3	2
At-Tubayq	Saudi Arabia	Raised platform of old, dark sandstone 300-400m above a sandy plain.	Ephemeral plant growth after rain, drought resistant shrubs and grass.	1,220,000	145	1	1	-	-
Jabal Aja and Northern Ha'il	Saudi Arabia	Mountainous region adjacent to semi-desert and the Jabal Aja and Northern Ha'il city south of the An Nafud Desert.	Extensive granite mountains with deep Acacia-lined valleys and adjacent semi-desert. One of the most vegetated areas in the north; the desert and sandstone hills bloom during wet springs.	400,000	255	4	1	2	6

N.B. No Population Data for Trigger species is available for Dumat al Jandal.

Important Plant Areas (International)

There are over 100 provisional Important Plant Area (IPA) sites that have been identified in Saudi Arabia, Oman and Yemen. However no IPA have been formally recognized and officially designated. Therefore there are no such sites within 2km of the development site boundary.

Biodiversity Protection Areas (National)

A network of national sites recognized for their biological conservation value fall under the jurisdiction of the former National Commission for Wildlife Conservation & Development, now the Saudi Wildlife Authority. These sites are not formally designated. There are no such sites within 2km of the development site and the nearest of these sites to the development site are the At Tubayq and Al Khunfah Protected Areas. Similarly, there are no proposed sites within 25km of the development site (Figure 11-2).



Figure 11-2: National Designated Areas

11.3.1.2 Ornithological Baseline Review

Birds pose a potential ecological concern to the development as the site lies in a region notable for the migration of birds along a broad-fronted west - east orientated migratory flyway which is active in spring (eastward movement) and autumn (westward movement) (BirdLife International, 2010).

The desktop study aims to determine the level and importance of bird migration in the vicinity of the Sakaka site and will be utilized to inform our baseline approach. To achieve this, designated and known bottleneck sites on the associated East Asian/East African Flyway have been assessed along with related literature in an attempt to identify key species, peak migration periods and defined routes of migration in the region. Important Bird and Biodiversity Areas (IBAs) as identified by BirdLife International are discussed separately and these are a key source of information in the region.

The following key sources have been used within the desktop study;

- BirdLife International; Important Bird Areas (BirdLife, 2016).
- BirdLife International; Migratory Soaring Birds Initiative (BirdLife, 2012).

- International Bird Research Centre (IBRC); Eilat, Israel (IBRC, 2016).
- Raptor Watch: A Global Directory of Raptor Migration Sites (Zalles & Bildstein, 2000).

Photovoltaic (PV) solar energy poses three potential risks to birds (Smith & Dwyer, 2016):

- **Collision with solar infrastructure;** such as PV cells and overhead power lines (Shobrak, 2012), leading to injury or mortality. Birds can be attracted to shaded areas created by PV cells (BirdLife, 2012) and can also mistake PV cells for waterbodies due to the reflection of polarized light (Smith & Dwyer, 2016).
- **Direct habitat loss** beneath the footprint of the solar development and associated infrastructure which may impact upon habitats supporting breeding, wintering and migratory species.
- **Barrier effect/avoidance** of the solar development and surrounding area during construction and operational works.

These risks are similar to those posed by wind energy developments although solar energy developments are significantly less likely to impact on birds (BirdLife International, 2012, Smith & Dwyer, 2016). Furthermore solar PV developments are significantly less likely to impact on birds than concentrated solar power technologies (CSP) which generate electricity through the use of mirrors concentrated on a central tower (BirdLife International, 2012).

The overhead power lines required for the development are already in existence and therefore there is no additional collision risk to birds utilizing the development area due to overhead lines (Shobrak, 2012).

11.3.1.2.1 Legislation and Guidance

The following have been considered in addition to the legislation outlined in Chapter 2 due to the passage of wild birds from international areas:

- Directive 2009/147/EC of the European Parliament and of the Council (Birds Directive, 2009).
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention, 1986).
- International Union of Conservation of Nature Red List of Threatened Species (IUCN, 2016).
- Avian interactions with renewable energy infrastructure (Smith & Dwyer, 2016).
- Electrocution and collision of birds with power lines in Saudi Arabia (Shobrak, 2012).
- Birds and Solar Energy within the Rift Valley/Red Sea Flyway (BirdLife International, 2012).

BirdLife International has produced standardized guidance on birds and solar energy within the Rift Valley/Red Sea flyway through its Migratory Soaring Birds (MSB) initiative (BirdLife International, 2012). Although Sakaka is not located near this flyway it is associated with another migration route, referred to as the East Asian/East African Flyway (Birdlife International, 2010), and the guidance will be consulted, where appropriate, to inform the assessment process. The MSB project, led by BirdLife International in conjunction with the United Nations Development Programme (UNDP) and Global Environment Facility (GEF) outlines three broad requirements, in relation to PV solar development, for pre-construction surveys as follows:

- **Breeding bird surveys** to provide baseline data on which to assess the potential impact of development on breeding species in the area.
- **Vulnerable and protected species-specific surveys** for species (including non-avian) that may require individual assessment.

- **Migratory bird surveys** if the site is along a migratory route, particularly near bottleneck sites. If required, the surveys should include Vantage Point (VP) surveys.

The requirement of these surveys, as stated within the guidance, can be adapted to the specified site and the nature of the development (BirdLife, 2012).

11.3.1.2.2 Migration Routes and Periods

The East Asian/East African Flyway (Figure 11-3) is one of three flyways connecting the Palearctic and Africa; the other two, the East Atlantic Flyway and Red Sea/Rift Valley Flyway are well-known and well-studied; especially at key bottleneck sites (Zalles & Bildstien, 2000, Kirby et al., 2008, Forsman, 2016). Collectively, these three migration routes make up the world's largest bird migration system (BirdLife International, 2010).

The East Asian/East African Flyway is a broad-fronted, west - east orientated route between East Asia and Africa (BirdLife International, 2010). It is a multi-species flyway; shorebirds, soaring birds and passerines migrate along the broad route which is active in spring (eastward movement) and autumn (westward movement) (Boere & Stroud, 2006, Kirby et al., 2008, BirdLife International, 2010).

In the Middle East the route passes through a vast area covering Iran, Iraq, Syria and the Kingdom of Saudi Arabia. There is a lack of available information on specific migration routes and bottleneck sites in this particular region and specifically in the north of the Kingdom of Saudi Arabia. Associated literature specifically states the lack of available historic data within these countries for migratory species utilizing the flyway (Stroud et al., 2006).

Although the flyway is less-studied than its counterparts it can be assumed there are no major bottleneck sites near Sakaka (BirdLife International, 2016). The closest major bottleneck sites lie in Jordan and Israel greater than 400km west of Sakaka and are associated with the north to south orientated Rift Valley/Red Sea flyway (Forsman, 2016).



Figure 11-3: Indicative East Asian/East African Flyway (N.B. The above layout is only an indication of these broad-fronted migration routes)

11.3.1.2.3 Key Species

As there is a lack of new collision risk posed to raptors and soaring migrant species due to the Sakaka solar PV type development and pre-existing overhead lines (Shobrak, 2012, Smith & Dwyer, 2016) and the site is a featureless, flat landscape, key species have simply been identified as those utilizing the site in any capacity.

11.3.1.3 Mammals

Saudi Aramco has identified ecologically sensitive mammal species within the Kingdom of Saudi Arabia (SAEP-396 Terrestrial Ecology Surveys), based on meeting one or more of the following criteria:

1. Any species that the International Union for Conservation of Nature (IUCN) has evaluated as being Internationally Threatened; and/or
2. Any species that the IUCN has evaluated as being Regionally Threatened (NB: the IUCN has published regional assessments for reptiles and carnivorous mammals only); and/or
3. Any species that the former National Commission for the Conservation of Wildlife and Development

(NCWCD) has evaluated as being Nationally Threatened (NCWCD Criteria 1); and,

- is endemic to Saudi Arabia or the Arabian Peninsula (NCWCD Criteria 2); and/or
- the conservation of the population within Saudi Arabia is essential to the conservation of the species globally (NCWCD Criteria 3); and/or
- is a relict species of global, regional, or national significance (NCWCD Criteria 4); and/or
- is of special ecological importance within Saudi Arabia (i.e. it fulfils a vitally important function in an ecosystem, such as providing key habitat for other species (NCWCD Criteria 5).

These mammal species are listed in Table 11-4 (excluding bats), and this list is based on a review of the International Union for the Conservation of Nature (IUCN) publication Regional Red List Status of Carnivores in the Arabian Peninsula (Mallon et al, 2011); and the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of these ecologically sensitive species has also been completed using published distribution maps.

Table 11-4: Ecologically Sensitive Mammal Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Asiatic Jackal	<i>Canus aureus</i>	1	EN Decreasing	LC Increasing	Absent
Arabian Wolf	<i>Canis lupus arabs</i>	1, 2, 5	EN Decreasing	LC Stable	Likely Absent
Nubian Ibex	<i>Capra nubiana</i>	1, 3		VU Decreasing	Possible
Caracal	<i>Caracal caracal</i>	1, 5	LC	LC Unknown	Absent
Sand Cat	<i>Felis margarita</i>	1, 2	NT Decreasing	NT Decreasing	Absent
Wild Cat	<i>Felis silvestris</i>	1	NT Decreasing	LC Decreasing	Absent
Arabian Mountain Gazelle	<i>Gazella gazella cora</i>	1, 2		VU Decreasing	Absent
Farasan Gazelle	<i>Gazella gazella farasani</i>	1, 2		VU Decreasing	Absent
Arabian Sand Gazelle	<i>Gazella subgutturosa</i>	1, 2		VU Decreasing	Possible
Indian Grey Mongoose	<i>Herpestes edwardsii</i>	1	DD	LC Stable	Absent
Striped Hyaena	<i>Hyaena hyaena</i>	1	EN Decreasing	NT Decreasing	Possible
Indian crested porcupine	<i>Hystrix indica</i>	1, 4		LC Stable	Absent
Arabian Hare	<i>Lepus capensis</i>	1, 2		LC Decreasing	Possible

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
	<i>arabica</i>				
Honey Badger	<i>Mellivora capensis</i>	1	NT Decreasing	LC Decreasing	Possible
Arabian Oryx	<i>Oryx leucoryx</i>	1, 2		VU Stable	Absent
Arabian Leopard	<i>Panthera pardus</i>	1, 2, 5	CR Decreasing	NT Decreasing	Absent
Hamadryas Baboon	<i>Papio hamadryas</i>	3		LC Increasing	Absent
Blanford's Fox	<i>Vulpes cana</i>	1, 4	VU Decreasing	LC Stable	Absent
<u>IUCN International Criteria</u> LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient <u>National Conservation Criteria</u> 1: Nationally threatened species; 2: Species that are endemic to Saudi Arabia, the Arabian Peninsula, the Red Sea or the Gulf; 3: Species in which the conservation of populations within Saudi Arabia is essential to the conservation of the species globally; 4: Relict species of global, regional or national significance; 5: Species of special ecological importance.					

The development site is also likely to support a range of other mammal species which have not been identified as ecologically sensitive. Those species assessed as likely to be present within the development site or its immediate surrounds are listed in Table 11-5.

Table 11-5: Other Mammal Species Likely to be Present within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Red fox	<i>Vulpes vulpes arabicus</i>		LC Stable	LC Stable	Present
Ruppel's fox	<i>Vulpes rueppelli</i>		LC Decreasing	LC Stable	Possible
Ethiopian hedgehog	<i>Paraechinus aethiopicus</i>			LC Stable	Present
Baluchistan gerbil	<i>Gerbillus nanus</i>			LC Stable	Present
Wagner's gerbil	<i>Gerbillus dasyurus</i>			LC Stable	Present
Sundevall's jird	<i>Meriones crassus</i>			LC Unknown	Present
Arabian jird	<i>Meriones arimalius</i>			LC Unknown	Possible
Lesser jerboa	<i>Jaculus jaculus</i>			LC Unknown	Present

11.3.1.4 Bats

The distribution and population status of bat species within the Kingdom of Saudi Arabia is likely to be under-recorded. A precautionary approach has therefore been adopted when interpreting published resources, and in particular determining the conservation status of species. For the purposes of this desk-top review, the IUCN Red List of Threatened Species (www.iucnredlist.org) has been utilized alongside the publication Bats of Saudi Arabia (Al-Agaili, 2003).

Table 11-6 lists the bat species identified by Al-Agaili (2003), and the global IUCN status is based on the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of the bat species identified has also been completed using published distribution maps.

Table 11-6: Bat Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Family Pteropodidae Fruit Bats					
Ethiopian epauletted fruit bat	<i>Epomophorus labiatus</i>	-	-	LC Stable	Absent
Egyptian fruit bat	<i>Rousettus aegyptiacus</i>	-	-	LC Stable	Absent
Straw-colored fruit bat	<i>Eidolon helvum</i>	-	-	NT Decreasing	Absent
Family Rhinopomatidae Mouse-tailed Bats					
Greater mouse-tailed bat	<i>Rhinopoma microphyllum</i>	-	-	LC Stable	Absent
Lesser mouse-tailed bat -	<i>Rhinopoma hardwickii</i>	-	-	LC Stable	Present
Muscat mouse-tailed –	<i>Rhinopoma muscatellum</i>	-	-	LC Unknown	Absent
Family Emballonuridae - Sheath-tailed Bats					
Egyptian tomb bat	<i>Taphozous perforates</i>	-	-	LC Stable	Absent
Naked-bellied tomb bat	<i>Taphozous nudiventris</i>	-	-	LC Stable	Absent
Family Nycteridae - Slit-faced Bats					
Aden slit-faced bat	<i>Nycteris thebaica</i>	-	-	LC Unknown	Absent
Family Rhinolophidae - Horseshoe Bats					
Geoffroy's horseshoe bat	<i>Rhinolophus clivosus</i>	-	-	LC Stable	Absent
Lesser horseshoe bat	<i>Rhinolophus hipposideros</i>	-	-	LC Decreasing	Absent
Blasius' horseshoe	<i>Rhinolophus blasii</i>	-	-	LC Decreasing	Absent
Mediterranean Horseshoe Bat	<i>Rhinolophus euryale</i>	-	-	NT Decreasing	Absent
Family Hipposideridae - Leaf-nosed Bats					
Lesser leaf-nosed bat	<i>Hipposideros caffer</i>	-	-	LC Decreasing	Absent
Small leaf-nosed bat	<i>Hipposideros megalotis</i>	-	-	LC Unknown	Absent

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Persian leaf-nosed	<i>Triaenops persicus</i>	-	-	LC Unknown	Absent
Trident leaf-nosed bat	<i>Asellia tridens</i>	-	-	LC Stable	Present
Small trident leaf-nosed bat	<i>Asellia patrizii</i>	-	-	LC Unknown	Absent
Family Molossidae - Free-tailed Bats					
European free-tailed bat	<i>Tadarida teniotis</i>	-	-	LC Unknown	Absent
Egyptian free-tailed bat	<i>Tadarida aegyptiaca</i>	-	-	LC Unknown	Absent
Lesser free-tailed bat	<i>Tadarida pumila</i>	-	-	LC Unknown	Absent
Nigerian free-tailed bat	<i>Tadarida nigeriae</i>	-	-	LC Unknown	Absent
Midas free-tailed bat	<i>Tadarida midas</i>	-	-	LC Decreasing	Absent
Family Vespertilionidae - Vespertilionid Bats					
Notch-eared bat	<i>Myotis emarginatus</i>	-	-	LC Stable	Absent
Rufous mouse-eared	<i>Myotis bocagei</i>	-	-	LC Unknown	Absent
Botta's serotine bat	<i>Eptesicus bottae</i>	-	-	LC Unknown	Absent
Sind serotine bat	<i>Eptesicus nasutus</i>	-	-	LC Unknown	Absent
Kuhl's pipistrelle	<i>Pipistrellus kuhlii</i>	-	-	LC Unknown	Present
Arabian pipistrelle	<i>Pipistrellus arabicus</i>	-	-	DD Unknown	Absent
Bodenheimer's pipistrelle	<i>Pipistrellus bodenheimeri</i>	-	-	DD Unknown	Absent
Schlieffen's bat	<i>Nycticeinops schlieffeni</i>	-	-	LC Unknown	Absent
Lesser yellow house bat	<i>Scotophilus leucogaster</i>	-	-	LC Unknown	Absent
Hemprich's long-eared bat	<i>Otonycteris hemprichi</i>	-	-	LC Unknown	Absent
Grey long-eared bat	<i>Plecotus austriacus</i>	-	-	LC Unknown	Absent
Schreiber's long-winged bat	<i>Miniopterus schreibersii</i>	-	-	NT Decreasing	Absent
Common noctule	<i>Nyctalus noctula</i>	-	-	LC Unknown	Absent
Western barbastelle	<i>Barbastella barbastellus</i>	-	-	NT Decreasing	Absent
Family Emballonuridae					

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Southern sheath-tailed	<i>Coleura afra</i>	-	-	LC Unknown	Absent
<u>IUCN International Criteria</u> LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient					

11.3.1.5 Reptiles

Saudi Aramco has identified ecologically sensitive reptile species within the Kingdom of Saudi Arabia based on the criteria referenced in SAEP-396 Terrestrial Ecology Surveys. These reptile species are listed in Table 11-7, and this list is based on a review of the International Union for the Conservation of Nature (IUCN) publication The Conservation Status and Distribution of Reptiles of The Arabian Peninsula (Cox et al, 2012); and the IUCN Red List of Threatened Species (www.iucnredlist.org). An evaluation of the likely presence of these ecologically sensitive species has also been completed using published distribution maps.

Table 11-7: Ecologically Sensitive Reptile Species and Likely Presence within Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
Saudi Fringed Fingred Lizard	<i>Acanthodactylus gongrorhynchatus</i>	1, 2	DD Unknown	DD Unknown	Absent
Levitons Cylindrical Skink	<i>Chalcides levitoni</i>	1, 2	DD Unknown	DD Unknown	Absent
Sarso Island Racer	<i>Coluber insulans</i>	1, 2	DD Unknown	DD Unknown	Absent
Braid Snake	<i>Coluber rhodorachis</i>	3			Unknown
Arabian Sand Boa	<i>Eryx jayakari</i>	3, 5	LC Stable	LC Stable	Present
Leviton's Leafnose Snake	<i>Lytrohynchus gasperetti</i>	1, 2	DD Unknown	DD Unknown	Absent
False Cobra	<i>Malpolon moilensis</i>	3, 5			Unknown
Arabian Blind Snake	<i>Myriopholis burii</i>	1, 2	DD Unknown	DD Unknown	Absent
Red Eyed Sea Snake	<i>Ophisops elbaensis</i>	1, 2	DD Unknown	DD Unknown	Absent
	<i>Trapelus jayakari</i>	1, 2	DD Unknown	DD Unknown	Absent
Horny Scaled Agama	<i>Trapelus ruderata</i>	3	LC Stable	LC Stable	Present

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Likely Presence within Development Site
	<i>Tropicolotes wolfgangboehmei</i>	1, 2	DD Unknown	DD Unknown	Unknown
Spiny Tailed Dhab	<i>Uromastix aegyptia</i>	1, 3	VU Decreasing	VU Decreasing	Unknown
Oscillated Dab Tailed Lizard	<i>Uromastix ocellatus</i>	3			Unknown
Yemen Monitor	<i>Varanus yemenensis</i>	1, 2, 5	DD Unknown	DD Unknown	Absent
Desert Cobra	<i>Walterinnesia aegyptia</i>	3	LC Decreasing	LC Decreasing	Unknown

IUCN International Criteria

LC: Least Concern; NT: Near Threatened; VU: Vulnerable; EN: Endangered; CR: Critically Endangered; DD: Data Deficient

National Conservation Criteria

1: Nationally threatened species; 2: Species that are endemic to Saudi Arabia, the Arabian Peninsula, the Red Sea or the Gulf; 3: Species in which the conservation of populations within Saudi Arabia is essential to the conservation of the species globally; 4: Relict species of global, regional or national significance; 5: Species of special ecological importance.

Cox et al (2012) have ascertained that the overall reptile species diversity is highest around the edge of the Peninsula and northern Saudi Arabia, and in proximity to the development site the number of species is listed as 29 – 35. This is illustrated on Figure 11-4. Within proximity to the development site, Cox et al (2012) estimate between 1 – 6 endemic species are present. Notwithstanding, many species within the Arabian Peninsula are data deficient and a precautionary approach has been taken when interpreting published data.

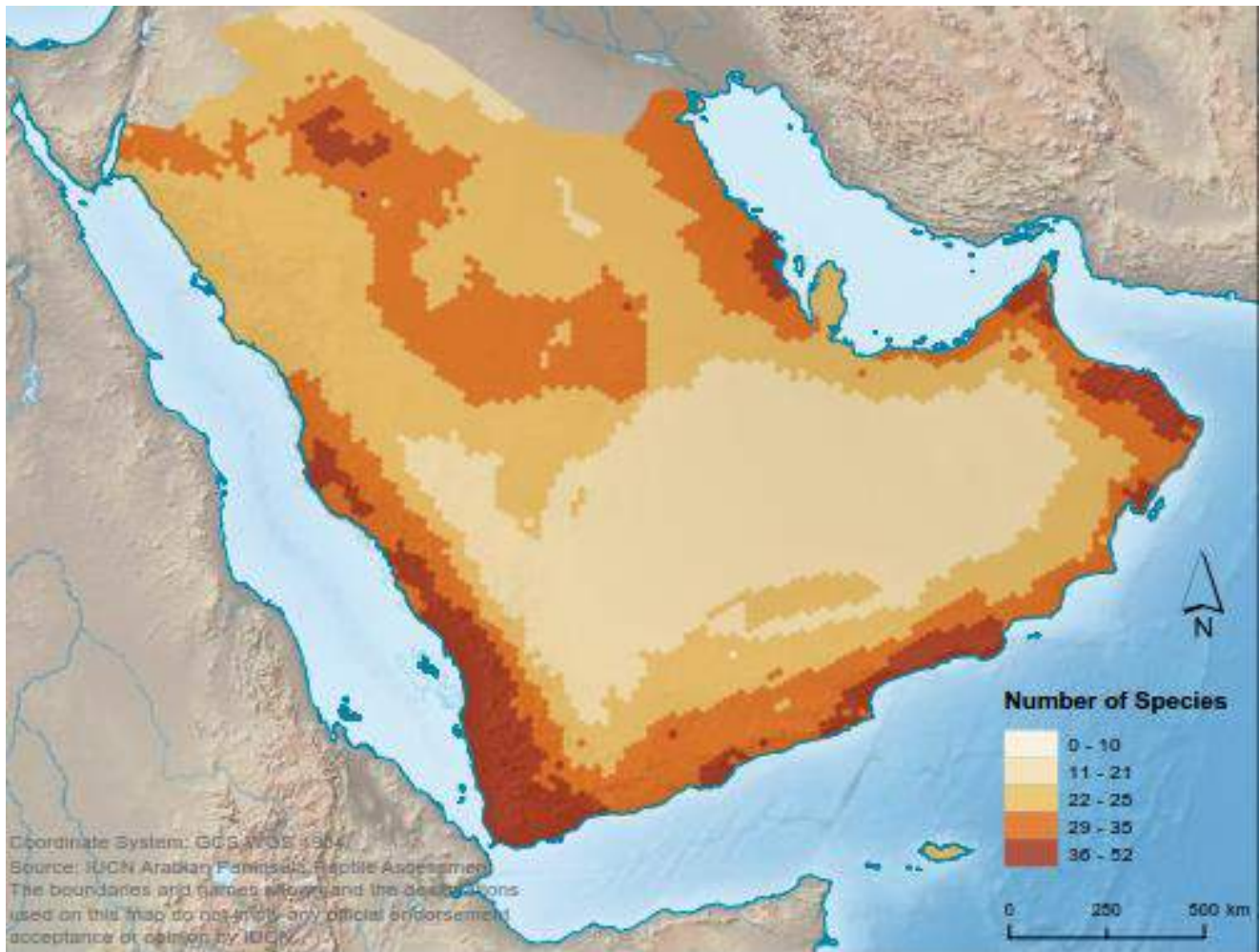


Figure 11-4: Species Richness of Reptiles in the Arabian Peninsula

11.3.2 Baseline Survey Design

The baseline survey methodologies are reported in the Sakaka Solar Energy Park Fatal Flaw Analysis and Baseline Survey report and Appendix G. These survey methodologies have been agreed with the Saudi Aramco and comply with national and international good practice guidelines.

Prior to the commencement of survey work an indicative index of bird species known to be present on the East Asia/East Africa Flyway was produced. Unique three-letter codes were attributed to each species for recording purposes during surveys. This species list is included within Appendix H. The location, timings and weather conditions during the baseline surveys are listed in Appendix I.

11.3.3 Baseline Survey Results

11.3.3.1 Ornithological Surveys

At the time of writing, a total of 18 species have been recorded during the planned surveys and through incidental observations. Five represent target species, observed during VP surveys and incidental sightings. A full list of species recorded on-site along with their conservation status and population trend is provided in Appendix J.

11.3.3.1.1 Autumn 2016 Migration Vantage Point Surveys

Flight details of target species observed during VP surveys are provided below (Table 11-8). Information in relation to bird flight seconds provided represents the total observed flight duration of all birds (*i.e.* where flights involved more than one bird, flight time was multiplied by the number of individuals involved). The proportion of time spent flying within each height band is given to the nearest integer. Flight duration represents the length of time birds were observed in flight irrespective of flight line location, and does not necessarily reflect the time spent flying within areas where birds may be susceptible to collision with transmission lines or other solar infrastructure.

Table 11-8: Spatial Distribution of Target Species Flight Lines

Species	Flights	Flight Time (seconds)	Max. number of birds observed concurrently	Band A %	Band B %
Long-legged buzzard	2	65	1	54	46
Greater-spotted eagle	1	90	1	0	100
Steppe eagle	1	65	1	100	0
Steppe buzzard	3	47	1	0	100
Pallid harrier	1	22	1	100	0

Flight lines for the target species are shown in Figure 11-5. All flight lines shown within the figures have been given a unique flying bout reference, related to the KSA species code.

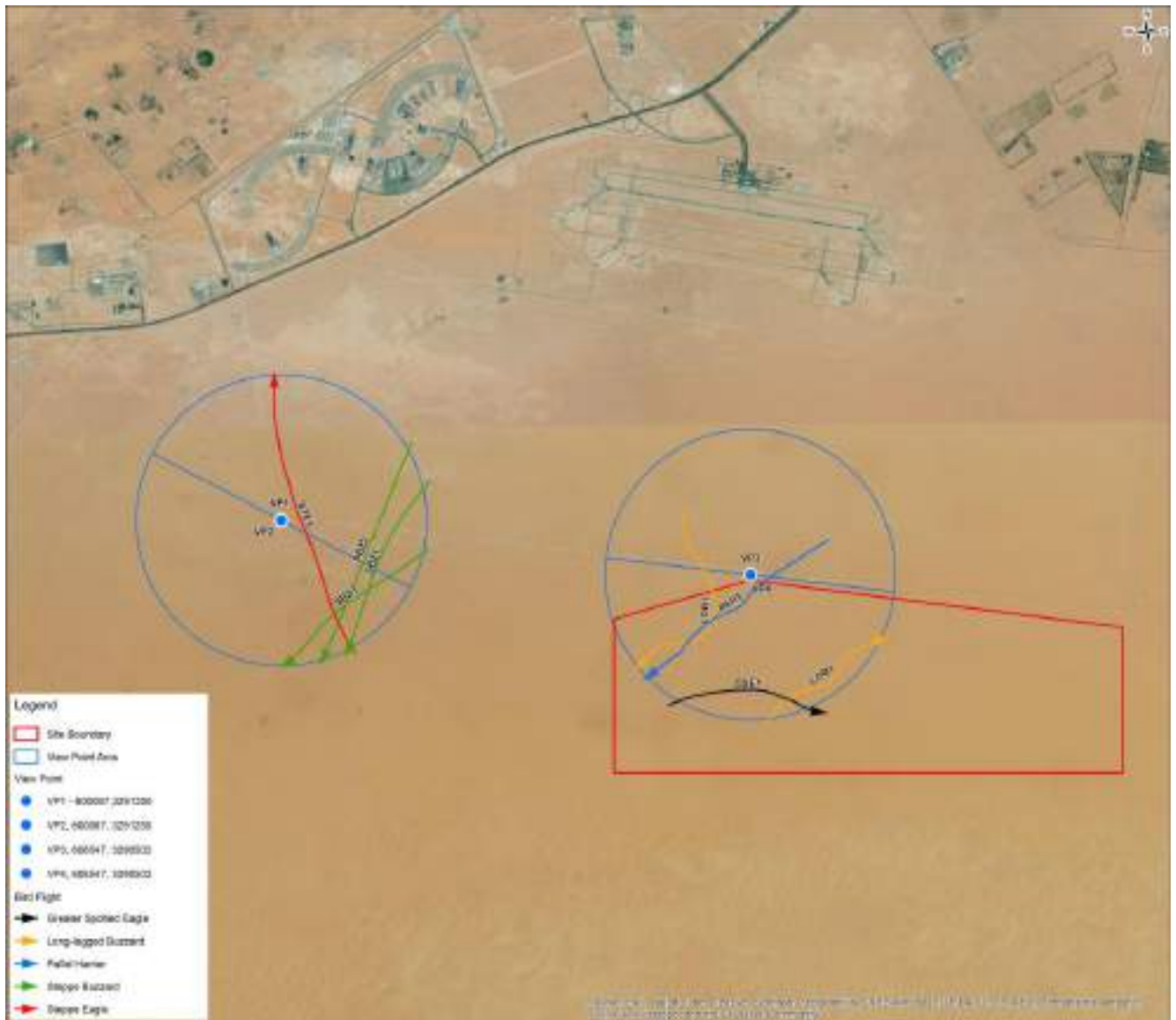


Figure 11-5: Flight Lines

The spatial distribution of autumn VP survey records is presented as the distribution of flights across the four VP locations (Figure 11-5) and is summarized in Table 11-9. Due to the low number of flight lines, the data for VP1 and 2, and VP3 and 4 have been combined.

Table 11-9: Spatial Distribution of Target Species Flight Lines

Species	VP1/2	VP3/4	Flight Total
Long-legged buzzard	1	1	2
Greater-spotted eagle	0	1	1
Steppe eagle	1	0	1
Steppe buzzard	3	0	3
Pallid harrier	1	0	1
Flight Total	6	2	8

VP watches generated a total of 8 flight lines of 5 target species. The most frequently recorded species was Steppe buzzard with three flights. Two or less flights were recorded for all other target species.

Despite a total 48 hours of VP survey effort, only a small number of target species were recorded. Due to the size of the data set caution needs to be exercised when interpreting the data. However based on the data, VP1 and VP2 appear to be more active than VP3 and VP4, with more frequent flight lines and species diversity. A number of incidental bird recordings were made during the autumn field surveys and are shown on Figure 11-6.

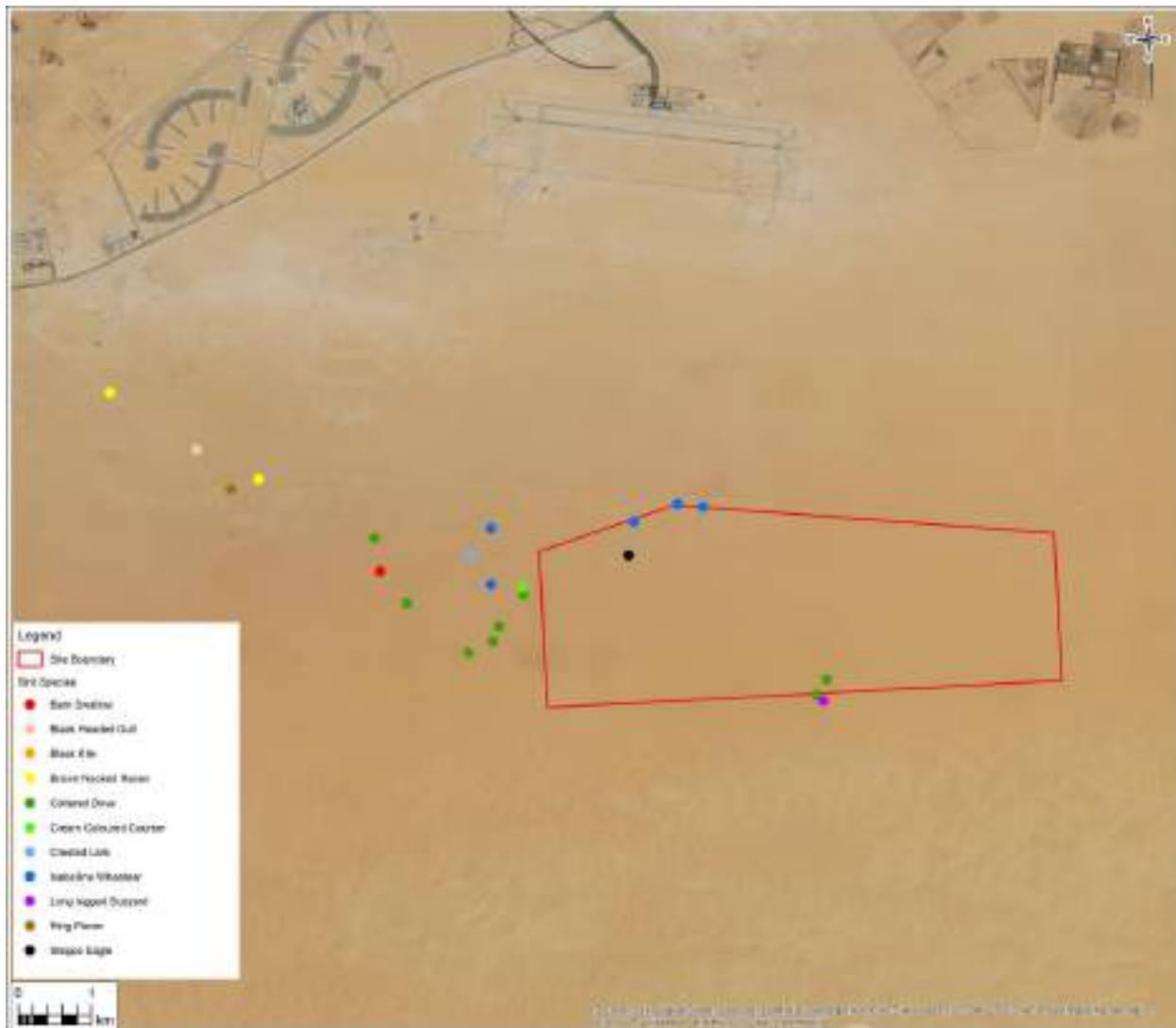


Figure 11-6: Incidental Bird Survey Recordings (Autumn 2016)

11.3.3.1.2 Winter 2016/2017 Bird Surveys

Eight species were recorded during the winter survey visits as shown in Figure 11-7.

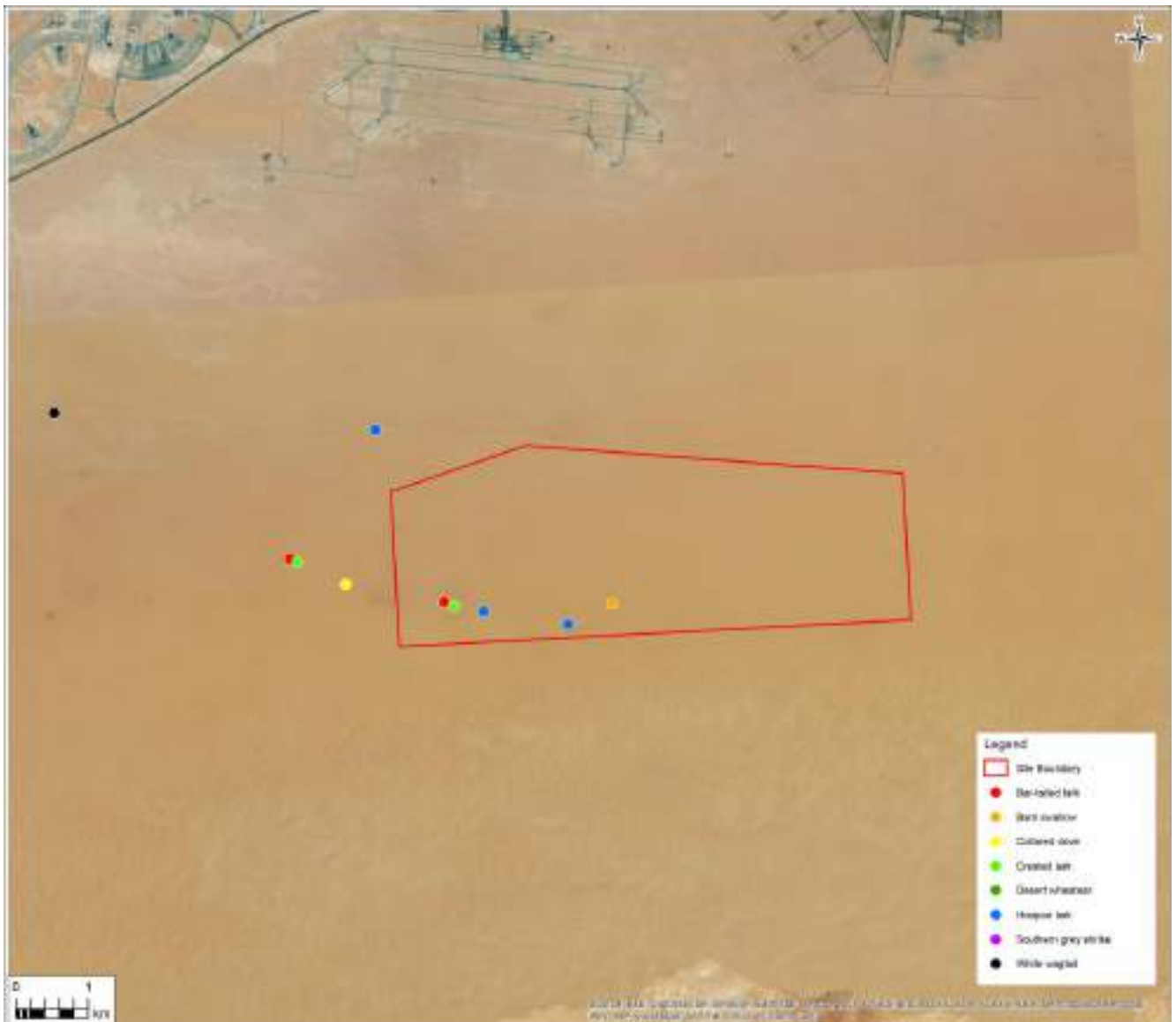


Figure 11-7: Winter 2016/2017 Bird Survey Sightings

11.3.3.2 Phase 1 Habitat Survey

11.3.3.2.1 Kingdom of Saudi Arabia Habitat Classifications

In the absence of specific Phase 1 habitat classifications for the Kingdom of Saudi Arabia, a set of interim codes has been developed for the development site. These codes utilize JNCC broad habitat classifications and habitat codes where these can be applied, and more specific codes for the Kingdom where habitat types are unique. The proposed Phase 1 habitat survey codes to be used for the Park are listed in Table 11-10. It should be noted that the JNCC Phase 1 habitat survey codes have been developed for habitats in the United Kingdom which typically support continuous vegetative communities, which aid with habitat classification. The habitats in the Kingdom of Saudi Arabia generally support more sparse vegetative communities and are often characterized by large areas of bare ground.

Table 11-10: Phase 1 Habitat Classifications for the Development Site

JNCC Habitat Classification	JNCC Habitat Code	KSA Adapted Code	Description
J. Miscellaneous	J.4 Bare Ground		Any type of bare soil or other substrate should be included within this classification. This will include consolidated sand, silts and gravels which support little or no vegetation.
		J.5 Dune	Dune habitat applies to vegetated and non-vegetated inland sand dunes within desert areas. Target notes should be used to classify the type of dune, including size and degree of mobility.

11.3.3.2.2 Phase 1 Habitat Survey for Development Site

The habitats within the development site can be classified into 2 broad habitat types (Table 11-10). The majority of the development site is comprised of gravel terrace with sand, silt, small rocks and occasional sandstone outcrops. The vegetation within this habitat type has been heavily grazed and is predominantly restricted to *Haloxylon salicornicum* which is comparatively more tolerant to grazing pressure than other flora. *Haloxylon salicornicum* plants are sparsely distributed and much of this habitat is devoid of vegetative growth.

Towards the southern part of the development site, the habitat transitions into low sand dune which characterizes the edge of the An Nafud Desert. The dunes are more densely vegetated than the gravel terrace areas, with mature plants at a density of approximately one per m², although the community is dominated by *Haloxylon salicornicum*.

The abandoned camel race-track within the development site lies within the gravel terrace habitat classification. It is comprised of a sand track demarcated by sand embankments approximately 0.5m in height. The race track supports a higher density of *Haloxylon salicornicum* specimens compared to the adjoining gravel terrace areas.

There are a number of transient encampments throughout and adjacent to the development site. These are used by seasonal graziers who reportedly utilize a corridor 150km in length to the south of Sakaka and Dumat al Jandal. At the time of the survey, several of these encampments were occupied and sheep, goats, camels and several donkeys were grazing the development site. There is extensive grazing pressure across the development site and the wider landscape, evidenced by the damage recorded to *Haloxylon salicornicum* plants, and the limited diversity of the floral communities.

The Phase 1 habitats within and adjoining the development site are illustrated on Figure 11-8 and the targets notes recorded during this survey are described in Appendix K and Appendix L.

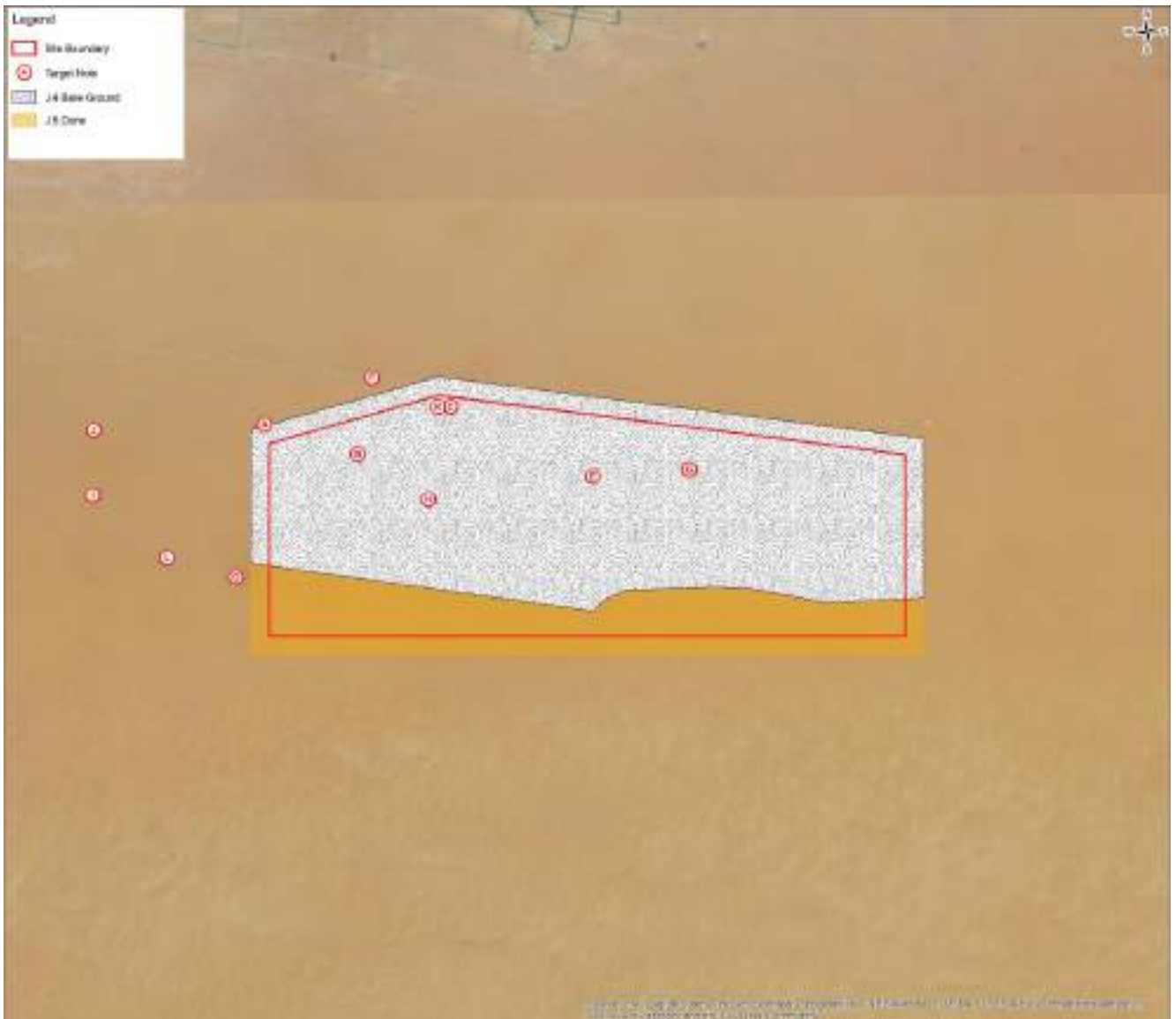


Figure 11-8: Phase 1 Habitats

11.3.3.3 Floral Communities

The flora of the Al Jouf region is strongly influenced by its elevation above sea level, rainfall and intensive grazing (Thomas, 2016). The frequency and density of perennial and annual species can vary considerably in response to rainfall patterns and grazing pressure. Several key plant communities and associations have been recorded for the region, including those for the edge of the An Nafud Desert where the development site is located.

The edges of the An Nafud Desert are dominated by *Haloxylon salicornicum*-*Zygophyllum mandavillei* or *Panicum turgidum* communities, supported by associated species such as *Centropodia fragilis*, *Dipterygium glaucum*, *Moltkiopsis ciliata*, *Stipagrostis drarii* (Thomas, 2016).

During the site visit the plant communities and associations were sampled at each of the Phase 1 habitat survey target note locations. A description of the community and key plant associations is listed in Table 11-11. The development site is sparsely vegetated with low species diversity as described in the Phase 1 habitat survey, and plant communities and associations do not directly align with those proposed by Thomas (2016). This is attributable to the intensive grazing pressure across the site and the terrain. It is likely that annual species have been under recorded during the survey.

Table 11-11: Flora Communities and Associations

Target Note	Description Floral Communities / Associations	Species List	DAFOR Scheme
A	The western part of the development site is sparsely vegetated with only occasional specimens of <i>Haloxylon salicornicum</i> and rare <i>Dipterygium glaucum</i> , both showing evidence of intensive recent grazing. Grazed <i>Stipagrostis spp.</i> plants occur locally where the sand content of the gravel terrace is greater.	<i>Haloxylon salicornicum</i> <i>Dipterygium glaucum</i> <i>Stipagrostis spp</i>	O R R
B	The sand embankments of the camel race-track and adjacent areas support the greatest concentration of flora. Frequent <i>Haloxylon salicornicum</i> occurs within the sand embankments with rare <i>Moltkiopsis ciliata</i> .	<i>Haloxylon salicornicum</i> <i>Moltkiopsis ciliata</i>	O R
C	The area around the Saudi Aramco meteorological station is almost devoid of vegetation, with only several grazed <i>Stipagrostis spp.</i> plants occur locally.	<i>Stipagrostis spp</i>	O
D	As the gravel terrace transitions into the dunes of the An Nafud desert the density of <i>Haloxylon salicornicum</i> . However the community remains species poor and this plant dominates.	<i>Haloxylon salicornicum</i>	A
E	Similar to Target Note B, the sand embankments of the camel race-track and adjacent areas support the greatest concentration of flora. Frequent <i>Haloxylon salicornicum</i> occurs within the sand embankments with rare <i>Moltkiopsis ciliata</i> .	<i>Haloxylon salicornicum</i> <i>Moltkiopsis ciliata</i>	O R
F	The SEC access track and the areas within the utility corridor are devoid of vegetation. Historically this has been a highly disturbed zone.	n/a	
G	The eastern part of the development site is comprised of gravel terrace but with a greater composition of sand. There are more frequent, isolated stands of <i>Haloxylon salicornicum</i> with grazed <i>Stipagrostis spp.</i> Although comparatively more vegetated than the western and central parts of the development site, plant growth remains sparse.	<i>Haloxylon salicornicum</i> <i>Stipagrostis spp</i>	O R
H	The central part of the development site is sparsely vegetated with only occasional specimens of <i>Haloxylon salicornicum</i> showing evidence of intensive recent grazing. Grazed <i>Stipagrostis spp.</i> plants occur locally where the sand content of the gravel terrace is greater.	<i>Haloxylon salicornicum</i> <i>Stipagrostis spp</i>	O R
L	Although the area within the enclosure is protected from grazing pressure, the community is again dominated by <i>Haloxylon salicornicum</i> , albeit mature specimens.	<i>Haloxylon salicornicum</i>	F

11.3.3.4 Mammals

Through a combination of Phase 1 habitat survey and the crepuscular / nocturnal surveys, the majority of the development site was accessed and sampled. Evidence of mammal activity in the form of tracks, burrows / dens, scats / droppings, hairs etc. were recorded in addition to any visual sightings. All recorded mammal activity is summarized in Table 11-12 and shown on Figure 11-9.

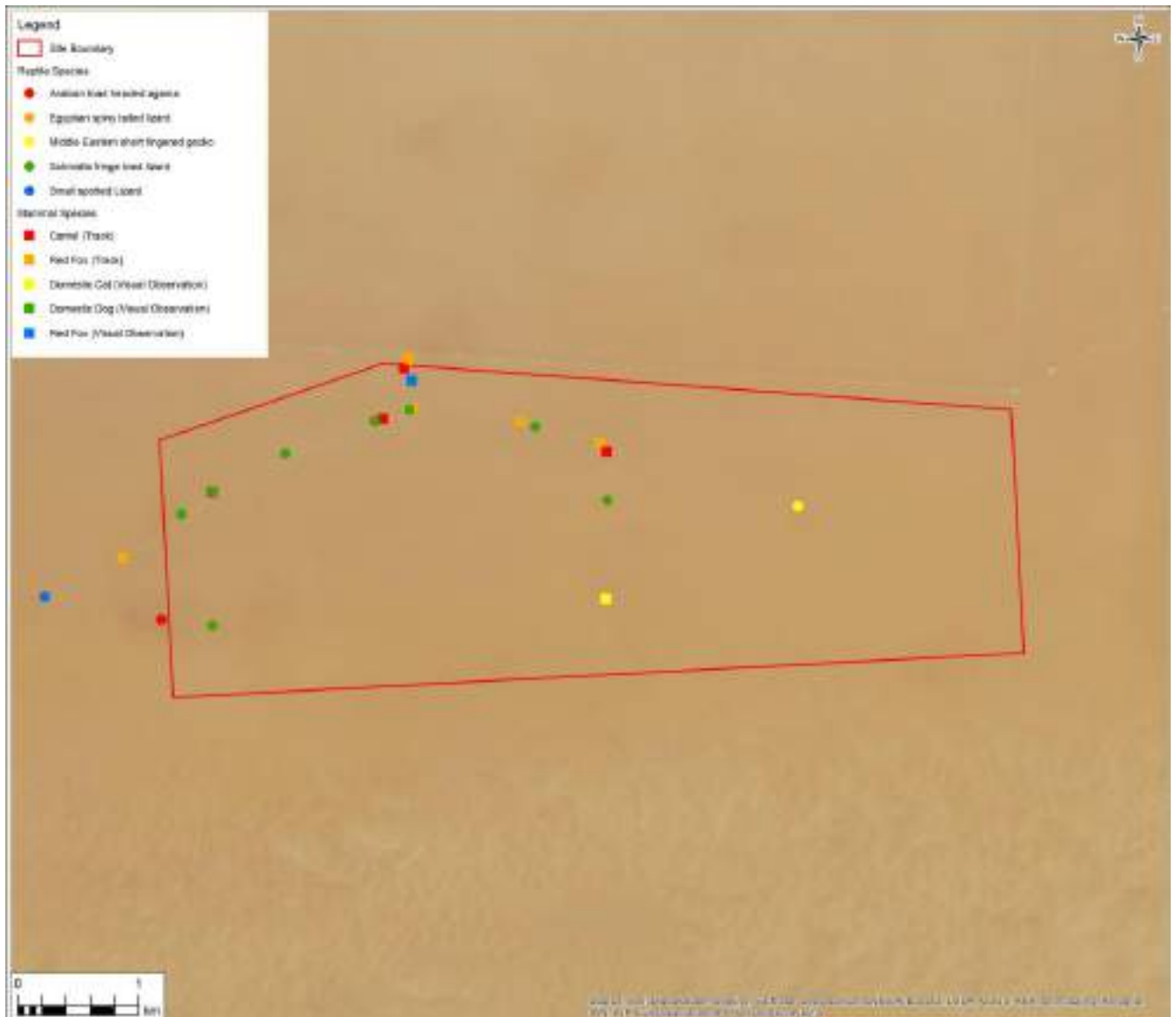


Figure 11-9: Mammal and Reptile Activity

The predominant mammal species recorded on the development site and the wider landscape were domesticated livestock (i.e. camels, sheep and goats) and feral dogs. These were recorded during the daytime and were present on the development site throughout the survey visit in October 2016. A single feral cat (Plate 1) was also recorded during the crepuscular / nocturnal survey undertaken on 12th October 2016 in proximity to the south-eastern corner of the abandoned race-track and an occupied encampment with livestock (29°43'15.85"N, 40° 7'5.95"E). It is likely that the cat was associated with the encampment.

In proximity to livestock feeding troughs there is evidence of significant small mammal activity in the form of burrows (Plate 2). Although these did not appear to be active at the time of the survey, it is likely that these are rat burrows. The occupied livestock areas were noted as attracting significant numbers of Eurasian collared dove *Streptopelia decaocto* and it is likely that seeds from animal feed are providing a food resource. This food resource is also likely to attract vermin.

A single red fox was recorded in proximity to the Saudi Aramco meteorology station and fox tracks were observed inside the race-track. Although a number of small burrows were recorded across the site, no other mammal activity was recorded during the Phase 1 habitat survey or the crepuscular/nocturnal surveys. The sparse vegetation and impact of grazing and vermin species is likely to be adversely affecting the ecological value of the site for native mammal species.

Table 11-12: Recorded Mammal Activity within the Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Description
Red Fox	<i>Vulpes vulpes arabicus</i>		LC Stable	LC Stable	Red fox tracks were recorded within the abandoned race-track and in proximity to the Saudi Aramco meteorological station.
Camel	<i>Camelus dromedarius</i>		n/a	n/a	Camel tracks were recorded throughout the site, in particular within the softer sand of the abandoned race-track. Camels were also recorded at several of the transient encampments within or adjacent to the development site.
Domestic Dog	<i>Canis lupus familiaris</i>		n/a	n/a	Dogs were recorded in proximity to the SEC access track
Domestic Cat	<i>Felis catus</i>		n/a	n/a	A single cat was recorded during one of the crepuscular / nocturnal surveys immediately to the south-east of the abandoned race-track.
Domestic Sheep	<i>Ovis aries</i>		n/a	n/a	Associated with transient encampments within or adjacent to the development site.
Domestic Goats	<i>Capra aegagrus hircus</i>		n/a	n/a	Associated with transient encampments within or adjacent to the development site.



Plate 1: Feral cat recorded to the south-east of the camel race-track



Plate 2: Rodent burrows associated with livestock feeding areas

11.3.3.5 Faunal Surveys Using Trail Cameras

A total of 68.5 hours of trail camera survey has been completed during autumn 2016. Only a single red fox was recorded during one of the camera trapping sessions. No other activity was recorded and no further trail camera survey will be undertaken. A summary of the trail camera survey is provided in Table 11-13.

Table 11-13: Trail Camera Survey Results

Trail Camera location	Activity Recorded	Image
A	A single red fox	
B	nil	

Trail Camera location	Activity Recorded	Image
C	nil	
D	nil	

11.3.3.6 Reptiles

Through a combination of Phase 1 habitat survey and the crepuscular / nocturnal surveys, the majority of the development site was accessed and sampled. Evidence of reptile activity in the form of tracks, burrows, scats were recorded in addition to any visual sightings. All recorded reptile activity is summarized in Table 11-14 and shown on Figure 11-9.

Schmidts fringe toed lizard *Acanthodactylus schmidtii* was the most numerous species recorded within the development site, and individuals were observed throughout the survey. This species is found in open desert dune areas of soft (aeolian) sand with little vegetation and burrows close to the roots of bushes and other vegetation (Behbehani et al, 2012). Accordingly, this species was primarily associated with the embankments of the race-track which provide more topographical variation, in particular on a north-south axis, and more sandy substrates with *H. salicornicum* for burrowing. The biology of *A. schmidtii* is not well documented, but it is thought that sand dwelling members of this genus rely heavily on ants as prey (Fuellner, 2001). During the crepuscular / nocturnal surveys several ant nests were recorded adjacent to the race-track, in addition to other invertebrate species.

Although just outside of the development site, a single small spotted lizard *Mesalina guttulata* was recorded in the deep wind-blown sand that has accumulated against the fenced area identified during the Phase 1 habitat survey (Target Note L).

A single Arabian toad headed agama *Phrynocephalus arabicus* was recorded towards the southern part of the site during the Phase 1 habitat survey, where the gravel terrace transitions into sand and low dunes. This species is found in areas of soft, wind-blown sand (Arnold 1980), but can also occur on harder and drier substrates with sparse vegetation. Similarly it feeds on insect prey.

During the crepuscular/nocturnal survey on 12th October a single Middle Eastern short fingered gecko *Stenodactylus doriae* was recorded taking shelter between small sandstone rocks. This species is known to be active at night and is most commonly encountered walking slowly across the desert sands (Hellyer et al, 2005). The eastern part of the site has a greater proportion of sand material to gravel and small rocks.

Although no live specimen was recorded, *Uromastix aegyptia* tracks were recorded in proximity to the Saudi Aramco meteorological station, leading to and from an active burrow. A trail camera was deployed in proximity to the burrow although no activity was recorded.

Reptile species are predominantly associated with the race-track and the transitional zone between the two habitat types to the south of the development site. These parts of the site support a greater density of plants, wind-blown organic material and invertebrate species.

Table 11-14: Recorded Reptile Activity within the Development Site

Common Name	Scientific Name	National Criteria	Regional IUCN Status	Global IUCN Status	Description
Schmidts fringe toed lizard	<i>Acanthodactylus schmidtii</i>		LC Stable	LC Stable	Multiple specimens were observed. All specimens associated with <i>Haloxylon salicornicum</i> plants on the abandoned race-track
Small spotted Lizard	<i>Mesalina guttulata</i>				A single specimen
Arabian toad headed agama	<i>Phrynocephalus arabicus</i>		LC Stable	LC Stable	A single specimen was recorded on the south-west corner of the race-track amongst transitional habitat.
Middle Eastern short fingered gecko	<i>Stenodactylus doriae</i>			LC Stable	A single specimen was recorded in the eastern part of the development site.
Egyptian spiny tailed lizard	<i>Uromastix aegyptia</i>	1, 3	VU Decreasing	VU Decreasing	A single active burrow with recent prints



Plate 3: Schmidts Fringe Toed Lizard



Plate 4: Middle Eastern Short Toed Gecko



Plate 5: Dhub burrow



Plate 6: Dhub tracks

11.3.3.7 Invertebrates

During the Phase 1 survey and day-time walk-over surveys, limited invertebrate species were recorded. The most frequently encountered were members of the family Tenebrionidae and included Urchin Beetle *Priionotheca cornata* and the Arabian darkling beetle *Pimelia arabica*. These species were recorded within the gravel terrace areas of the development site, active during the day.

A single desert mantis *Eremiaphila baueri* and a weevil (species unknown) were observed within the northern part of the development site in proximity to the Saudi Aramco meteorological station. The weevil was discovered sheltering under a rock while the *E. baueri* was actively hunting.

During the crepuscular and nocturnal surveys, several *P. Arabica* were recorded in addition to a single churchyard beetle *Blaps kolari*. Several active ant nests were also recorded during these surveys, primarily in proximity to the race-track and unoccupied encampments where there is evidence of historic livestock feeding. Two species were noted; the larger species was identified as the desert runner ant *Cataglyphis niger*. The smaller species remains unidentified.

No spiders or scorpions were recorded during the crepuscular and nocturnal surveys.



Plate 7: Weevil (species unknown)



Plate 8: Arabian darkling beetle



Plate 9: Ant colony (species unknown)



Plate 10: Desert Runner Ant



Plate 11: Arabian Darkling Beetle



Plate 12: Churchyard Beetle

11.3.3.8 Bats

11.3.3.8.1 Assessing Need for Survey

The development site is in close proximity to the towns of Sakaka and Dumat al Jandal. The areas surrounding these towns are rural and support low intensity agricultural activities. As a result of irrigation there is an abundance of semi-natural vegetation, standing water and insect prey. These areas are therefore assessed as providing high quality foraging and commuting habitat and offer roost sites in the form of trees and buildings.

The area to the south of the development site marks the edge of the An Nafud Desert which supports natural stands of *Haloxylon salicornicum* vegetation and occasional transient graziers. Insect prey is abundant in proximity to the livestock enclosures and swallows were recorded feeding in these areas. These areas are therefore assessed as providing moderate quality foraging and commuting habitat in the context of Saudi Arabia.

Although the development site itself does not provide foraging habitat or landscape features which could be used by commuting bats, its proximity to such areas within the wider landscape means that a precautionary approach has been taken. It is assessed that the level of risk the Park will have on bat species is low, and survey effort commensurate with this level of risk has been undertaken.

11.3.3.8.2 Roost Surveys

There are no permanent structures within the development site which offer suitable roosting opportunities. The only structures present are transient accommodations in the form of Bedouin style tents which are not assessed as having potential. Similarly there are no natural landscape features which could be used by bats for roosting (e.g. trees, subterranean caves etc.). It has therefore been determined that the site does not provide any roosting sites for bat species.

11.3.3.8.3 Bat Activity and Automated Surveys

No bat activity was recorded during the transect surveys or automated surveys, despite optimal weather conditions at the time of survey.

11.4 Ecosystem Services

The developable area of the Park is comprised of a flat rock and gravel terrace with sand. There are no major landscape features such as wadi channels or rocky outcrops, and the developable area supports negligible vegetation. The site is therefore not assessed as important for regulating (i.e. flood risk management) or provisioning services (i.e. agriculture or grazing).

There is a disused camel racing track within the footprint of the developable area, but this is no longer used. The most prominent land-use comprises of seasonal animal husbandry enclosures which are owned by Saudi nationals and operated by immigrant labor. There is no indication that these operations are owned by indigenous Bedouin which would be considered as Indigenous Peoples under IFC Performance Standard 7.

No recreational land-uses were observed on the site, including hunting with falcons which is classified as a feature of Intangible Cultural Heritage by the United Nations Educational, Scientific and Cultural Organization (UNESCO). Originally a method of obtaining food, the practice of falconry has evolved over time to be more associated with nature conservation, cultural heritage and social engagement within and amongst communities (www.unesco.org).

The site is not considered to provide ecosystem services which warrant further assessment.

11.5 Ecological Impact Assessment Methodology

The assessment of ecological impact has utilized UK best practice Guideline for Ecological Impact Assessment as published by the Chartered Institute of Ecology and Environmental Management (2016). In accordance with these guidelines the approach in determining significance of impacts takes into account the value of an ecological receptor at geographical scale, and the geographical scale at which the impact is assessed as significant.

This approach includes the following key stages:

- identification and evaluation (at a geographical scale) of ecological resources and features likely to be affected;
- identification of the biophysical changes likely to affect valued ecological resources and features; and,
- assessment of whether these biophysical changes are likely to give rise to a significant ecological impact, defined as an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical scale, including cumulative impacts.

This differs from the assessment of impact significance in other areas of environmental impact assessment, where significance would be a function of receptor sensitivity and impact magnitude. For ecology, these aspects are independent.

11.5.1 Determination of Significance

11.5.1.1 Receptor Value (Sensitivity)

Within the Kingdom of Saudi Arabia, there is limited legislation which affords species with legal protection and there is also limited data on the conservation status and population trends of individual species. Therefore the value, or potential value, of each biological resource has been developed using the following source documents:

- the list of species of High Conservation Priority as prepared by the former National Commission for Wildlife Conservation & Development(undated), now the Saudi Wildlife Authority, in response to the ratification of the U.N. Convention on Biological Diversity (1993); and,
- the International Union for the Conservation of Nature (IUCN) Red List 2012.

The species of High Conservation Priority are assigned a value in accordance with the following categories, and species may fall within one or more categories:

- i. Genera, species, or subspecies that are critically endangered, endangered, or vulnerable (globally, regionally, or nationally); taxa which are locally extinct in the wild may be included, provided that there is an SWA policy to reintroduce them.
- ii. Genera, species, or subspecies endemic to the Arabian Peninsula, the Red Sea, or the Gulf.
- iii. Genera, species, or subspecies of which the conservation of populations within Saudi Arabia is essential to the conservation of the taxon (e.g. near-endemics and migrants for which Saudi Arabia represents a critical range).
- iv. Relict genera, species, or subspecies that are of global, regional, or national significance.
- v. Genera or species of special ecological importance (i.e. fulfilling a vitally important function in an ecosystem such as providing a key habitat for other species, serving as indicator species, etc.).
- vi. Genera of species of significant economic importance.
- vii. Genera or species that serve a “flagship” function (i.e. high-profile species of cultural value, the protection of which will also protect large numbers of other species that share their habitats).

The IUCN Red List categorizes species into nine groups based on their risk of global extinction, set through criteria such as rate of decline, population size, area of geographic distribution, and degree of population and distribution fragmentation (Figure 11-10). The nine categories are:

- Extinct (EX) – No known individuals remaining.
- Extinct in the Wild (EW) – Known only to survive in captivity, or as a naturalized population outside its historic range.
- Critically Endangered (CR) – Extremely high risk of extinction in the wild.
- Endangered (EN) – High risk of extinction in the wild.
- Vulnerable (VU) – High risk of endangerment in the wild.
- Near Threatened (NT) – Likely to become endangered in the near future.
- Least Concern (LC) – Lowest risk. Does not qualify for a more at risk category. Widespread and abundant taxa are included in this category.
- Data Deficient (DD) – Not enough data to make an assessment of its risk of extinction.
- Not Evaluated (NE) – Has not yet been evaluated against the criteria.

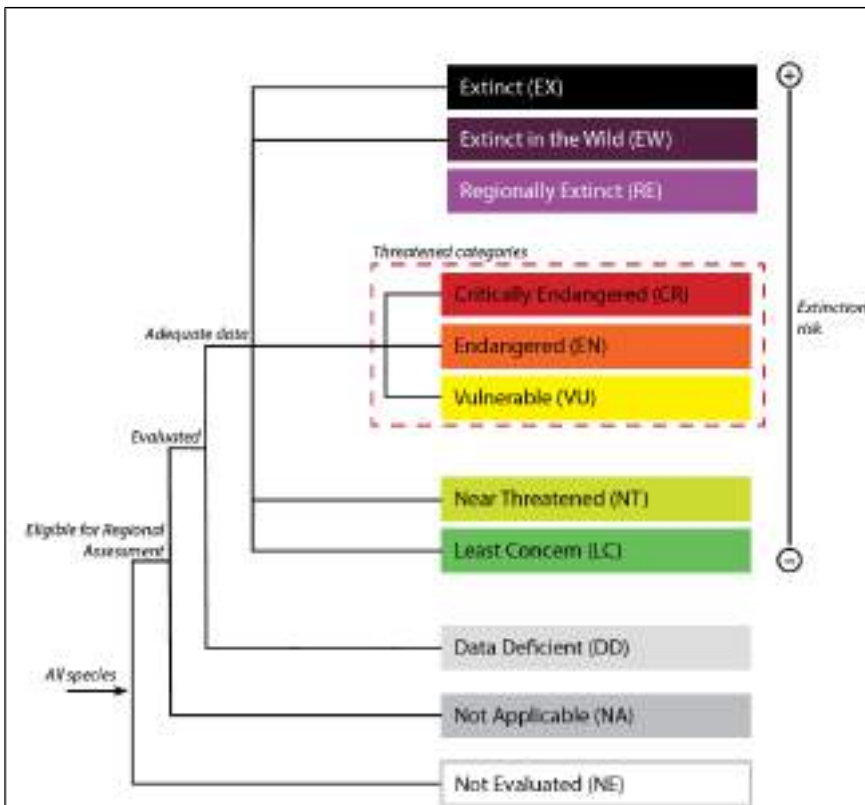


Figure 11-10: IUCN Classification System

Using the list of species of High Conservation Priority and the IUCN Red List, a geographical frame of reference has been developed to assign value (Table 11-15). To fully acknowledge the spatial range associated with some biological resources (e.g. migratory birds) and potential impacts outside national boundaries, a “very high” level of significance will be considered where appropriate.

Table 11-15: IUCN Classification System

Value / Importance	Criteria
International	Internationally designated sites or habitats. Nationally significant populations of globally threatened or endangered species (e.g., IUCN Vulnerable or Endangered Red Data Book species). Sites supporting >1% of a bio-geographical population of a species or subspecies.
National	Nationally designated or protected sites. Best examples of habitat within the country (e.g., the largest area of a particular habitat, a good example of a threatened or declining habitat). Strong populations of rare or nationally threatened species (e.g., a species occurring in less than 1% of the land surface of the country).
Regional	Sites or habitats internationally recognized but not necessarily designated or protected (e.g., Important Bird Areas). Strong populations of endemic or near-endemic species or subspecies to the Arabian Peninsula. Extensive areas of semi-natural vegetation or habitats characteristic of the Arabian Peninsula.
Provincial	Areas of habitat considered to enrich the habitat resource within 50 km of the site

	or within a defined geographic area of the country. Provincially designated or protected sites. Sustainable or strong populations of nationally scarce species (would be defined according to the size of the country and information available, e.g., species occurring in less than 5% of the land surface of the country).
Local	Areas of semi-natural vegetation or habitat considered to appreciably enrich the habitat resource within the context of the site and surrounding area. Sustainable populations of uncommon or declining species.
Site	Sites that retain habitats and/or species of limited ecological importance owing to their size, species composition or other factors.

The IUCN Red List of species is founded on a scientific understanding of the population status and trends of species. The value of utilizing the list of species of High Conservation Priority is that the cultural and economic value of species is recognized and assigned a value of importance.

11.5.1.2 Impact Magnitude

For the purposes of this assessment, the impact descriptors in Table 11-16 are taken to summarize the overall magnitude of positive or negative impacts in accordance with the guidance produced by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2016), including:

- Impact extent/scale (e.g. entire habitat loss, partial habitat loss or indication over specific area affected);
- Direct or indirect impact (e.g. direct mortality of individuals due to construction activities, or indirect mortality of individuals from reduced prey resources due to land use change);
- Reversibility of impact (reversible or irreversible);
- Frequency of impact (single event, recurring or constant);
- Duration of impact (short-term, medium-term, long-term or permanent); and
- Likelihood of occurrence (certain/near certain, probable, unlikely or extremely unlikely).

The magnitude of impacts is defined using the criteria set out in Table 11-16. Impact magnitude was identified as high, moderate, low or negligible, following the above impact characterization approach.

Table 11-16: Impact Descriptors and Characterization for Ecological Features

Impact Descriptor	Impact Magnitude / Characterization
High	An impact resulting in a permanent effect on the distribution and/or abundance of a habitat, species assemblage/community or population, in such a way as to alter the integrity of the feature and its conservation status. If negative, this type of effect would reduce the integrity of the feature and its conservation status. If positive, it would result in an improvement to the conservation status of the feature.
Moderate	An impact resulting in a long-term but reversible effect on the distribution and/or abundance of a habitat, species assemblage/community or population. If negative, this type of effect would have neutral long-term implications for the integrity of the feature or its conservation status. If positive, it would not alter the long-term conservation status of the feature.

Impact Descriptor	Impact Magnitude / Characterization
Low	An impact resulting in a short-term reversible effect on the distribution and/or abundance of a habitat, species assemblage/community or population.
Negligible	No discernible impact on the distribution and/or abundance of a habitat, species assemblage/community or population.

11.5.2 Evaluation of Significance

In accordance with CIEEM (2016), a significant impact is an impact (negative or positive) on the integrity of a defined site or ecosystem and/or on the conservation status of habitats and species. Significance of impacts is also determined by taking cognizance of the list of species of High Conservation Priority and IUCN Classifications.

The above magnitude and importance information is taken together and applied to a matrix to determine the significance of an impact (Table 11-17). Impacts can be adverse or beneficial, either decreasing or improving the health, ecological status or viability of a population, species or habitat.

Only impacts on important ecological features (provincial importance or above) are usually progressed through the detailed assessment process. For example, a small area of featureless desert would be evaluated as of less than provincial ecological importance, and would not progress through the assessment process as this only includes features of local importance or below. However, any impact on an IUCN protected area or Important Bird Area (IBA), would progress through the assessment process as such sites are designated as nationally and internationally important. In this instance, for the Sakaka solar energy park impacts on ecological features at the site level have been considered to ensure best practice mitigation recommendations are documented.

Mitigation may, however, be required to be developed prior to construction to ensure that ecological features are avoided, regardless of feature importance or significance of impact, where practicable (e.g., damage to small mammal burrows).

Where impacts are assessed as being Major or Moderate these were considered to be potentially significant under the terms of EIA, and would require further assessment and development of mitigation to reduce impacts where feasible.

Table 11-17: Impact Significance

Magnitude Importance	High	Moderate	Low
International	Major	Major	Moderate
National	Major	Moderate	Moderate
Regional	Major	Moderate	Minor
Provincial	Moderate	Minor	Negligible
N.B. Major = High, Minor = Low			

The impact significance terms are detailed in Table 11-18 and take account of Species of High Conservation Priority (1993), IUCN Classifications (2016) and CIEEM guidance (2016).

Table 11-18: Description of Significance Categories

Significance Category	Typical Description
Major	Associated with features of international, national or regional importance. Likely to be a damaging impact or loss of integrity. Effects likely to be permanent and irreversible resulting in a loss of structure and/or function. If beneficial, they will have a significant positive effect on the international or national feature.
Moderate	Associated with features of international, national, regional or provincial area importance. Likely to be a damaging impact or loss of integrity. Effects are likely to be long term but reversible. If beneficial, they will have a significant positive effect on the international or national feature.
Minor	Associated with features of regional, or provincial area importance. Likely to be a damaging impact or loss of integrity. Effects are likely to be short term and reversible. If beneficial, they will have a significant positive effect on the international or national feature.
Negligible	No significant effects.

11.5.3 Construction, Commissioning and Operational Impacts

To aid consistency of the ecological impact assessment, a standard list of potential adverse impacts for the Park has been developed for the construction, commissioning and operational phases of the Park. These impacts are described as:

- Habitat loss;
- Habitat degradation;
- Habitat fragmentation;
- Direct mortality / injury;
- Disturbance; and,
- Pollution.

When determining the significance of impact for each ecological resource (e.g. habitats, mammals, birds and reptiles), the species of highest 'value' and sensitivity has determined the impact assessment outcome.

Table 11-19: Predicted Construction and Commissioning Impacts

Impact	Source
Habitat loss	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of PV solar panels. Construction of temporary and permanent access/haul tracks. Establishment of construction workforce accommodation camps and office facilities. Establishment of material storage areas. Installation of utilities. Installation of temporary and permanent fencing. Stockpiling of overburden from cut and fill operations.
Habitat degradation	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of PV solar panels.

Impact	Source
	Smothering and compaction of habitat from storage of overburden arising from cut and fill operations and access/haul tracks. Changes to hydrological functionality of wadi drainage channels and the pattern of surface water flows (i.e. erosion and deposition). Increased use of natural environment by construction workforce. See impacts under pollution
Habitat fragmentation	Construction of PV solar panels. Construction of temporary and permanent access/haul tracks. Installation of utilities. Installation of temporary and permanent fencing.
Direct mortality / injury of species	Site clearance, grading and excavation and cut and fill operations to prepare development areas. Construction of temporary and permanent access/haul tracks. Establishment of construction workforce accommodation camps and office facilities. Establishment of material storage areas. Installation of utilities. Installation of temporary and permanent fencing. Stockpiling of overburden from cut and fill operations. Movement of construction vehicles.
Disturbance	Noise/vibration during construction. Movement of construction vehicles. Light pollution during construction.
Pollution	Noise and dust emissions. Run-off from disturbed ground. Spillage of oils/chemicals.

Table 11-20: Predicted Operational Impacts

Impact	Source
Habitat loss	No further impacts predicted.
Habitat degradation	Changes to hydrological functionality of wadi drainage channels and the pattern of surface water flows (i.e. erosion and deposition). Increased use of natural environment by operational workforce. See impacts under pollution
Habitat fragmentation	Permanent presence of significant infrastructure, primarily the PV solar panels.
Direct mortality / injury of species	Collision risk with PV solar infrastructure.
Disturbance	Increase in the movement of people and vehicles within the development site.
Pollution	Spillage of oils/chemicals e.g. PV panel cleaning chemicals.

11.6 Impact Assessment

11.6.1 Baseline Survey Evaluation

The conservation status of ecological features recorded during baseline surveys is provided in Table 11-21, along with a short justification for the assigned conservation importance of each feature. The evaluations take into account baseline conditions and utilizes the criteria in Table 11-15 to develop an understanding of the implications for features that may be affected by the proposed development.

Table 11-21: Conservation Status, Baseline and Evaluation of Terrestrial Features.

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
Migratory birds	IUCN: Least Concern, Vulnerable, Near Threatened, Endangered and Not Evaluated.	Eight records of individual birds of five species recorded during vantage point surveys. Fifteen bird species recorded on-site during the autumn migration period (including likely resident birds, see below). Dumat al Jandal IBA 16km north of the Park.	The wider region is part of the broad-fronted East Africa-East Asian migratory flyway; however, very little migrant activity has been recorded on-site during baseline surveys. There is a lack of new collision risk posed to raptors and soaring migrant species due to the PV type development and pre-existing overhead powerlines. The species recorded have varying degrees of conservation status although all have been recorded in small number. For example, the most severe classification of the species recorded (Endangered) applies to steppe eagle. The global population of which is estimated at 90,000 mature individuals (IUCN, 2016); only one individual was recorded on site.	Provincial
Resident birds (including breeding and wintering birds)	IUCN Least Concern	Eight species recorded during surveys outside the migration season. Combined with the results of other survey visits it is thought a maximum of ten species reside on-site for prolonged periods.	It is considered likely that some of the species recorded during baseline surveys breed in low densities within the development site. Breeding may occur at any time of year although it is generally associated with periods following seasonal rainfall events. Suspected breeding birds include, but are not limited to, bar-tailed lark, collared dove, crested lark, desert wheatear and hoopoe lark. All of these species are of 'Least Concern' conservation status (IUCN, 2016).	Site
Habitats	No formal designation	The habitats on site are ubiquitous within the Kingdom of Saudi Arabia and receive no formal designation or protection.	The habitats on site are homogenous and are dominated by the underlying geology. There are no features of significant value or interest.	Site
Floral Communities	Not yet classified by IUCN	Four species recorded during site surveys.	The site supports impoverished floral communities, influenced by the underlying geology, arid climate and grazing pressure from local herders. The communities are characterized by low diversity and low abundance, and species recorded are ubiquitous.	Site
Mammal species	IUCN Least Concern	Evidence of red fox and domesticated livestock were recorded during surveys.	Red fox are common within the Kingdom of Saudi Arabia and commonly associated with human settlements, including seasonal and transient livestock herders and graziers. The remaining mammal species recorded are all domesticated livestock and not a conservation concern.	Site
Bat species	IUCN: Least Concern, Near Threatened, Data Deficient	No bat activity was recorded	The proposed development of the Sakaka Solar Energy Park is evaluated as having a low risk of adverse effects on bat species. On the basis that there is no risk to bats, no further impact assessment has been considered.	Not applicable

Ecological Feature	Conservation Status	Baseline	Evaluation	Importance
Reptile species	IUCN: Least Concern, Vulnerable	A total of five species were recorded during site surveys the most numerous and frequently recorded being Schmidts fringe toed lizard. There is evidence of a single Egyptian spiny tailed lizard	Although <i>Uromastix aegyptia</i> activity was recorded, only a single burrow was recorded within the developable area and no further burrows were recorded adjacent to the developable area. Based on population size this is not considered to be an important population. The remaining species are not considered to be of conservation concern.	Site
Invertebrate species	Not yet classified by IUCN	A total of 7 species were recorded during site surveys.	The invertebrate communities recorded reflect the complexity of the habitats and associated floral communities. Accordingly the communities are characterized by low abundance and low diversity. The species recorded are ubiquitous and are not yet classified by IUCN.	Site

11.6.2 Construction Phase Impacts

Impacts expected to be experienced during the construction phase of the Park relate to habitat loss and degradation, impacts of disturbance and increased risk of direct mortality / injury associated with the movement of construction plant and equipment. Due to ecological receptors being predominantly sensitive at the site level only, and the conservation status of species where known, impacts are mostly low to negligible significance. The construction phase impacts are presented in Table 11-22.

Table 11-22: Potential Construction Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB01	Migratory birds	Provincial	Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB02	Resident birds (including wintering birds)	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Local Reversible	Moderate	Low
TB03	Habitats	Site	Habitat loss Habitat degradation Habitat fragmentation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Site Reversible	Moderate	Low
TB04	Floral Communities	Site	Habitat loss Habitat degradation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Medium Site Reversible	Low	Negligible

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB05	Mammal species	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Site Reversible	Low	Negligible
TB06	Reptile species	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Site Reversible	Low	Negligible
TB07	Invertebrate species	Site	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Site Reversible	Low	Negligible

11.6.2.1 Impact on migratory birds

There is potential for disturbance of migratory bird species throughout and adjacent to the developable area, leading to displacement of passing migratory birds utilizing the broad-fronted East Africa to East Asia migratory flyway. Any effect would be short-term and negative, although the site is assessed as low value for migratory bird species. Based on the very little migrant activity recorded on-site during baseline surveys, impact significance is assessed as negligible.

Impact TB01 – Negligible Significance

11.6.2.2 Impact on resident birds

There is potential for construction phase impacts on breeding birds, in particular during the site preparation activities (i.e. site grading and construction of roads). Impacts are predicted to include loss of breeding habitat (i.e. ground nesting sites), habitat degradation, habitat fragmentation, direct mortality and injury and disturbance. These impacts on breeding birds are assessed as long-term and negative due to the impact on breeding success. It is considered likely that some of the species recorded during baseline surveys breed in low densities within the development site. Suspected breeding birds include, but are not limited to, bar-tailed lark, collared dove, crested lark, desert wheatear and hoopoe lark. All of these species are of 'Least Concern' conservation status (IUCN, 2016). Due to the low densities of the breeding birds and the conservation status of those species considered likely to breed within and adjacent to the developable area, impact significance is assessed as low.

Impact TB02 – Low Significance

11.6.2.3 Impact on habitats

The habitats on site are homogenous and are comprised of gravel and sandy terrace. There are no distinct habitat types which are of conservation value or interest within or adjacent to the developable area. However the development of this site will result in the loss of habitat for the duration of the project and contribute to impacts of habitat degradation and fragmentation. Impact significance is assessed as low.

Impact TB03 – Low Significance

11.6.2.4 Impact on floral communities

The development of the site and construction phase activities have the potential to impact on floral communities resulting from habitat loss and degradation. However the site supports impoverished floral communities, influenced by the underlying geology, arid climate and grazing pressure from local herders. The communities are characterized by low diversity and low abundance, and species recorded are ubiquitous. Impact significance is assessed as low.

Impact TB04 – Low Significance

11.6.2.5 Impact on mammal species

The mammal fauna within and adjacent to the developable area of the project site is assessed as being impoverished, with only red fox *Vulpes vulpes* recorded as the only non-domesticated species. This species is listed as Least Concern (IUCN, 2016). The remaining mammal species recorded are all domesticated livestock and not a conservation concern. No bats were recorded roosting or using the site for foraging habitat. Impact significance is assessed as negligible.

Impact TB05 – Negligible Significance

11.6.2.6 Impact on reptile species

A total of five reptiles species were recorded within the project site (i.e. Schmidts fringe toed lizard *Acanthodactylus schmidtii*, small spotted lizard *Mesalina guttulata* Arabian toad headed agama *Phrynocephalus arabicus*, Middle Eastern short fingered gecko *Stenodactylus doriae* and spiny tailed lizard *Uromastyx aegyptia*). Although no live specimen of *Uromastyx aegyptia* was observed, tracks were recorded in proximity to the Saudi Aramco meteorological station, leading to and from an active burrow. Based on population size of *Uromastyx aegyptia* this is not considered to be an important population. The remaining species are not considered to be of conservation concern.

Although the development of the site has the potential to impact on reptiles (e.g. habitat loss and degradation, habitat fragmentation, direct mortality and injury and disturbance), based on the conservation status of the majority of species being Least Concern and the low population of *Uromastyx aegyptia*, impact significance is assessed as negligible.

Impact TB06 – Negligible Significance

11.6.2.7 Impact on invertebrate species

The invertebrate communities are characterized by low abundance and low diversity. The species recorded are ubiquitous and are not yet classified by IUCN. Impact significance is assessed as negligible.

Impact TB07 – Negligible

11.6.3 Operation Phase Impacts

Impacts expected to be experienced during the operational phase of the Park relate to habitat fragmentation and modification, and increased levels of disturbance associated with routine maintenance activities. Due to ecological receptors being predominantly sensitive at the site level only, and the conservation status of species where known, impacts are mostly low to negligible significance. The construction phase impacts are presented in Table 11-23.

Table 11-23: Potential Operational Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB08	Migratory birds	Provincial	Direct mortality/injury Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB09	Resident birds (including wintering birds)	Site	Habitat degradation Direct mortality/injury Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB10	Habitats	Site	Habitat fragmentation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB11	Floral Communities	Site	Habitat degradation	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB12	Mammal species	Site	Habitat fragmentation Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB13	Reptile species	Site	Direct mortality/injury Disturbance	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible
TB14	Invertebrate species	Site	Direct mortality/injury	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Provincial Reversible	Low	Negligible

11.6.3.1 Impact on migratory birds

During operation, there is a potential risk of migratory birds colliding with PV solar infrastructure. There is also potential for disturbance leading to displacement of passing migratory birds utilizing the broad-fronted East Africa to East Asia migratory flyway. However any effect would be short-term and impact significance is assessed as negligible.

Impact TB08 – Negligible Significance

11.6.3.2 Impact on resident birds

Similar to migratory birds, there is potential for breeding birds to collide with PV solar infrastructure, and for impacts of displacement due to disturbance. Any effect would be short-term and negative.

The construction of the solar energy park will change the structural characteristics of the landscape, and introduce more complex structures which will influence micro-climatic conditions (e.g. the solar arrays will cast shade). As a consequence, there is potential for increased opportunities for breeding by resident bird species. This effect would be for the duration of the operation of the solar energy park and based on the conservation status of the likely resident bird species, impact significance is assessed as negligible.

Impact TB09 – Negligible Significance

11.6.3.3 Impact on habitats

The installation of the perimeter fence for the operational life of the solar energy park has the potential to fragment habitats within the locality of the Park. However there are no habitats of conservation value or interest within or adjacent to the developable area and the impact assessment is assessed as negligible.

Impact TB10 – Negligible Significance

11.6.3.4 Impact on floral communities

As stated previously, the construction of the solar energy park will change the structural characteristics of the landscape, and influence micro-climatic conditions (e.g. the solar arrays will cast shade). In addition, the spot cleaning of the panels is likely to increase the availability of water over and above typical rainfall levels. There is potential for increased opportunities for floral communities to develop within the developable area of the Park. Based on the conservation status of the species recorded in the locality, the impact significance is assessed as negligible.

Impact TB11 – Negligible Significance

11.6.3.5 Impact on mammal species

The change in land-use and installation of the perimeter fence for the operational life of the solar energy park will exclude species from the site and increase effects of habitat fragmentation and displacement. Any effect would be permanent for the duration of the operation of the Park and negative. Based on the conservation status of the species recorded in the locality, the impact significance is assessed as negligible.

Impact TB12 – Negligible Significance

11.6.3.6 Impact on reptile species

During the operation of the Park, the majority of reptile species will be able to return to the solar energy park during the operational phase. This would reduce impacts of habitat fragmentation. However, there is an increased risk of direct mortality / injury and disturbance during routine operational maintenance activities. Any effect would be short-term and negative. Based on the conservation status of the species recorded in the locality, the impact significance is assessed as negligible.

Impact TB13 – Negligible Significance

11.6.3.7 Impact on invertebrate species

During the operation of the Park, invertebrate species will be able to return to the solar energy park during the operational phase. This would reduce impacts of habitat fragmentation. However, there is an increased risk of direct mortality / injury and disturbance during routine operational maintenance activities. Any effect would be short-term and negative. Based on the conservation status of the species recorded in the locality, the impact significance is assessed as negligible.

Impact TB14 – Negligible Significance

11.6.4 Decommissioning Phase Impacts

Impacts expected to be experienced during the decommissioning phase are broadly similar to those predicted during the construction phase of the Park. Due to ecological receptors being predominantly sensitive at the site level only, and the conservation status of species where known, impacts are mostly low to negligible significance.

However the removal of the perimeter fence and the solar park infrastructure has the potential to restore the site to its pre-development condition. This impact is presented in Table 11-24.

Table 11-24: Potential Decommissioning Phase Impacts on Ecological Receptors

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TB15	Habitats	Site	Habitat restoration	Effect: Positive Action: Direct Likelihood: Likely Frequency: Continuous Duration: Long Extent: Local Permanence: Reversible		Moderate	Low

11.6.4.1 Impact on habitats

The removal of the perimeter fence and all infrastructure associated with the development of the Park (i.e. perimeter and internal roads, solar tables and frames, cables and electrical infrastructure, buildings and foundations) provides an opportunity to restore the site to its pre-development condition to the benefit of both floral and faunal communities. Based on the value of habitats in the locality, the impact significance is assessed as positive and low significance.

Impact TB14 – Low Significance

11.7 Mitigation

The assessment of impact demonstrates that the likelihood of significant adverse effects during construction, operation and decommissioning is low to negligible, predominantly at the site level only. There is therefore no requirement for specific mitigation measures. Notwithstanding, good practice measures should be implemented and these are described in the following sections.

11.7.1 Construction Phase

Prior to site clearance works, it is recommended that a competent terrestrial ecologist completes a walk-over survey. The objective of the survey is to ensure that the baseline conditions of the site remain the same and have not changed. This includes completing a survey for ground nesting bird species. If nesting birds are recorded, active nests should be identified wherever practicable and an exclusion zone established until any eggs have hatched and young fledged (i.e. maximum of 21 days).

If active large mammal burrows (i.e. red fox) or spiny tailed lizard burrows are recorded, it is recommended that a competent ecologist oversees the exclusion and possible translocation of these species. Although not required by law, this is considered to be in the interests of animal welfare and the conservation status of spiny tailed lizard (i.e. vulnerable – decreasing).

11.7.2 Operation Phase

To monitor the potential long term impact of the Park on migratory and resident breeding bird species, it is recommended that any bird carcasses discovered during routine and scheduled maintenance are recorded (i.e. species and suspected cause of death). This information will contribute towards a better understanding of the potential impact of the Park and permit the implementation of further control measures if necessary.

Although impacts of habitat loss and fragmentation are not considered significant, it is recommended that the perimeter fence is designed to permit the unhindered movement of mammal and reptiles species. This can be achieved by leaving a small gap (i.e. 200mm) on certain panels between the base of the fence and ground level, or cutting small holes (i.e. 200mm x 200mm) in the base of the fence on certain panels.

11.7.3 Decommissioning Phase

The decommissioning of the Park creates an opportunity to restore and enhance habitats within the developable area to their pre-development condition. A site restoration plan should be prepared by the IPP in consultation with stakeholders and the community and include clear objectives for the establishment and management of habitats within the developable area of the Park.

The recommendations for the construction phase should also be implemented during the decommissioning phase (e.g. pre-decommissioning walk-over survey by a competent ecologist).

11.8 Conclusion

The developable area of the Sakaka solar energy park is considered to have low ecological value. It is characterized by uniform and ubiquitous habitat types and supports low abundance and low diversity plant and animal communities. Development, operation and decommissioning impacts are assessed as low to negligible, although mitigation measures are proposed; most notably for remediating potential impacts on migratory and breeding birds. Predicted impacts are not likely to effect the provincial, national or international conservation status of receptors.

The decommissioning phase of the solar energy park enables the impacted area to be returned to its pre-development condition. This is considered to be a positive impact, albeit at the site level.

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12. Archaeology & Cultural Heritage

12.1 Introduction

This chapter provides an assessment of cultural heritage assets found within the development site and assesses the impact of the Park upon them. Assessment of cultural heritage was undertaken based on guidance provided by *Performance Standard 7: Indigenous Peoples* and *Performance Standard 8: Cultural Heritage* (International Finance Corporation (IFC) 2012a, 2012b), and *Guidance on Heritage Impact Assessments for Cultural World Heritage Properties* (International Council on Monuments and Sites (UNESCO) 2011). A glossary of archaeological terms is included in Appendix M.

12.2 International and National Standards and Guidance

12.2.1 International Conventions

Treaties concluded or ratified by Saudi Arabia relating to cultural heritage and relevant to this assessment comprise:

- United Nations Educational, Scientific and Cultural Organization, 1972. *Convention Concerning the Protection of the World Cultural and Natural Heritage*. UNESCO;
- United Nations Educational, Scientific and Cultural Organization, 2003. *Convention for the Safeguarding of Intangible Cultural Heritage*. UNESCO (ratified 2008);

12.2.2 Guidance

This assessment has been prepared based on guidance provided by:

- Guidance on Heritage Impact Assessments for Cultural World Heritage Properties (ICOMOS 2011);
- Performance Standard 7: Indigenous Peoples (IFC 2012a); and
- Performance Standard 8: Cultural Heritage (IFC 2012b).

12.3 Baseline Environmental Conditions

12.3.1 Baseline Review

12.3.2 Objectives

The objectives of this screening study are to:

- characterize the historic environment within the Al Jouf province;
- characterize the historic environment within 25km of the development site;
- identify heritage assets within the footprint of and within a 10km Study Area around the development site; and
- assess the potential for impact on cultural heritage as a result of the proposed schemes.

12.3.3 Study Area

Based on professional judgement and guidance provided by ICOMOS (2011) a Study Area for the development site has been defined as the footprint of the site and an area extending 10km in all directions from it.

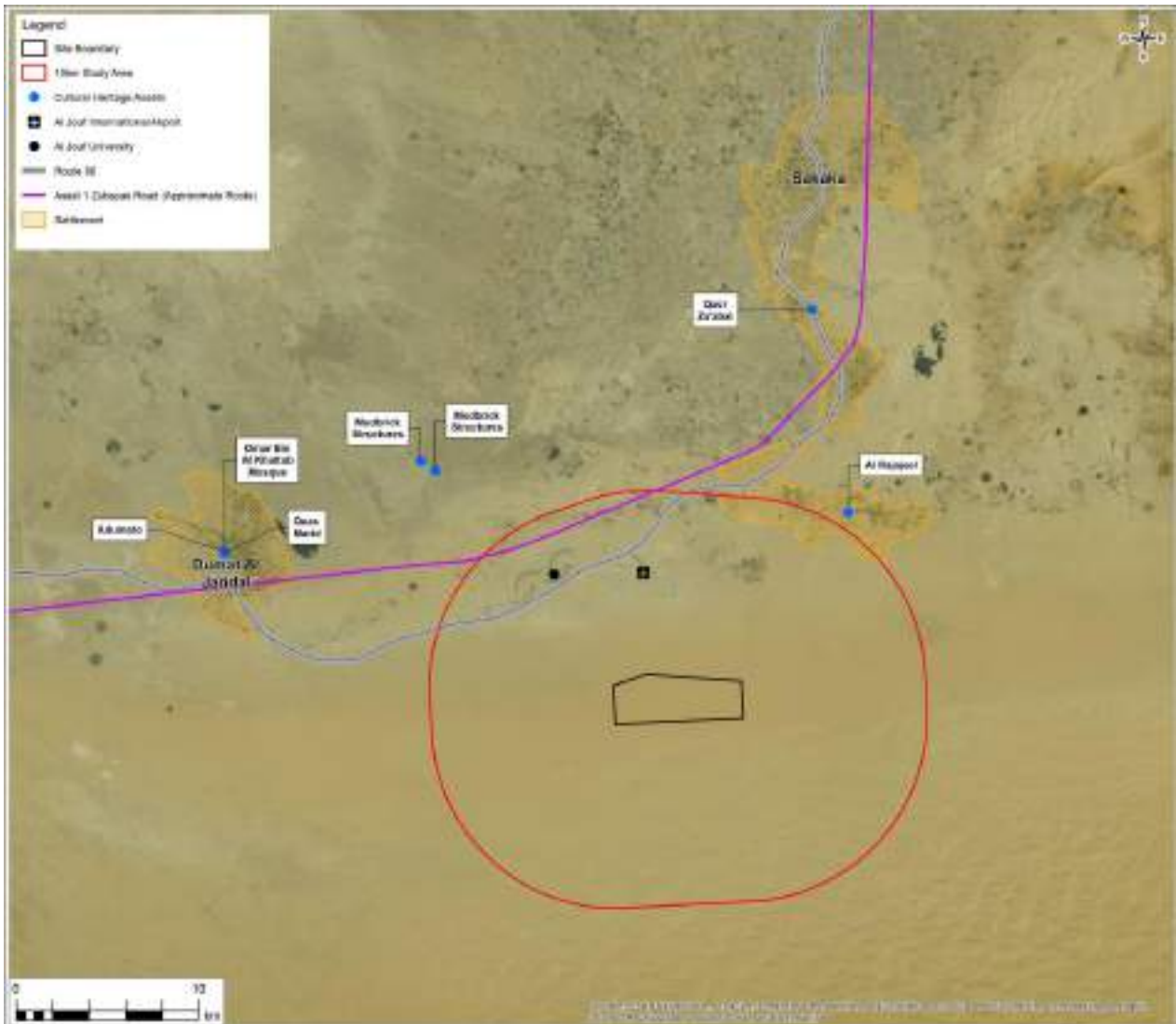


Figure 12-1: Study Area

12.3.4 Data gathering

The following sources of information were consulted:

- Google Earth for information on archaeological sites in Al Jouf Province;
- Saudi tourism website for information on cultural heritage in Al Jouf Province;
- Saudi Commission for Tourism and National Heritage for information on locally identified archaeological sites; and,
- UNESCO Intangible Cultural Heritage List for information on relevant intangible cultural heritage.

12.3.5 Archaeological and historical background

12.3.5.1 Summary

The earliest evidence for human habitation on the Arabian Peninsula, derived from archaeological work in Yemen, dates to approximately 53,000 BC (Delganes 2012). The Arabian Peninsula was home to some early

settled peoples, including the Dilmun civilization, one of the oldest in the Middle East, dating to the 3rd millennium BC. Mesopotamian records regard Dilmun as an important trading center, controlling the Persian Gulf trade routes. The Thamud, Kindah and Al-Magar civilizations flourished in the Arab peninsula from the 1st millennium BC to the time of Muhammad. Muhammad and his companions united the tribes of Arabia under Islam, creating a single Arab Muslim religious polity in the Arab Peninsula. The modern state of Saudi Arabia was formed in 1932 when the two kingdoms of the Hejaz and Najd kingdoms united.

12.3.5.2 The development site

The Sakaka site is located within the Al Jouf Region, an area of approximately 100,200km², within the north of Saudi Arabia, bordering Jordan. The Sakaka site is located approximately 20km south-east of Dumat Al Jandal and approximately 25km south-west of the capital of the Province; Sakaka.

A number of significant archaeological sites are present within 25km of the Sakaka site. To the north-east these include the prehistoric site of Al Rajajeel, comprising a series of standing stones dating to the 4th century BC and Qasr Za'abal, a mudbrick structure dating to the 1st century AD. To the north-west are several undated mudbrick structures. Further to the north-west, in the ancient settlement of Dumat Al Jandal, is Qasr Marid, a large fortified site dating to the 3rd century AD and associated with the Nabatean civilization. Qasr Marid stands in a commanding position over the remains of the city of Adumato, an Akkadian settlement, and is close to the Omar Bin Al Khattab mosque, itself dating to the 7th century AD.

The Sakaka site is located to the south of the modern road; Route 80. This follows the Arabian route of the Hajj from Baghdad and Kufa to Mecca. This 900 mile route was one of the earliest routes created specifically for pilgrims and generally follows ancient trade routes across the region. The route is known as the 'Darb Zubayda' or Zubayda's Road and is the most significant of the early routes having been extensively developed during the era of the Abbasid caliphs (750 AD – 1258 AD). Archaeological finds have been made in association with the route, including milestones and writing implements (The British Museum, 2016).

From sources identified in the desktop review, a total of one heritage asset was identified within the Study Area for the Sakaka site.

12.3.5.3 Tangible forms of cultural heritage

No tangible forms of culture have been identified within the footprint of the Sakaka site or within the 10km Study Area from sources identified in chapter 3.3.

12.3.5.4 Unique natural features or tangible objects

No unique natural features or tangible objects have been identified within the footprint of the Sakaka site or within the 10km Study Area from sources identified in chapter 3.3.

12.3.5.5 Intangible forms of culture

12.3.5.5.1 Very high value

The historic pilgrimage (Hajj) route of Darb Zubayda (Asset 1; Zubayda's Road) comprises a 900 mile route from Iraq to Mecca. The historic route, which is still visible in areas of northern Saudi Arabia, roughly follows the modern Route 80, which runs from Sakaka in the east to Dumat Al-Jandal in the west, passing through the north-west part of the 10km outer Study Area. As a result of its association with the development of Islam, a movement of global significance, Asset 1 has been assessed to be of very high value.

12.3.5.6 Potential for unknown archaeological remains

Modern development (such as Al Jouf International Airport and Al Jouf University; both within the Study Area) and the construction of Route 80 in close proximity to the Sakaka site are likely to have truncated or removed buried archaeological remains where present within their footprints. However, known human activity in the area from at least 55,000 BC onwards, and the presence of Zubayda's Road (Asset 1; very high value) suggests that

further archaeological sites and un-stratified archaeological finds may be identified within the footprint of the Sakaka site and any associated access roads and compound/set down areas. As a result, the potential for unknown archaeological remains has been assessed to be moderate.

12.3.6 Baseline Survey - Methodology

A baseline field walkover survey was carried out to confirm the findings of the desk based assessment.

12.3.7 Baseline Survey - Results

No additional cultural heritage features were found in the field, above those identified during the baseline survey.

12.4 Assessment Methodology

12.4.1 Approach

12.4.1.1 Assumptions and limitations

No intrusive archaeological investigations have been undertaken. The information available as a result of desk-based work is considered sufficient for all assets for the purposes of assessment.

While archaeological sites are identified in the Al Jouf Province by the Saudi Commission for Tourism and National Heritage, no information concerning the names, type or date of these sites has been included within available data.

At the time of writing no information was available concerning access routes or compounds/set down areas associated with the construction phase of each site. As a result these have not been considered during assessment.

12.4.1.2 Assessment of value

Based on guidance provided by ICOMOS (2011) and IFC (2012a, 2012b) cultural heritage was considered to comprise:

- (i) '*tangible forms of cultural heritage*'; defined as moveable or immovable objects, property, sites, structures, or groups of structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values;
- (ii) '*unique natural features or tangible objects*' embodying cultural values, such as sacred groves, rocks, lakes, and waterfalls; and,
- (iii) certain instances of '*intangible forms of culture*' that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles.

Based on guidance provided by ICOMOS (2011) and professional judgement an assessment of the value of each heritage asset was undertaken on six point scale of very high, high, medium, low, negligible and unknown. Individual cultural heritage sites, objects or practices are referred to as heritage assets. Setting; the surroundings in which a place is experienced, its local context, embracing present and past relationships to the adjacent landscape, where relevant, is considered to contribute to the value of heritage assets.

Criteria to assess the value of heritage assets are presented in Table 12-1.

Table 12-1: Criteria to Assess the Value of Heritage Assets

	IFC Category			
	Tangible	Tangible	Unique tangible features or tangible objects	Intangible forms of culture
ICOMOS Grading:	Archaeology	Built heritage or Historic Urban Landscape	Historic landscape	Intangible cultural heritage or associations
Very High	Sites of acknowledged international importance inscribed as WH property. Individual attributes that convey Outstanding Universal Value (OUV) of the WH property. Assets that can contribute significantly to acknowledged international research objectives.	Sites or structures of acknowledged international importance inscribed as of universal importance as WH property. Individual attributes that convey OUV of the WH property. Other buildings or urban landscapes of recognized international importance.	Landscapes of acknowledged international importance inscribed as WH property. Individual attributes that convey OUV of the WH property. Historic landscapes of international value, whether designated or not. Extremely well-preserved historic landscapes with exceptional coherence, time-depth or other critical factors.	Areas associated with Intangible Cultural heritage (ICH) activities as evidenced by the national register. Associations with particular innovations, technical or scientific developments or movements of global significance. Associations with particular individuals of global importance.
High	Nationally designated Archaeological Monuments protected by the State Party's laws. Undesignated sites of the quality and importance to be designated. Assets that can contribute significantly to acknowledged national research objectives.	Nationally designated structures with standing remains. Other buildings that can be shown to have exceptional qualities in their fabric or historical associations not adequately reflected in the listing grade. Conservation Areas containing very Important buildings. Undesignated structures of clear national importance.	Nationally designated historic landscape of outstanding interest. Undesignated landscapes of outstanding interest. Undesignated landscapes of high quality and importance, and of demonstrable national value. Well preserved historic landscapes, exhibiting Considerable coherence, time-depth or other critical factors.	Nationally designated areas or activities associated with globally important ICH Activities. Associations with particular innovations, technical or scientific developments or movements of national significance. Associations with particular individuals of national importance.
Medium	Designated or undesignated assets that can contribute significantly to regional research objectives.	Designated buildings. Historic (unlisted) buildings that can be shown to have exceptional qualities or historical associations. Conservation Areas containing buildings that contribute significantly to its historic character. Historic townscapes or built-up areas with important historic integrity in their buildings, or built settings.	Designated special Historic landscapes. Undesignated historic landscapes that would justify special historic landscape designation. Landscapes of regional value. Averagely well preserved historic landscapes with reasonable coherence, time-depth or other critical factors.	With ICH activities as evidenced by local registers. Associations with particular innovations or developments of regional or local significance. Associations with particular individuals of regional importance.
Low	Designated or undesignated assets of local importance. Assets compromised by poor preservation and/or poor survival of contextual associations. Assets of limited value, but with potential to contribute to local research objectives.	"Locally Listed" buildings. Historic (unlisted) buildings of modest quality in their fabric or historical associations. Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings.	Robust Undesignated historic landscapes. Historic landscapes with importance to local interest groups. Historic landscapes whose value is limited by poor preservation and/or poor survival of contextual associations.	ICH activities of local significance. Associations with particular individuals of local importance. Poor survival of physical areas in which activities occur or are associated
Negligible	Assets with little or no surviving archaeological interest.	Buildings or urban landscapes of no architectural or historical merit; buildings of an intrusive character.	Landscapes little or no significant historical interest.	Few associations or ICH vestiges surviving.
Unknown	The importance of the asset has not been ascertained.	Buildings with some hidden (i.e. inaccessible) potential for historic significance.	n/a	Little is known or recorded about ICH of the area.

12.4.1.3 Assessment of magnitude of impact

Magnitude of impact is the degree of change that would be experienced by an asset and its setting if the proposed scheme was completed, as compared with a 'do-nothing' situation. Magnitude of impact is assessed without reference to the value of each asset, and may include physical impacts on the asset or impacts on its setting or amenity value. The assessment of magnitude was undertaken using professional judgement guided by the criteria presented in ICOMOS (2011). Criteria for defining magnitude of impact are presented in Table 12-2. Unless otherwise stated, all impacts are adverse.

Table 12-2: Criteria to Assess Magnitude of Impact on Tangible and Intangible Heritage Assets

	IFC Category			
	Tangible	Tangible	Unique tangible features or tangible objects	Intangible forms of culture
ICOMOS Impact Grading:	<i>Archaeological attributes</i>	<i>Built heritage or Historic Urban Landscape attributes</i>	<i>Historic landscape attributes</i>	<i>Intangible cultural heritage attributes or associations</i>
Major	Changes to attributes that convey OUV of WH properties. Most or all key archaeological materials, including those that contribute to OUV such that the resource is totally altered. Comprehensive changes to setting.	Change to key historic building elements that contribute to OUV, such that the resource is totally altered. Comprehensive changes to the setting.	Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit and loss of OUV.	Major changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Moderate	Changes to many key archaeological materials, such that the resource is clearly modified. Considerable changes to setting that affect the character of the asset.	Changes to many key historic building elements, such that the resource is significantly modified. Changes to the setting of an historic building, such that it is significantly modified.	Change to many key historic landscape elements, parcels or components; visual change to many key aspects of the historic landscape; noticeable differences in noise or sound quality; considerable changes to use or access; resulting in moderate changes to historic landscape character.	Considerable changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Minor	Changes to key Archaeological materials, such that the resource is slightly altered. Slight changes to setting.	Change to key historic building elements, such that the asset is slightly different. Change to setting of an historic building, such that it is noticeably changed.	Change to few key historic landscape elements, parcels or components; slight visual changes to few key aspects of historic landscape; limited changes to noise levels or sound quality; slight changes to use or access; resulting in limited change to historic landscape character.	Changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
Negligible	Very minor changes to key archaeological materials, or setting.	Slight changes to historic building elements or setting that hardly affect it.	Very minor changes to key historic landscape elements, parcels or components; virtually unchanged visual effects; very slight changes in noise levels or sound quality; very slight changes to use or access; resulting in a very small change to historic landscape character.	Very minor changes to area that affect the ICH activities or associations or visual links and cultural appreciation.
No change	No change.	No change to fabric or setting.	No change to elements, parcels or components; no visual or audible changes; no changes in amenity or community factors.	No change

12.4.1.4 Assessment of significance of effect

For tangible and intangible heritage assets, the significance of effect was determined as a combination of the value of the asset and the magnitude of impact. This was achieved using professional judgment informed by the matrix presented in Table 12-3. Five levels of significance of effect are defined; neutral, slight, moderate, large and very large. Unless otherwise stated all effects are adverse.

Table 12-3: Matrix to Assess the Significance of Effects on Heritage Assets

Magnitude of Impact Value	No change	Negligible	Minor	Moderate	Major
Very High	Neutral	Slight	Moderate / Large	Large / Very Large	Very Large
High	Neutral	Slight	Moderate / Slight	Moderate / Large	Large / Very Large
Medium	Neutral	Neutral / Slight	Slight	Moderate	Moderate / Large
Low	Neutral	Neutral / Slight	Neutral / Slight	Slight	Slight / Moderate
Negligible	Neutral	Neutral	Neutral / Slight	Neutral / Slight	Slight
Unknown	Neutral	Neutral	Neutral	Neutral	Neutral

12.5 Impact Assessment

Potential impacts described below are reported in line with the following:

- potential impacts represent those which could result from the construction and operation of the Park; and
- potential impacts are presented without mitigation and, therefore, represent a worst-case scenario.

Impacts identified during assessment resulting from construction include the removal of buried archaeological remains and un-stratified archaeological finds. Impacts resulting from operation include a permanent effect on intangible cultural heritage. Impacts are described below, in order of significance of effect.

The assessment of impact assumes that a 'chance find' procedure will be developed for the Park, to be implemented during construction, in order to identify any previously unrecorded archaeological sites or un-stratified archaeological finds. This procedure will be outlined and included within the construction environmental management plan. This procedure is in compliance with the requirements of IFC Performance Standard 8.

12.5.1 Construction Phase

Impacts associated with the construction phase of the development are shown in Table 12-4.

Table 12-4: Construction Phase Archaeological & Cultural Heritage Impacts

ID	Receptor(s)	Sensitivity	Impact	(Likely) Impact Characterization	Magnitude	Significance
CH01	Previously undiscovered cultural heritage assets	Low	Partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds, including those potentially associated with Zubayda's Road.	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Rare Duration: short Extent: Local Permanence: Reversible	Low	Low

12.5.1.1 Partial or total removal of any unknown buried archaeological remains

Construction of the proposed scheme would require the installation of a Solar PV Power Plant comprising Solar PV Modules, PV Inverters, PV Mounting Structure, DC electrical distribution system, AC electrical distribution system, communication and server room and a High-Voltage Switching Station. Construction would result in the grading, levelling and backfilling of the site, likely to result in the partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds, including those potentially associated with Zubayda's Road (Asset 1; very high value). The magnitude of this temporary impact has been assessed to be low and the significance of effect to be minor.

Impact CH01 – Low Significance

12.5.2 Operation Phase

The operation of the scheme is not predicted to result in any effects on identified heritage assets.

12.5.3 Decommissioning Phase

The decommissioning of the scheme is not predicted to result in any effects on identified heritage assets.

12.6 Mitigation

As a result of desk-based assessment, further work is recommended to offset identified potential effects on the historic environment resulting from construction and operation of the proposed schemes. These comprise:

12.6.1 Pre-Construction Phase

12.6.1.1 Mitigation by design

The siting of compounds and access routes relating to the development site must take into account the presence of the historic hajj route to the north.

12.6.1.2 Consultation

Undertake further consultation with Saudi Commission for Tourism and National Heritage in order to confirm the nature, scope and scale of required fieldwork.

12.6.1.3 Site inspection

A site inspection is recommended for all proposed schemes in advance of construction in order to identify any previously unrecorded archaeological sites and / or un-stratified archaeological finds.

12.6.2 Construction Phase

No mitigation is recommended for the operation phase of the Park, over and above the aforementioned Chance Find Procedure.

12.6.3 Operation Phase

No mitigation is recommended for the operation phase of the Park.

12.6.4 Decommissioning Phase

No mitigation is recommended for the decommissioning phase of the Park.

12.7 Conclusion

This Cultural Heritage assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the impact assessment may have to be re-visited if significant alterations are made to the design, with any updates reported in an Addendum to this ESIA.

Due to the nature of the site and the location of previous discovered archaeological remains, it is considered highly unlikely that further high value remains will be disturbed as a consequence of the introduction of the Park, especially given the low intrusivity of the groundworks.

The 'chance find' procedure mitigation measure is expected to sufficiently protect any high value assets which may be discovered during the construction of the Park.

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13. Traffic & Transport Infrastructure

13.1 Introduction

The purpose of this chapter of the Environmental and Social Impact Assessment (ESIA) is to describe the existing traffic and transportation infrastructure of the development site and surrounding area, identify future plans for expansion, and assess the impact of the Park on this existing and planned transport infrastructure.

Potential impacts from traffic and transport on other aspects of the environment are addressed in the relevant sections of this report as follows:

- Chapter 6– *Air Quality and Meteorology*;
- Chapter 9 – *Noise and Vibration*;
- Chapter 14 – *Socio-economic*; and,
- Chapter 17 – *Health and Safety*.

13.2 International Standards and Guidance

13.2.1 IFC General EHS Guidelines

Section 3 Community Health and Safety of the IFC General EHS Guidelines (IFC, 2007) provides guidelines for the management of traffic safety during the construction and operation phases of a project and includes the operation of project equipment on private or public roads and all project personnel during displacement to and from the workplace. Section 3 states that the prevention and control of traffic related injuries and fatalities should include the adoption of safety measures that are protective of project workers and of road users, including those most vulnerable to road traffic accidents (IFC, 2007).

Section 3 recommends measures to improve traffic safety, including collaboration with local communities and responsible authorities and coordination with emergency responders.

Section 4 Construction and Decommissioning of the IFC General EHS Guidelines (2007) recognizes that construction activities may result in a significant increase in movement of heavy vehicles for the transport of construction materials and equipment, increasing the risk of traffic related accidents. It states that increased risk of traffic-related accidents to workers and local communities should be minimized through a combination of education and awareness raising, and the adoption of procedures identified in Section 3 Community Health and Safety of the IFC General EHS Guidelines (IFC, 2007).

13.2.2 National Legislation

13.2.2.1 General Authority for Meteorology and Environment

The GAME has set the framework and activities required to enable sustainable management of mobile source emissions within the Kingdom of Saudi Arabia. This standard introduces emission limits for individual pieces of equipment used outdoors and aims to protect, maintain and improve the Kingdom's quality of life, human health, occupational health and natural ecosystems including croplands, forests and deserts whilst maintaining appropriate economic and social development. This standard applies to construction equipment and plant that might be used during the construction and operation of a project, but does not apply to road vehicles.

This standard includes emission limits for diesel (compression-ignition) engines, small and large petrol (spark-ignition) engines, and other recreational vehicles not included in Saudi Standards, Metrology and Quality Organization (SASO)(GAME, 2012).

The standard requires that all owners or operators of non-road engines equipment and vehicles must ensure that they undertake appropriate emission-related maintenance. Emission-related maintenance includes any adjustment, cleaning, repair, or replacement of emission-related components, which include the following:

- i) electronic control units, after treatment devices, fuel-metering components, EGR-system components, crankcase-ventilation valves, all components related to charge-air compression and cooling, and all sensors and actuators associated with any of these components; and
- ii) any other component whose primary purpose is to reduce emissions (GAME, 2012).

13.2.2.2 Saudi Standards, Metrology and Quality Organization

Although the GAME has established emission standards for the Kingdom of Saudi Arabia, emission standards for road vehicles are controlled by the Saudi Standards, Metrology and Quality Organization (SASO). In 2004, SASO adopted Euro 2 emissions standards for passenger cars with gasoline engines, and diesel powered light duty vehicles have been subject to standards based upon the EU legislation which was effective from 1984. The Kingdom of Saudi Arabia has previously proposed that Euro 3 standards would be implemented from 2010, but a lack of low sulfur fuel prevented this initiative from being implemented. The final date of the transition is still uncertain although the Kingdom of Saudi Arabia is implementing a national program to reduce the sulfur content of fuels.

13.3 Baseline Environmental Conditions

13.3.1 Baseline Review

13.3.1.1 National Background

13.3.1.1.1 Air

The Kingdom of Saudi Arabia has four international airports; the King Abdulaziz International airport in Jeddah, the King Khalid International airport north of Riyadh, the Prince Mohammad Bin Abdulaziz International airport in Madinah, and King Fahd International airport at Dammam.

Air travel represents the fastest means of transport between the large towns and cities of the Kingdom of Saudi Arabia, with a total of 29 civilian airports spread across the country. Military airports and a number of airports owned by Saudi Arabian Oil Company (Saudi Aramco) are also found throughout the country. All airports in Saudi Arabia are under the control of the General Authority of Civil Aviation (GACA). The Statistical Yearbook for 2015 reported 466,332 flights from international airports (including both departures and arrivals) carrying 65,941,677 passengers and 116,907 flights from domestic airports carrying 13,049,478 passengers over the course of the year (GACA, 2017).

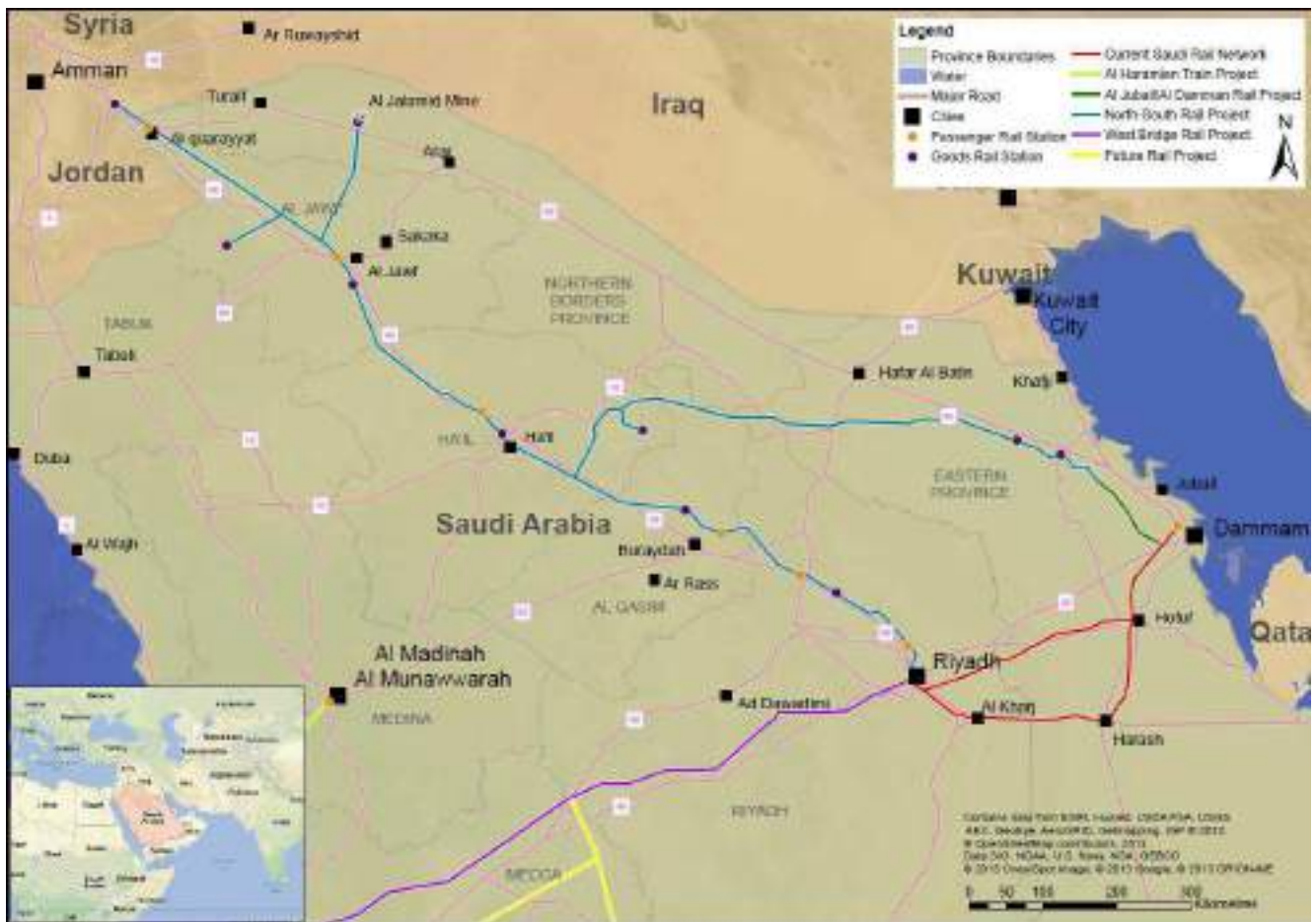
13.3.1.1.2 Rail

Rail is the least developed means of transportation in the Kingdom of Saudi Arabia, and consists primarily of a single track, standard-gauge line. There are number of expansion programs currently under consideration by SRO, to connect the western region with the eastern region; northern with the central region and to link the holy cities of Mecca and Medina, as well as the whole Kingdom, with all Gulf Cooperating Countries (GCC).

Railroads are broadly divided into three sections; the passenger line is 449km long and connects Riyadh to Amman through Ahsa and Abqaiq. The cargo line is 556km, starts at King Abdulaziz port in Dammam and ends in Riyadh, and the branch line consists of 373km which connects industrial, agricultural production sites, military bases, and some residential areas (SRO, 2014).

Expansion of the railway network (Figure 13-1) is being undertaken through the development of a Saudi Railway Master Plan 2010-2040, which will be implemented in three stages of development. Projects that are part of the first stage of development include:

- First Level Projects are high priority projects identified by SRO as development stage, to be undertaken between 2010 and 2025 approximate length (Saudi Railways Organization, 2013).



13.3.1.1.3 Road

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SAPTCO is a leading national bus service provider, offering affordable public transport inside and outside the Kingdom. It operates a fleet of 4,500 buses carrying out 800 daily scheduled trips during low seasons and 1,000 trips in high seasons (SAPTCO, 2015).

SAPTCO operates a network of intercity buses, connecting more than 385 cities, villages, and small villages throughout the Kingdom. The intercity route covers the main five cities; Riyadh, Mecca, Madinah, Jeddah, and Dammam. SAPTCO has expanded its services from national to international level, providing a gateway to the United Arab Emirates, Bahrain, Qatar, Kuwait, Egypt, Jordan, Yemen, and Sudan (SAPTCO, 2015).

13.3.1.1.4 Ports

The Saudi Ports Authority (SPA) was established in 1997 with the key responsibilities of handling day to day port management affairs, operation, and maintenance work, and to serve the shipping industries (SPA, 2014). There are six commercial ports in the Kingdom of Saudi Arabia situated at Jeddah, Dammam, Jizan, Dhaha, Jubail and Yanbu; three industrial ports are well established in the eastern province; Jubail (King Fahd Industrial Port), Dammam (King Abdulaziz Port) and Jubail commercial port (SPA, 2014).

13.3.1.2 Regional and Local Background

13.3.1.2.1 Airports

Al Jouf International Airport is located approximately 4km to the north of the development site. This international airport which serves Sakaka, Dumat Al Jandal and Al Jouf was established in 1974 although it has recently been extended. It is comprised of a single terminal and has a passenger handling capacity of 175,000 (www.gaca.gov.uk).

There are military assets located in the immediate vicinity of the airport. The General Authority for Civil Aviation has issued a 'letter of no objection' to Saudi Aramco for the development of the Park.

13.3.1.2.2 Rail

The Saudi Railways Organization (SRO) and the Saudi Railway Company (SAR) are the two state-owned railway companies in the Kingdom that operate Saudi Arabia's passenger and freight network. The national network is shown on Figure 13-1.

The North South Railway Line is a 2,750 kilometers railway project owned by the Saudi Railway Company (SAR). It is comprised of two lines, the first of which runs from Riyadh to the north-west of the Kingdom and the city of al Haditha on the Jordanian border. This line includes new stations in the towns of Majmaa, Qasim, Hail, Jouf, and Quriyyat. The second line will start from Al Jalamid mine and the 'Mining City of the North' located in the north-east of the Kingdom, and run through Jouf and Hail until it arrives at Al Baithah Railway junction in Qassim region. From Qassim it will then head to the port and export facilities at Ras al Khair. This line will enable phosphoric acid, sulfur and other products manufactured in the mining city to be freighted for export. This line is the nearest to the development site, located approximately 30km to the west.

13.3.1.2.3 Road

Road 80 and Road 65 are the main highway transportation routes linking Sakaka and Dumat al Jandal with the rest of Saudi Arabia, both of which are located in proximity to the development site. Road 80, a dual carriageway links the towns of Sakaka and Dumat al Jandal with Tabuk in the west and the border town of Ar'ar in the north-east. Road 65, similarly a dual carriageway, crosses the An Nafud desert and links Al Jouf province with Hail, Qasim and eventually Riyadh.

To the immediate north of the development site, the Saudi Electricity Company has constructed a service road for its overhead transmission lines. This service road is approximately 8m wide and is comprised of compacted aggregate material.

13.3.2 Traffic Survey

Jacobs was commissioned in 2015 to undertake a traffic study to assess the road safety and traffic impacts of bulk fuel distribution by trucks at 9 of Saudi Aramco's 22 bulk plants across the Kingdom. The Al Jouf bulk plant adjacent to the development site was included in this study. The objectives of the study were to:

- Evaluate the existing traffic conditions and issues raised by bulk plant operators.
- Evaluate the predicted future traffic conditions, based on traffic growth and expansion of the road network.
- Propose short and long term alternative solutions, and recommended a preferred solution.

This survey was conducted on Road 80 using standard methodology, automated traffic count devices, video and 'tube counters' in order to accurately record the number of vehicles travelling past the survey location within a 24 hour period. The results from this previous survey will be utilized and no further survey work will be carried out.

Baseline traffic data was collected during 2015 using 2 automated traffic counts (ATC) and 4 turning movement counts (TMC). The location of the survey locations are shown on Figure 13-2 and described in Table 13-1.



Figure 13-2: Baseline Traffic Survey Locations (Source: Jacobs, 2016)

Table 13-1: Traffic Survey Locations

Ref. No.	Location	Type	Date	Duration
1	Highway 80 U-turn	Turning	13-14 April 2015	12

Ref. No.	Location	Type	Date	Duration
2	Highway 80 at Azfaa Road	Turning	13-14 April 2015	12
3	Bulk Plant Access	Turning	13-14 April 2015	12
4	Highway 80	Volume + Speed	13-14 April 2015	24
5	Highway 80 U-turn	Turning	13-14 April 2015	12
6	Azfaa Road	Volume + Speed	13-14 April 2015	24

13.3.3 Automated Traffic Count Data

The ATC data collected was used to provide a continuous flow profile allowing the highway network peak hours to be determined. From the analysis, the public network peak periods are:

- AM Peak – 07.00 – 08.00
- PM Peak – 14.00 – 15.00

The traffic volume flow profile for both north and southbound directions on Highway 80 and the Azfaa Road is shown in Figure 13-3.

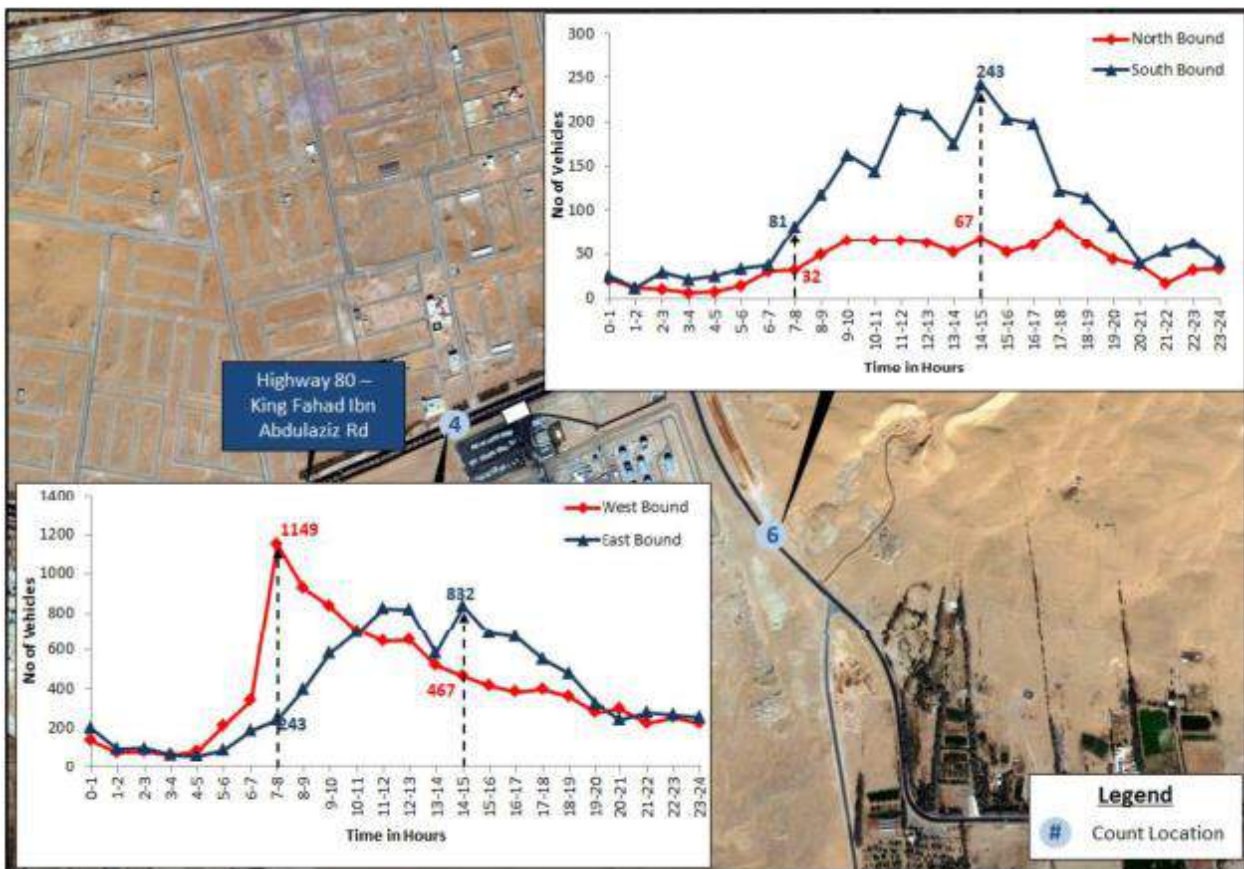


Figure 13-3: Traffic Volumes on Highway 80 and Azfaa Road

13.3.4 Turning Movement Count (TMC) Data

The TMC data collected is illustrated on Figure 13-4. The AM and PM peak periods are:

- AM Peak – 07.00 – 08.00
- PM Peak – 14.00 – 15.00



Figure 13-4: AM and (PM) Peak Hour Turning Movement Counts – Highway 80 Interchapters

As can be seen in Figure 13-4 the busiest flows in the AM and PM peak hours are the highway 80 through movements where there are approximately 1250 westbound in the AM peak and approximately 850 eastbound in the PM peak.

13.3.5 Observed and Peak Demand

According to demand data supplied by Saudi Aramco there are approximately 410 trucks arriving and departing the bulk plant each day. During the peak hours of the day there are approximately 27 trucks arriving and departing the bulk plant. This data complements the traffic survey data undertaken by Jacobs which indicated approximately 33 trucks arriving and departing during the peak hours of the day.

Future demand data indicates that by 2040 there will be approximately 670 trucks arriving and departing per day. The peak hours of which will have approximately 45 trucks arriving and departing the bulk plant.

13.3.6 Road Capacity

Level of Service (LOS) analysis is a system of measurement used to quantify the capacity of road networks to provide an indication of how 'free flowing' traffic is at a particular location.

Existing 2015 Synchro modelling was undertaken to assess the capacity of the surrounding interchapters during the AM and PM peak periods. The Synchro modelling indicated that the existing interchapters all operate with LOS values of A during both the AM and PM peak periods. LOS A indicates freely moving traffic and therefore, a road operating within capacity. The recommendations for the bulk plant are centered on safety improvements only as Highway 80 is operating within design capacity for both current and future demand.

13.3.7 Baseline Survey

No additional baseline survey above that carried out as part of the Al Jouf Bulk Plant Traffic Survey (Jacobs (2015) was carried out as part of this assessment.

13.4 Assessment Methodology

13.4.1 Approach

This Section describes the impact on existing traffic and transport infrastructure as a result of the construction, operation and decommissioning/closure of the proposed Sakaka Solar Energy Park. The significance of the potential impacts on existing traffic and transport infrastructure are characterized in accordance with standard methodology as described in chapter 5 of this ESIA.

Section 3 Community Health and Safety of the International Finance Corporation (IFC) General Environment Health and Safety (EHS) Guidelines 2007, has been used to inform the impact assessment.

13.5 Impact Assessment

13.5.1 Construction Phase

Impacts upon traffic and transportation infrastructure experienced during the construction phase of the development are likely to relate to the increased volume of traffic making use of Road 80 in order to access the development site. This traffic is likely to include construction plant and delivery vehicles transporting solar panels and other infrastructure to the development site. Standard vehicles will be used for the delivery of modules to the development site, and therefore no upgrades to local and regional road infrastructure will be required. The junction present between Road 80 and the development site will require upgrades in order to meet the need for the increased vehicles anticipated to make use of it. Table 13-2 shows construction phase impacts.

Table 13-2: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TT01	Road Users	Moderate	Increased traffic volume due to introduction of construction traffic.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Short Local Reversible	Moderate	Moderate

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TT02	Road Users	Moderate	Increased number of Road Traffic Accidents due to the increased number of vehicle movements along Road 80.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Likely Infrequent Short Local Reversible	Moderate	Moderate
TT03	Al Jouf International Airport	Moderate	Increased traffic at development site restricting access to airport.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Unlikely Infrequent Short Local Reversible	Moderate	Low

13.5.1.1 Increased traffic volume due to construction traffic

During the construction of the Park, road traffic will increase associated with the transportation of materials and solar modules to site. It is estimated that there will be approximately 16,238 vehicle movements over the 20 month construction period. This equates to approximately 27 vehicle movements per day. This material will be transported to the development site along Road 80, which is the primary access to the development site.

Based on the existing transportation study for the Saudi Aramco bulk plant, Road 80 has been assessed as being well within its capacity and is considered to be capable of supporting the increased volume of traffic expected to arise as a result of the Park. Despite this, a moderate magnitude has been assigned to the impact due to the presence of human road users.

Modules are expected to enter the Kingdom of Saudi Arabia via sea to one of the major ports and then be transported via road to the development site. Standard heavy goods vehicles will be used, and therefore no upgrades to road infrastructure are anticipated to be required. Additionally, it is anticipated that deliveries will take place during the night where possible, in order to minimize disruption to users of Road 80.

Traffic will be managed as per the requirements of IFC EHS Standard 3.0: *Community Health and Safety* and IFC EHS Standard 4.0: *Construction and Decommissioning*. This will minimize the potential for impacts to occur as a result of the Park.

However, due to the human nature of this receptor, the impact associated has been assessed as moderate.

Impact TT01 – Moderate Significance

13.5.1.2 Increased number of road traffic accidents

Although Road 80 will remain within capacity, it is anticipated that due to the increased volume of traffic during the construction phase of the Park, in particular an increase in heavy goods vehicles, that the risk of road traffic accidents has the potential to rise.

Traffic will be managed as per the requirements of IFC EHS Standard 3.0: *Community Health and Safety* and IFC EHS Standard 4.0: *Construction and Decommissioning*. This will minimize the potential for impacts to occur as a result of the Park.

Due to the human nature of the receptors, this impact is assessed as being of moderate significance.

Impact TT02 – Moderate Significance

13.5.1.3 Increased traffic at development site restricting access to airport

Despite the introduction of new construction traffic during the construction phase of the development, Road 80 is expected to operate well within its capacity and therefore, negative impacts upon access to the airport are assessed as being of low significance. It is not anticipated that any air travel would be involved in the construction of the Park, and therefore, no impact is expected upon the existing capacity of the airport.

Impact TT03 – Low Significance

13.5.2 Operation Phase

During the operational phase of the Park, it is anticipated that traffic volume along Road 80 will increase, however due to the low operational requirements of the Park, this increase will be marginal (Table 13-3).

Table 13-3: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
TT04	Road Users	Moderate	Increased traffic volume due to introduction operational traffic.	Effect: Action: Likelihood: Frequency: Duration: Extent: Permanence:	Negative Direct Certain Continuous Short Local Reversible	Low	Low

13.5.2.1 Increased traffic volume due to introduction operational traffic.

300 operational staff will be located at the Park, and will travel from nearby locations. These movements will contribute towards additional vehicle movements. In addition, periodic emptying of on-site storage tanks will be carried out via tankers which will also represent additional vehicle movements. It is estimated that approximately 5 vehicle movements per day for sanitary waste and solid waste management.

Traffic will be managed as per the requirements of IFC EHS Standard 3.0: *Community Health and Safety* and IFC EHS Standard 4.0: *Construction and Decommissioning*. This will minimize the potential for impacts to occur as a result of the Park.

Despite the increase in vehicle movements, it is not anticipated that any significant impacts would be associated with the operational phase of the Park and therefore, this impact has been assessed as low significance.

Impact TT04 – Low Significance

13.5.3 Decommissioning Phase

Impacts during the decommissioning phase of the Park are anticipated to be similar to those experienced during the construction phase. See chapter 13.5.1 for details.

13.6 Mitigation

13.6.1 Construction Phase

Mitigation measures required during the construction phase of the Park, relate primarily to the development and implementation of traffic management plans in accordance with the requirements of IFC EHS Guidelines 3.0: *Community Health and Safety* and IFC EHS Guidelines 4.0: *Construction and Decommissioning*, and measures to ensure that the increase in vehicle numbers is appropriately managed and accounted for (Table 13-4).

Table 13-4: Construction Phase Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
TT01	Moderate	Contractor to develop and employ a traffic management plan in order to structure the required deliveries and vehicle movements around existing usage and capacity of Road 80. This plan should include a delivery schedule which is developed in accordance with current usage patterns of the road, and avoids peak traffic flows.	Low
TT02	Moderate	Contractor to develop and employ a traffic management plan in order to ensure road traffic accidents are minimized and avoided. The traffic management plan should make allowance for the safe passage of pedestrians both across and around roads upon which deliveries are expected to increase normal traffic volume. This may include the introduction of crossing points or alternative routes for pedestrians.	Low

The EPC contractor will be required to prepare a traffic management plan to mitigate the risks associated with the increased volume of traffic present during the construction phase of the Park. This plan should include the following recommendations:

- EPC contractor responsibilities for traffic and transportation aspects, including daily transportation of workers and deliveries to site. This will include the development of emergency response plans for the construction phase of the project;
- Use of only licensed and experienced drivers;
- All vehicles, equipment and machinery shall undergo regular maintenance with manufacturer specifications;
- All drivers to adhere to speed limits;
- Procedures shall be put in place for monitoring of increased traffic movements and associated environmental and safety concerns;
- All drivers are trained through third party agencies and possess competency certificates; and,
- Procedures shall be implemented to monitor the condition of roads used by the traffic associated with the Park, and a maintenance program be implemented to ensure that roads remain in good condition.

13.6.2 Operation Phase

It should be noted that no significant levels of traffic will be generated during the operation phase of the Park. However, there remains potential for road traffic accidents, and as a best practice recommendation, an operational traffic management plan should be prepared in accordance with the requirements of IFC EHS Guidelines 3.0: *Community Health and Safety* and IFC EHS Guidelines 4.0: *Construction and Decommissioning*. This plan should include:

- Procedures for monitoring increased traffic movements and anticipating and proactively managing potential traffic congestion at the junction between the site access road and Road 80,
- Assessment of Hazard Identification and Risk Assessment during the operation phase; and,
- A commitment for quarterly road safety training and annual defensive driving training for staff and operators.

13.6.3 Decommissioning Phase

During the decommissioning phase of the Park, traffic will increase due to the requirement to remove material from the development site. A traffic management plan should be developed by the IPP in accordance with the requirements of IFC EHS Guidelines 3.0: *Community Health and Safety* and IFC EHS Guidelines 4.0: *Construction and Decommissioning* in order to reduce the risk of road traffic accidents, as during the construction phase.

13.7 Conclusion

This Traffic and Transport assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the assessment should be reviewed with any updates and reported in an Addendum to this ESIA.

The impacts upon traffic and transportation, expected to arise as a result of the Park are related to the increased volume of traffic upon Road 80. Impacts can be mitigated through the development of a traffic management plan by the IPP.

There are a number of other projects planned in the local area, such as the MODON city for women, and a new solar park planned to be installed to the west of the development site by SEC. Impacts related to the cumulative effect of these developments upon transport infrastructure in the local area are covered in Chapter 19 *Cumulative Impact Assessment*. It is advised that liaison is carried out wherever possible in order to avoid cumulative impacts where projects are planned to take place simultaneously.

The cumulative impact upon transportation infrastructure should be reviewed following stakeholder consultation and the subsequent preparation of the traffic management plan by the IPP.

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14. Socio – Economic Aspects

14.1 Introduction

This chapter provides an overview of the existing Socio-Economic conditions present at the development site, and an evaluation and assessment of the potential impacts upon them which may arise as a result of the Sakaka Solar Energy Park (the Park).

National, regional and local socio-economic characteristics are described, including economy; population and demographics; employment; education; culture; municipal and social services; and, land use and ownership. The assessment of impacts related to Socio-Economics has been carried out utilizing the standard methodology outlined in chapter 5 and assesses changes in the four following key socio-economic parameters:

- Effects of the project on socio-economic indicators;
- Effects on livelihoods and/or displacement of affected communities.
- Involvement of local manpower in project operation; and,
- Changes in land use and natural resources.

14.2 International and National Standards and Guidance

14.2.1 International standards

The international standards and guidance that are relevant for the Socio-Economic impact assessment of the Sakaka Solar Energy Park are set out below.

14.2.1.1 World Bank/International Finance Corporation

The World Bank has a set of Safeguard Policies to reduce or eliminate the negative environmental and social impacts of projects. World Bank OP 4.01 requires that, for all Category A projects and, as appropriate, Category B projects, during the environmental assessment process the project sponsor should consult project-affected groups and local non-governmental organizations (NGOs) about the project's environmental aspects and take their views into account. Other World Bank Safeguard Policies that are relevant to this project include:

- OB/BP 4.12: Involuntary Resettlement
- OP 4.10: Indigenous Peoples
- OP 4.11: Physical Cultural Resources

The International Finance Corporation (IFC) has a sustainability framework that consists of Performance Standards to manage environmental and social risks to projects. The following Performance Standards are relevant to this Socio-Economic impact assessment:

- Performance Standard 1: Assessment and Management of Social and Environmental Risks and Impacts
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources
- Performance Standard 7: Indigenous Peoples

- Performance Standard 8: Cultural Heritage

The IFC have also produced “A Project Developer’s Guide to Utility-scale Solar Photovoltaic Power Plants” (IFC 2015), which details suggested environmental considerations for Environmental Impact Assessment and management requirements for construction and operation, including land matters and livelihood restoration.

In addition, IFC Performance standards recommend implementation of the IFC EHS guidelines. IFC Guidelines of relevance to this Socio-economic assessment include:

- IFC General EHS Guidelines (2007)
- IFC EHS Guidelines for Electric Power Transmission and Distribution (2007)

14.2.1.2 Equator Principles

The Equator Principles are a set of ten ethical lending principles which are aligned with the IFC Performance standards, and require the implementation of the IFC EHS guidelines as a minimum standard for all financed projects in non-designated countries. Key Equator Principles of relevance to this chapter include:

- Principle 4: Environmental and Social Management System and Equator Principles Action Plan
- Principle 5: Stakeholder Engagement
- Principle 6: Grievance Mechanism

14.2.2 National environmental legislation

With regards to land use, the following legislative guidance in Saudi Arabia under RCER-2015, volume II Appendix C should be referred to:

- The current utilities infrastructure and their usage should be reviewed. The assessment should anticipate the impacts of the project on the increased demands on existing utility infrastructure notably water supply, sewage and wastewater treatment, and electricity. Existing services and infrastructure may become overloaded adversely affecting existing users. If there are any significant benefits, where the development enables a major improvement to local infrastructure, those should be explained clearly and reported.

14.3 Baseline Environmental Conditions

The establishment of baseline Socio-Economic conditions has been undertaken using a combination of review of existing published information including government reports and statistics, academic studies, news reports, and any other available literature.

The General Authority for Statistics is the primary source for statistics for the Kingdom of Saudi Arabia. The Fifty First Statistical Year Book has been published for 2015 by the General Authority for Statistics and includes official statistical data on the activities and achievements of various public and private sector organizations in the Kingdom of Saudi Arabia.

14.3.1 Limitations

Primary data from the community via stakeholder and community engagement activities in accordance with the stakeholder engagement plan, specifically interviews with local stakeholders and Socio-Economic questionnaires was not available at the time of preparing this Socio Economic Chapter.

Information for the wider associated works required to support the development (e.g. logistical routes etc.) and the communities and stakeholders potentially affected by these was also not available at the time of drafting.

Inclusion of this information at a later stage of the development shall be undertaken as part of an addendum to this ESIA, and shall be completed prior to any construction works commencing by the IPP.

14.3.2 National Social Background

14.3.2.1 The Economy of the Kingdom of Saudi Arabia

The economy of the Kingdom of Saudi Arabia was agriculture-based with a largely nomadic population until oil was discovered in the 1930s, and it was not until the oil crisis of the 1970s that the country's economy began to grow rapidly. The Kingdom of Saudi Arabia possesses approximately one-fifth of the world's proven petroleum reserves and is the world's largest exporter of oil. The Kingdom of Saudi Arabia plays a leading role in the Organization of the Petroleum Exporting Countries (OPEC), and has the highest Gross Domestic Product (GDP) in the Gulf Co-operation Council (GCC) region.

Historically, the economy has been tightly controlled and focused on exploitation of oil reserves, however, private sector growth, a policy to encourage employment of more Saudi nationals and increased diversification of the economy are a priority. Saudi Arabia acceded to the World Trade Organization (WTO) in 2005, to attract foreign investment and to help to diversify the economy. The diversification of the economy remains a priority for the Kingdom and is a central tenant of Vision 2030.

14.3.2.2 National Economic Activity

The petroleum sector is the main contributor to budget revenues, and in 2013 accounted for approximately 80% of budget revenues, 45% of GDP, and 90% of export earnings (CIA, 2013). The Kingdom of Saudi Arabia's ambitious diversification program is aimed at expanding the existing manufacturing base into areas including logistics and transport, technology, medicine and finance. The Saudi government has made it a priority to diversify the industrial sector to reduce dependence on oil extraction and refinement (Ministry of Economy and Planning 2010).

The structural reform agenda is gaining momentum. The authorities have recently announced the launch of the National Transformation Plan which will support the achievement of the goals of Vision 2030. The plan aims to introduce structural measures such as improvements in public sector efficiency, privatization, further subsidy reforms and revenue diversification initiatives. As part of the National Transformation Plan, the Ministry of Energy, Industry and Mineral Resources (MIEM) is launching the National Renewable Energy Program (NREP). The NREP plans to implement 9.5 GW of renewable power by 2023.

The latest Middle East and North Africa (MENA) Economic Monitor Report, published in spring 2016 by the World Bank, reported that the Kingdom of Saudi Arabia's current account balance deteriorated with low oil prices, as hydrocarbons account for 89% of exports. The current account balance moved from a surplus of 10% of GDP in 2014 to a deficit of 5.2% of GDP in 2016. The Economic Monitor Report (World Bank, 2016) expects Saudi's current account balance to improve but remain in deficit at 2.8% of GDP in 2016.

Economic Monitor Report (World Bank, 2016) reports the fiscal deficit widened substantially in 2015 with moderate tightening in 2016. Expenditure cuts were limited to a modest 2.5% in 2015 while the revenues dropped by 38%. The fiscal deficit had a large increase to 18.9% in 2015. The deficit was financed largely by Saudi Arabian Monetary Agency's (SAMA) large stock of foreign assets (estimated to exceed \$600 billion by the end of 2015). The 2016 budget reflects moderate tightening.

Measures have been taken within the Kingdom of Saudi Arabia to actively manage the budget deficit. Domestic oil prices were raised by 50%, and natural gas and water prices are planned to be increased as well. In addition, budgetary allocations for education, health, and municipality services have faced significant cuts in an attempt to consolidate the deteriorating fiscal balances (World Bank, 2016). Some revenue generation measures have also been introduced, including 2.5% tax on undeveloped land and \$23 airport fee for international visitors. Other measures, including a 5% Value Added Tax (VAT) and additional taxes on tobacco and soft drinks, have been announced awaiting implementation.

14.3.2.3 Population and Demographics

Up until the 1960s, most of the population was nomadic or semi-nomadic, but the recent rapid economic growth has resulted in more than 95% of the population now being settled. In 2011, urbanization had reached 85%.

Some cities and oases now have densities of more than 1000 people per square kilometer according to the 2004 and 2010 Census records.

The population statistics for the Kingdom of Saudi Arabia and the Al Jouf region, split between males and females and Saudi's and non-Saudi are listed in Table 14-1 (General Authority for Statistics, 2016). The data for Al Jouf region is split by gender, age-groups and nationality. The total population of the Kingdom in mid-2015 was 31,015,999 (i.e. 20,774,906 Saudi and 10,241,093 non-Saudi) and the total population in Al Jouf region was 497,509 (i.e. 373,662 Saudi and 123,847 non-Saudi). The proportion of Saudi nationals which comprise the population in Al Jouf region is markedly higher than the national average, 75.12% versus 66.98% respectively. The younger age groups also comprise the majority of the population in Al Jouf.

Table 14-1: Population Statistics for Saudi Arabia and Al Jouf Region (source: General Authority for Statistics 2016)

Total			Non-Saudi			Saudi			Age Groups
National Population Statistics									
Total	Females	Males	Total	Females	Males	Total	Females	Males	Total
31015999	13363850	17652149	10241093	3160387	7080706	20774906	10203463	10571443	
Al Jouf Region Population Statistics									
56841	28607	28234	3293	1511	1782	53548	27096	26452	0-4
49180	24312	24868	3668	1710	1958	45512	22602	22910	5 - 9
40844	19930	20914	2916	1343	1573	37928	18587	19341	10 - 14
35805	17519	18286	2099	949	1150	33706	16570	17136	15 - 19
41364	18738	22626	4605	1289	3316	36759	17449	19310	20 - 24
48732	20385	28347	14190	3799	10391	34542	16586	17956	25 - 29
46195	18660	27535	17661	4672	12989	28534	13988	14546	30 - 34
47360	17729	29631	23831	6047	17784	23529	11682	11847	35 - 39
43409	15552	27857	22435	5151	17284	20974	10401	10573	40 - 44
29856	10535	19321	13653	2365	11288	16203	8170	8033	45 - 49
19689	6509	13180	7963	735	7228	11726	5774	5952	50 - 54
14472	5536	8936	4159	428	3731	10313	5108	5205	55 - 59
9653	4008	5645	1986	265	1721	7667	3743	3924	60 - 64
5935	3089	2846	717	82	635	5218	3007	2211	65 - 69
3645	1744	1901	485	281	204	3160	1463	1697	70 - 74
2273	933	1340	96	0	96	2177	933	1244	75 - 79
2256	836	1420	90	90	0	2166	746	1420	Above - 80
497509	214622	282887	123847	30717	93130	373662	183905	189757	Total

14.3.2.4 Employment Profile

Employment statistics for the Kingdom of Saudi Arabia, by administrative area and main occupation groups have been compiled by the General Authority for Statistics for mid-2016. These statistics have also been generated for employed males and employed Saudi's (15 years and above). Although no explicit statistics have

been provided for women, the number of women in employment can be deduced. Employment statistics are listed in Table 14-2 to Table 14-7.

provides the statistics for employed persons (15 years and above), and the total number of employed persons in Al Jouf administrative area is 178,970. Therefore 35.97% of the total population in Al Jouf administrative area is in employment. This compares to 39.90% for the Kingdom as a whole. The largest proportion of jobs in Al Jouf administrative area are within the service industry, followed by engineering and sales.

Of the 178,970 persons employed in the Al Jouf administrative area, 75,798 are Saudi nationals (approximately 42.35%). This compares to 40.57% for the national population, indicating that Saudi nationals comprise a slightly higher proportion of the employed persons in Al Jouf area than the national average.

64,528 of the 75,798 Saudi national employed are Saudi males, which by default indicated that 11,450 women are in employment in the Al Jouf area. Women comprise 15% of the employed Saudi persons in the Al Jouf area. This compares to 16.64% at the national level and so is marginally lower.

Table 14-6 lists the employed persons (15 years and above) by main economic activity groups and administrative area. Within the Al Jouf area, the principal employment sectors are public administration and defense (40,187), wholesale and retail (23,656), construction (23,579), and education (21,542).

Al Jouf region is farmed within the Kingdom for its olive groves and olive oil production. The region supports both small scale farms and the large mechanized plantation of Nadec. Al Jouf also holds an Olive Festival which gives producers a chance to market and promote their products. Al Jouf has the largest organic olive orchard in the world of approximately 600,000 trees and this has been forecast to increase to nearly 1,000,000 trees.

The Saudi Industrial Property Authority (MODON) plans to develop an industrial city in Al Jouf for women. The proposed city is located on Road 80 to the west of the Saudi Electricity Company (SEC) power plant and sub-station, approximately 10km north-west of the development site. This city will provide employment opportunities for Saudi women locally.

Table 14-2: Total Employed persons (15 Years and above) by Administrative Area and Main Occupation Groups

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Riyadh	96,753	389,910	309,650	360,953	346,423	880,796	84,890	104,089	775,751	3,349,215
Makkah	70,364	291,830	288,508	246,321	432,060	915,438	104,799	79,852	758,675	3,187,847
Madinah	17,053	74,744	93,207	50,442	93,516	183,907	41,667	13,075	127,442	695,053
Qassim	10,410	58,318	63,635	54,879	68,478	156,748	46,537	7,420	133,289	599,714
Easte. Prov.	72,315	306,695	239,214	144,397	166,525	544,175	28,668	91,310	451,122	2,044,421
Asir	13,168	53,188	90,073	53,224	49,303	288,752	37,685	9,944	163,896	759,233
Tabuk	4,009	20,808	30,338	22,455	19,670	119,803	30,874	4,968	55,846	308,771
Hail	5,311	19,688	29,079	25,321	23,505	74,398	23,519	2,746	43,243	246,810
North.	3,121	8,262	14,346	9,445	10,113	41,532	7,075	3,886	29,330	127,110

Total	Occupations of Supporting Basic Engineering	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Services	Occupations of Sales	Occupations of Clerical	Technicians in Professional, Technical and Humanitarian Fields	Specialists in Professional, Technical and Humanitarian Fields	Lawmakers, Directors and business Managers	Administrative Area
										Border
517,359	67,514	11,451	44,888	166,211	74,034	43,187	63,793	37,674	8,607	Jazan
196,847	40,602	4,197	12,721	58,576	20,393	16,561	20,524	17,194	6,079	Najran
165,349	38,077	1,588	8,592	46,455	14,297	16,002	22,607	13,823	3,908	AL - Baha
178,970	37,257	2,157	7,164	59,596	21,088	14,377	20,938	13,041	3,352	AL - Jouf
12,376,699	2,722,044	336,683	479,079	3,536,387	1,339,405	1,057,564	1,285,912	1,305,175	314,450	Total

Table 14-3: Total Males Employed persons (15 Years and above) by Administrative Area and Main Occupation Groups

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Riyadh	86,849	328,975	195,850	282,361	335,363	755,509	84,890	101,141	775,365	2,946,303
Makkah	67,609	248,608	205,263	209,773	420,093	804,197	104,348	70,277	757,366	2,887,534
Madinah	15,817	59,867	61,255	39,827	91,833	157,305	41,297	12,451	127,442	607,094
Qassim	9,659	44,326	38,346	45,803	66,653	117,191	46,537	7,420	133,289	509,224
Easte. Prov.	67,983	275,430	190,958	121,886	159,022	420,517	28,668	90,078	451,122	1,805,664
Asir	12,998	42,150	46,414	44,867	48,506	236,010	36,986	9,615	163,896	641,442
Tabuk	3,103	17,234	19,669	17,336	18,884	107,438	29,627	4,718	55,846	273,855
Hail	4,908	15,235	20,763	22,326	23,176	55,044	23,466	2,746	43,243	210,907
North. Border	2,852	6,390	7,206	7,874	9,856	32,265	7,075	3,833	29,330	106,681
Jazan	7,135	27,106	36,857	32,715	72,475	138,500	44,888	11,451	67,514	438,641
Najran	5,486	13,660	12,767	14,391	20,056	45,871	12,721	4,197	40,602	169,751
AL - Baha	3,487	9,787	13,032	13,887	14,128	39,512	8,592	1,464	38,077	141,966
AL - Jouf	2,951	11,296	13,337	12,686	20,779	47,726	7,164	2,157	37,257	155,353
Total	290,837	1,100,064	861,717	865,732	1,300,824	2,957,085	476,259	321,548	2,720,349	10,894,415

Table 14-4: Saudis Employed persons (15 Years and above) by Administrative Area and Main Occupation Groups

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Riyadh	65,752	140,375	202,427	304,523	61,788	365,637	18,544	5,260	14,749	1,179,055
Makkah	51,680	108,205	195,847	176,345	84,417	402,105	80,851	14,185	55,183	1,168,818
Madinah	13,666	36,467	65,613	42,781	11,792	91,835	18,281	1,546	15,174	297,155
Qassim	9,562	27,335	50,791	50,631	33,656	72,235	13,214	444	11,722	269,590
Easte. Prov.	44,184	104,078	133,906	119,802	52,687	207,807	14,910	51,473	60,295	789,142

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Asir	11,613	38,525	81,659	51,539	10,298	185,251	16,239	161	5,499	400,784
Tabuk	3,889	6,797	22,964	20,157	7,083	88,627	18,547	400	5,446	173,910
Hail	5,178	10,800	24,558	24,292	3,251	38,770	11,040	87	1,243	119,219
North. Border	2,545	4,395	13,078	9,335	3,347	26,823	6,112	379	2,106	68,120
Jazan	7,952	31,207	62,023	40,754	20,773	111,036	10,804	1,645	10,697	296,891
Najran	5,641	9,226	17,081	15,614	8,066	28,432	4,357	486	3,362	92,265
AL - Baha	3,871	9,886	19,150	15,154	8,724	25,843	4,917	146	3,141	90,832
AL - Jouf	3,082	7,332	16,407	13,368	5,696	26,918	1,765	0	1,230	75,798
Total	228,615	534,628	905,504	884,295	311,578	1,671,319	219,581	76,212	189,847	5,021,579

Table 14-5: Saudis Males Employed persons (15 Years and above) by Administrative Area and Main Occupation Groups

Administrative Area	Lawmakers, Directors and business Managers	Specialists in Professional, Technical and Humanitarian Fields	Technicians in Professional, Technical and Humanitarian Fields	Occupations of Clerical	Occupations of Sales	Occupations of Services	Occupations of Agriculture, Animal Husbandry & Fishing	Occupations of Industrial, Chemical Operations and Food Industries	Occupations of Supporting Basic Engineering	Total
Riyadh	57,066	97,539	103,766	231,666	52,206	345,929	18,544	5,260	14,749	926,725
Makkah	49,295	76,541	122,294	142,473	74,326	391,315	80,400	8,167	55,183	999,994
Madinah	12,430	24,125	35,852	32,625	10,543	89,287	17,911	1,195	15,174	239,142
Qassim	9,119	17,129	30,261	41,555	31,831	68,343	13,214	444	11,722	223,618
Easte. Prov.	39,852	75,629	95,035	97,291	45,706	200,862	14,910	50,768	60,295	680,348
Asir	11,443	28,867	38,465	43,182	10,060	182,415	15,540	0	5,499	335,471
Tabuk	2,983	4,274	12,695	15,038	6,297	87,501	17,300	285	5,446	151,819
Hail	4,775	7,503	16,426	21,297	2,922	37,973	10,987	87	1,243	103,213
North. Border	2,276	3,036	6,302	7,764	3,090	26,519	6,112	326	2,106	57,531
Jazan	6,480	20,867	35,128	30,282	20,365	110,081	10,804	1,645	10,697	246,349
Najran	5,048	6,809	10,916	13,520	7,729	27,554	4,357	486	3,362	79,781
AL - Baha	3,450	6,412	12,126	13,245	8,555	25,342	4,917	146	3,141	77,334
AL - Jouf	2,681	5,829	9,131	11,677	5,628	26,587	1,765	0	1,230	64,528
Total	206,898	374,560	528,397	701,615	279,258	1,619,708	216,761	68,809	189,847	4,185,853

Table 14-6: Total Employed persons (15 Years and above) by Main Economic Activity Groups and Administrative Area

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Agriculture, forestry and fishing	99,224	111,191	47,102	63,125	38,418	39,184	37,436	24,025	8,705	62,727	13,425	8,564	6,893	560,019
Mining and quarrying	10,722	9,569	3,451	0	138,790	692	2,638	0	1,027	3,676	564	137	213	171,479
Manufacturing	346,635	273,203	45,789	26,201	270,865	25,012	11,788	8,675	6,305	23,826	8,901	4,300	10,226	1,061,726
Electricity, gas, steam and air conditioning supply	12,170	21,450	6,348	4,076	22,217	4,916	2,507	1,744	480	3,123	1,874	503	830	82,238
Water supply; sewerage, waste management and remediation activities	8,867	17,785	3,088	1,381	11,128	2,622	1,858	446	387	821	494	152	232	49,261
Construction	639,122	517,958	99,498	96,983	320,476	113,897	32,509	34,942	22,553	44,459	34,580	31,489	23,579	2,012,045
Wholesale and retail trade; repair of motor vehicles and motorcycles	519,297	601,384	96,065	76,074	230,163	59,813	29,137	27,950	12,114	61,979	24,383	18,525	23,656	1,780,540
Transportation and storage	101,166	161,849	16,271	12,850	83,043	16,646	8,389	2,753	1,977	20,216	4,988	3,008	2,191	435,347
Accommodation and food service activities	106,239	116,059	37,076	14,458	44,884	23,784	5,198	7,311	1,148	10,485	4,219	3,455	8,029	382,345
Information and communication	50,304	36,818	4,083	1,566	29,160	2,176	3,094	1,249	1,132	1,206	1,825	1,664	716	134,993

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Financial and insurance activities	66,805	25,442	3,726	5,216	28,553	4,446	1,107	1,097	585	1,415	2,585	1,299	998	143,274
Real estate activities	20,237	42,958	3,581	11,310	16,076	2,961	1,166	1,694	1,403	1,868	2,725	908	764	107,651
Professional, scientific and technical activities	53,475	43,995	11,946	5,736	64,690	8,599	2,277	1,574	744	2,465	972	803	1,838	199,114
Administrative and support service activities	109,176	107,766	7,721	9,062	51,376	8,122	6,828	3,217	1,813	8,695	4,795	4,722	1,905	325,198
Public administration and defense; compulsory social security	453,455	397,077	99,361	93,043	216,568	213,182	95,477	51,867	30,378	120,192	34,168	28,834	40,187	1,873,789
Education	347,035	270,282	88,427	77,602	133,442	116,372	27,923	33,559	15,458	89,225	20,078	31,303	21,542	1,272,248
Human health and social work activities	148,974	129,655	39,609	31,995	92,115	20,775	12,515	14,554	6,065	20,581	16,086	10,184	9,695	552,803
Arts, entertainment and recreation	3,862	2,617	3,186	105	15,209	357	0	0	120	167	473	441	0	26,537
Other service activities	50,590	63,035	13,906	13,905	30,959	16,184	4,064	4,786	2,398	9,811	4,031	3,657	5,774	223,100
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	197,878	233,527	64,819	55,026	205,946	79,389	22,860	25,367	12,318	30,359	15,681	11,401	19,702	974,273

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Activities of extraterritorial organizations and bodies	3,982	4,227	0	0	343	104	0	0	0	63	0	0	0	8,719
Total	3,349,215	3,187,847	695,053	599,714	2,044,421	759,233	308,771	246,810	127,110	517,359	196,847	165,349	178,970	12,376,699

Table 14-7: Saudis Employed persons (15 Years and above) by Main Economic Activity Groups and Administrative Area

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Agriculture, forestry and fishing	22,028	86,606	18,613	23,655	17,852	16,357	19,823	11,001	6,883	19,764	4,766	5,053	1,794	254,195
Mining and quarrying	7,441	3,561	1,467	0	117,347	692	391	0	1,027	2,454	564	137	57	135,138
Manufacturing	50,333	40,811	8,125	2,479	72,230	3,567	1,096	1,668	758	7,316	2,111	941	668	192,103
Electricity, gas, steam and air conditioning supply	6,239	13,394	3,470	3,801	15,933	4,067	1,743	1,578	398	1,279	1,704	503	830	54,939
Water supply; sewerage, waste management and remediation activities	5,338	9,726	1,018	1,234	6,004	995	612	446	99	244	178	36	99	26,029
Construction	23,321	44,294	8,404	2,800	35,366	3,654	1,596	1,723	950	3,394	1,627	1,323	1,007	129,459
Wholesale and retail trade; repair of motor vehicles and motorcycles	62,926	77,873	12,069	15,107	48,035	8,060	5,299	3,796	1,994	12,164	5,674	9,025	4,849	266,871
Transportation and storage	24,494	56,776	12,490	7,691	31,407	3,871	5,862	1,825	1,371	9,233	3,363	1,867	903	161,153
Accommodation and food service activities	8,526	14,386	3,381	746	4,624	789	400	485	84	596	600	232	103	34,952
Information and communication	15,418	14,605	1,818	1,215	8,891	1,902	1,412	401	350	1,062	1,825	884	716	50,499

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Financial and insurance activities	37,204	15,919	2,926	5,216	14,791	4,113	1,107	1,097	527	1,415	2,217	1,234	998	88,764
Real estate activities	13,277	25,835	1,248	10,374	8,639	2,093	1,166	703	1,046	1,106	2,074	908	634	69,103
Professional, scientific and technical activities	11,840	11,261	2,633	1,555	7,554	774	162	59	509	1,224	417	419	444	38,851
Administrative and support service activities	21,655	33,569	2,185	5,135	21,459	6,978	2,411	992	1,567	6,311	1,117	2,290	1,393	107,062
Public administration and defense; compulsory social security	450,063	382,208	98,685	89,943	192,941	212,333	95,299	51,374	30,161	119,248	33,678	28,637	33,487	1,818,057
Education	317,109	243,847	85,930	73,450	119,885	110,402	26,331	32,928	15,127	87,765	17,436	30,073	19,577	1,179,860
Human health and social work activities	84,348	82,336	26,506	19,556	53,899	16,365	7,789	8,218	4,328	18,585	11,938	5,274	7,073	346,215
Arts, entertainment and recreation	0	504	368	105	3,036	357	0	0	56	0	0	291	0	4,717
Other service activities	17,033	10,092	5,450	5,123	6,297	3,311	1,120	925	810	3,668	841	1,705	1,098	57,473
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	462	0	369	405	2,609	0	291	0	75	0	135	0	68	4,414

	Riyadh	Makkah	Madinah	Qassim	Easte. Prov.	Asir	Tabuk	Hail	North. Bord.	Jazan	Najran	AL - Baha	AL - Jouf	Total
Activities of extraterritorial organizations and bodies	0	1,215	0	0	343	104	0	0	0	63	0	0	0	1,725
Total	1,179,055	1,168,818	297,155	269,590	789,142	400,784	173,910	119,219	68,120	296,891	92,265	90,832	75,798	5,021,579

Based on the General Authority for Statistics, the Saudi unemployment rate for the Kingdom in Quarter 3 of 2016 was 12.1%

14.3.2.5 National Education

General education in the Kingdom consists of kindergarten, six years of primary school and three years each of intermediate and high school. The Ministry of Education (MOE) sets overall standards for the country's educational system, and also oversees special education for the handicapped.

The first government school for girls was built in 1964; by the end of the 1990s there were girls' schools in every part of the Kingdom (MOE, 2015). Today, Saudi Arabia's education system includes 25 public and 27 private universities, with more planned; approximately 34,000 schools; and a large number of colleges and other institutions (MOE, 2015).

In addition to the dramatic growth of the educational system since the introduction of the First Development Plan in 1970, there has been an improvement in the quality of education; while the number of students in the educational system increased six-fold between the 1970s and the 1990s, the number of full-time teachers grew more than nine-fold. The Kingdom's ratio of 15 students to every teacher is one of the lowest in the world.

14.3.2.6 Governance

The Kingdom of Saudi Arabia is a monarchy based on Islam. The government is headed by the King, who is also the commander in chief of the military. The King appoints a Crown Prince who is second in line to the throne.

The King governs with the help of the Council of Ministers, also called the Cabinet, formed of 22 government ministries. The King is also advised by a legislative body called the Consultative Council (Majlis Al-Shura). The Consultative Council proposed new laws and amends existing ones. It consists of 150 members who are appointed by the King for four-year terms that can be renewed. The country is divided into 13 provinces, with a governor and deputy governor in each, with its own council that advises the governor and deals with the development of the province.

14.3.2.7 Legal System

The judicial system and all legal matters in Saudi Arabia are based on Islamic law (Shari'ah) for both criminal and civil cases. Shari'ah presumes that a defendant is innocent until proven guilty, and only in serious crimes or in cases of repeat offenders is one likely to witness severe punishments. The Saudi court system consists of three main parts; the largest being the Shari'ah Courts, which hear most cases in the Saudi legal system. The Shari'ah courts are organized into several categories:

- Courts of the First Instance (Summary and General Courts);
- Courts of the Cassation; and,
- The Supreme Judicial Council.

King Salman bin Abdulaziz Al Saud sits at the top of the Saudi legal system and acts as the final court of appeal and as a source of pardon. Supplementing the Shari'ah courts is the Board of Grievances, which hears cases that involve the government. The third part of the Saudi court system consists of various committees within government ministries that address specific disputes, such as labor issues. In April 2005, a royal order approved in principle a plan to reorganize the judicial system, which was approved by a royal order in October 2007. Changes include the establishment of a Supreme Court and special commercial, labor and administrative courts.

14.3.2.8 Religion

The Kingdom of Saudi Arabia is an Islamic theocratic monarchy. Islam is the official religion of the Kingdom and it is required by law that all Saudi citizens be Muslims. The Government does not legally recognize or protect freedom of religion. The public practice of non-Muslim religions is prohibited, which is enforced by the Saudi Mutaween, or Committee for the Propagation of Virtue and the Prevention of Vice. According to a Pew Forum report (2009), approximately 97% of the total population is Muslims, of these; 85-90% are Sunni Muslim and 10-15% are Shia Muslim.

14.3.2.9 Culture

The cultural heritage of Saudi Arabia is largely influenced by Islamic heritage, the role of the country as a trade center, and Bedouin traditions. The protection of cultural heritage has been entrusted to the Department of Culture at the Ministry of Culture and Information. Other institutions that promote culture include the King Fahd Library in Riyadh, which offers one of the largest collections of rare manuscripts on Arabic and Islamic literature; the National Museum in Riyadh, which is the largest museum in Saudi Arabia; and the Saudi Arabian Society for Culture and Arts. The Department of Museums and Antiques has responsibility for safeguarding the Kingdom's cultural heritage. Saudi Arabia places emphasis on preserving Islamic archaeological heritage. In addition to Makkah and Madinah, there are a large number of mosques within the Kingdom of Saudi Arabia, such as those built by the first caliphs after the death of the Prophet Muhammad, which have been subject to restoration. The restoration of the old Qasr Al-Hokm area in Riyadh and old Dariya, is an example of the Kingdom of Saudi Arabia's commitment to maintaining and preserving its cultural heritage for the benefit of its citizens. Similar restoration work of old quarters has been undertaken in other cities around the Kingdom of Saudi Arabia, such as Jeddah and Hail.

Traditional and cultural values are enforced by the Committee for the Promotion of Virtue and the Prevention of Vice. These values include the prohibition of alcoholic beverages and pork products, prohibition of driving by women, enforcement of conservative dress, with women wearing the abayah, segregation of unrelated males and females and closure of stores and shops during prayer times.

Bedouin constitute only a small portion of the total population of the Middle East although the area they inhabit is large due to their once nomadic lifestyle. The Bedouins were traditionally divided into tribes organized on several levels and governed by tribal chieftains, or Sheikhs, who were elected by tribal elders. The individual family unit (known as a tent or bayt), which typically consisted of three or four adults and any number of children, would adopt a seminomadic pastoral lifestyle, migrating throughout the year following water and plant resources. Royal Tribes traditionally herded camels, whilst others herded sheep, and goats. The fertile crescent of Arabia was in the past known for its lucrative import trade of items such as exotic herbs and spices, gold, ivory and livestock, and the nomadic Bedouins were often mobile markets of this trade. Many Bedouin now adopt a modern lifestyle owing to Government appropriation of lands, reductions in their grazing ranges and increases in population, as well as the changes brought about by the discovery and development of oil fields in the region. No Bedouin were recorded as using the site during the baseline surveys.

14.3.2.10 Local Education

The higher education facility in Al Jouf Province is Al Jouf University, which has 27,291 students and a total of 2824 graduates in 2015. This University is located west of Sakaka, 6.2km north of the development site.

14.3.2.11 Healthcare

The Prince Mohammed Medical City is a 1000 bed medical facility in Al Jouf. This facility will be comprised of a fully equipped general hospital, cardiac center, eye hospital, general laboratory and

rehabilitation center. This project is part of the Governments ongoing commitment to the balanced regional development of health care facilities in the Kingdom, and to reduce pressure on specialized beds in the cities of Riyadh, Jeddah and Dammam.

The hospital is being constructed in two phases. Phase 1 which includes the main hospital is scheduled to be opened in April 2017. Phase 2 is scheduled to be completed in April 2019 and will include a further 500 beds, the cardiology center, neuroscience center, oncology center, ophthalmology hospital and rehabilitation hospital.

When this project was formerly announced it was estimated to create 6,000 jobs locally for Saudi and non-Saudi staff.

14.3.2.12 Land Ownership

The Park is located within a Saudi Aramco reservation and therefore falls under the jurisdiction of the Ministry of Energy Industry and Mineral Resources. Under Saudi Aramco's General Instruction Manual Land Use Permit Procedures G.I. 2.716, there is a requirement to apply for a Land Use Permit (LUP) from Saudi Aramco Facilities Planning Department (FPD) to release the land for the Park. Following receipt of the LUP, FPD will conduct a preliminary review of the release request to ensure that the requested land is not needed for existing short-term or planned long-term land uses; and, this process involves internal and external consultation.

The Park has applied for and received a LUP, and the proposed site is located in a non-classified area within the approved Land Use Permit (LUP) No. 41641. The land use permit area is shown in Figure 14-1.

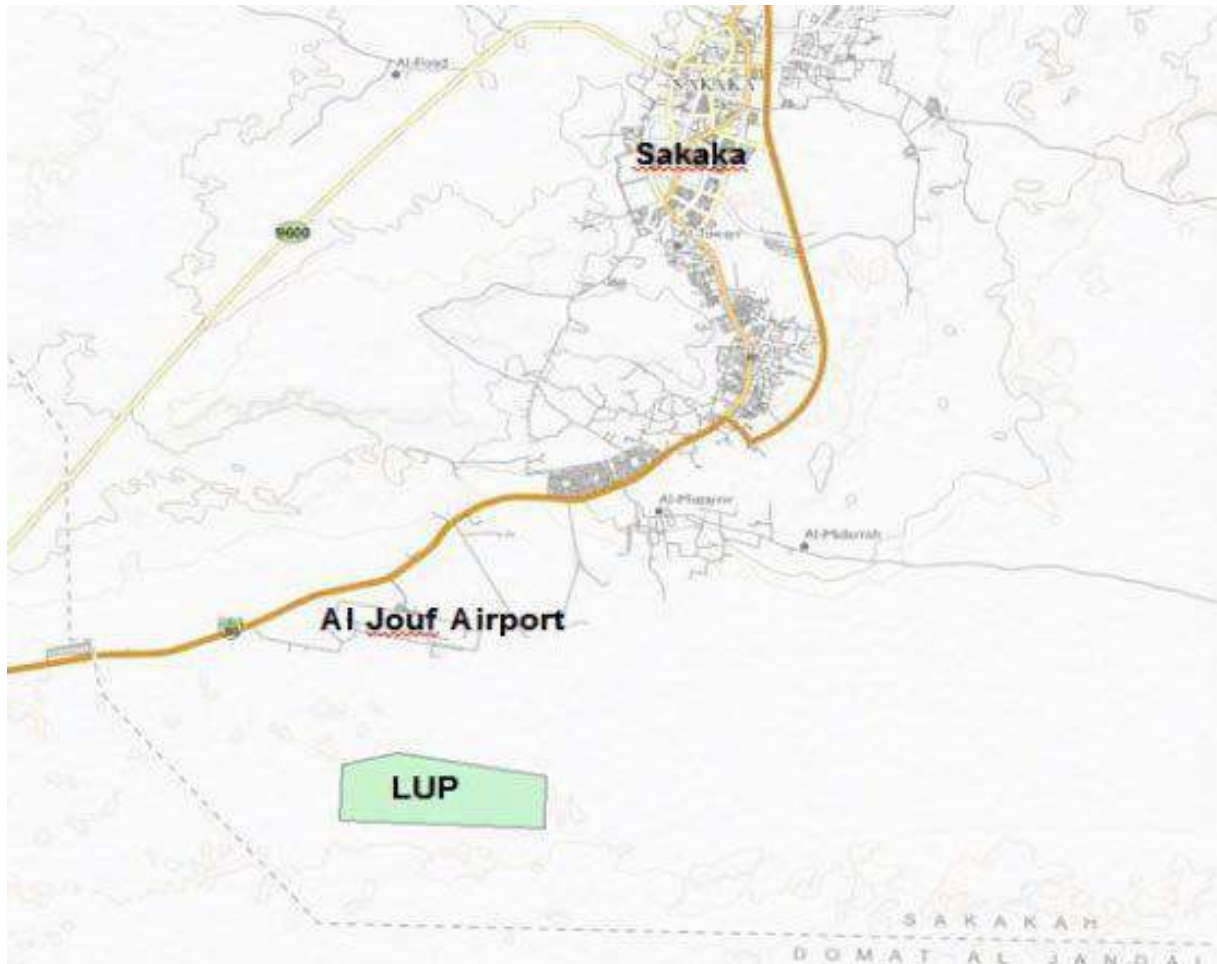


Figure 14-1: Land Use Permit 41641

14.3.2.13 Land Use

There is no evidence of significant historical land-use or development within the development site. Existing informal land uses of camel grazing and hunting are likely to have taken place on the site for decades previously, although with no formal authorization. The site has been used previously for camel racing. Figure 14-2 shows aerial photography of the camel racing track. The site also falls within land which is utilized by seasonal herders who pass through the region as the grazing is depleted. Seasonal grazers were encountered during the baseline surveys and no evidence of hunters or Bedouin using the site was recorded.

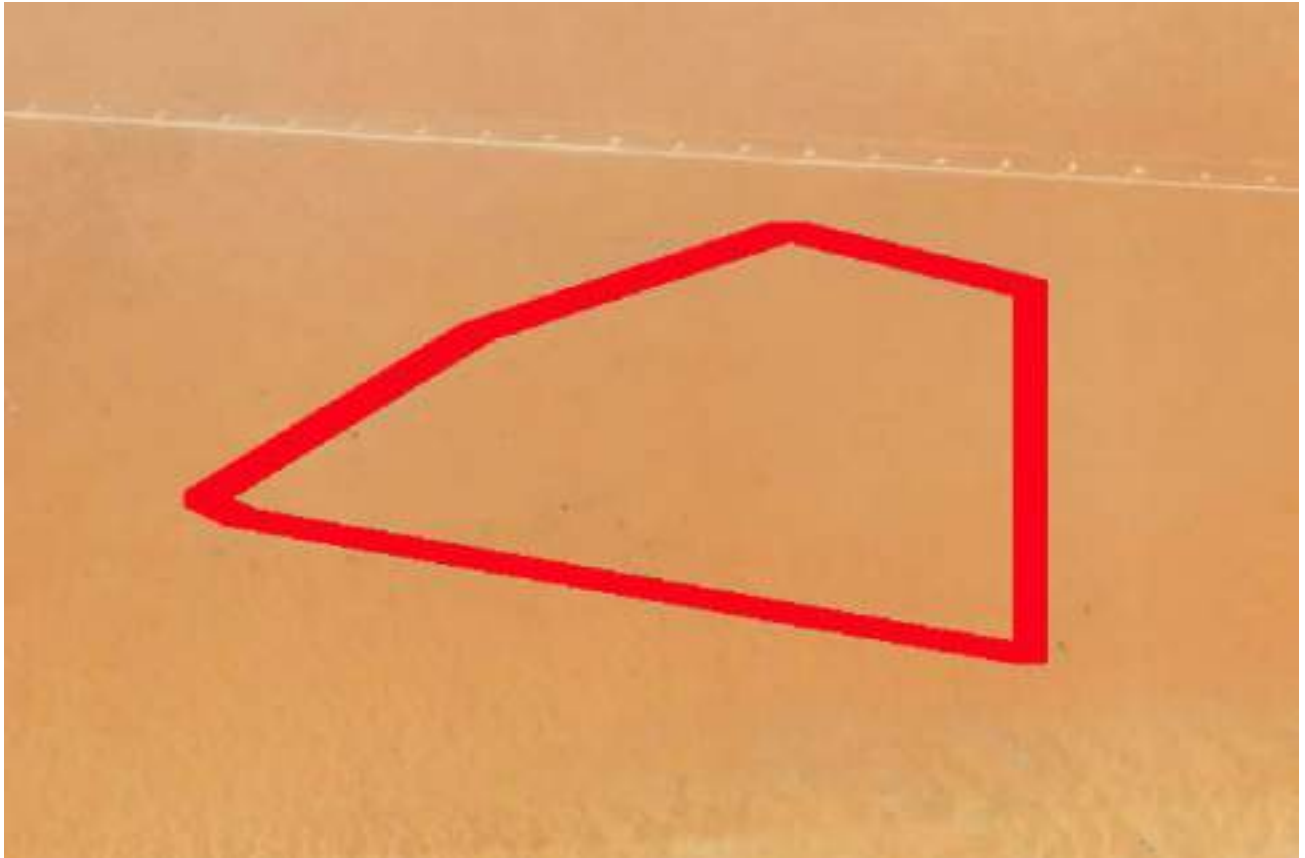


Figure 14-2: Camel Racing Track (Aerial Photography)

14.3.2.14 Existing Development

The area within the development site boundary is currently unused. The area directly to the north of the development site is owned by Al Jouf International Airport, although this area does not form part of the operational components of the airport. There is evidence of unauthorized land use both within the development site, and the surrounding area. This includes, seasonal herding, the erection of temporary shelters and other non-permitted recreational activities.

The northern boundary of the development site is bordered by a Saudi Electricity Company (SEC) utility corridor which includes two 132kV transmission lines and pylons, and a 13.8kV transmission line and a service road constructed from graded and compacted natural material. Mobile communication technology and fiber optic cabling is present within the development site. There is expansion work currently underway involving the installation of underground cabling and infrastructure to support the new overhead power lines, this is taking place to the north of the development site, along the peripheral of Road 80.

14.3.2.15 Future Development

The area to the north of the development site, currently owned by Al Jouf International Airport, is designated for expansion of the airport. However, there are no expansion plans at present. It is understood that the Saudi Electricity Company (SEC) is also planning develop a 50 MW solar PV power plant to the west of the development site. The specifications of this power plant are currently unknown.

14.3.3 Baseline Survey – Methodology

Existing published information has been used to establish the baseline Socio-Economic conditions. Primary data from the community via stakeholder engagement activities will be collected during subsequent phases of the development as identified in the Stakeholder Engagement Plan (SEP). The SEP identifies the range of people and organizations that may be regarded as stakeholders in the project and describes the strategy to be used for engaging with these stakeholders in a culturally appropriate manner. The results of the stakeholder and public consultation shall be incorporated into the addendum for the ESIA to be submitted for approval prior to construction.

14.4 Assessment Methodology

14.4.1 Approach

The approach to the Socio-economic assessment follows the methodology described in Chapter 5 of this ESIA.

14.4.2 Sensitive Receptors

Potential receptors relevant to the Socio-Economic impact assessment include:

- Al Jouf International Airport to the north of the development site;
- Local towns including settlements along the route of potential transportation routes;
- Local utility infrastructure and providers;
- Construction workforce; and
- Seasonal herders who utilize the wider landscape.

14.5 Impact Assessment

The following section considers and assesses the potential impacts, both negative and positive, that the proposed Sakaka Solar Energy Park may have upon the Socio-Economic factors identified by the baseline. Consideration has been given to impacts associated with the construction, operation and decommissioning phases of the Park. Each aspect has been assessed subjectively in accordance with the methodology outlined in chapter 5.

The Sakaka Solar Energy Park is expected to be implemented over a ten year period. Construction of Phase one of the Park is expected to start in Q2 2018, will take approximately 20 months and will be in operation for 25 years.

14.5.1 Construction Phase

Specific potential impacts on the Socio-Economic environment due to construction activities are summarized in and discussed in the following text. Impacts associated with traffic, utility use, and health and safety of the local community, are addressed in the relevant sections of this ESIA; Section 13 - *Traffic and Transport Infrastructure*, Section 15 - *Utilities Infrastructure and Usage*, and Section 17 - *Health and Safety Aspects* respectively.

Table 14-8: Construction Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE01	Local communities	High	Economic growth during construction phase	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE02	Local communities	High	Increased employment opportunities during construction	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE03	Local communities	High	Education opportunities during construction phase	Effect:	Positive	Moderate	Low
				Action:	Indirect		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Long		
				Extent:	Provincial		
				Permanence:	Irreversible		
SE04	Local infrastructure	Low	Increased pressure on municipal and social services due to increased population from construction workforce	Effect:	Negative	Low	Low
				Action:	Indirect		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE05	Seasonal herders	High	Reduced access to land	Effect:	Negative	High	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE06	Seasonal herders	High	Impact on existing livelihoods	Extent:	Local	High	Moderate
				Permanence:	Irreversible		
				Effect:	Negative		
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		

14.5.1.1 Economic growth during construction phase

The construction phase of the Park is expected to create 16,500 person years of construction work; the majority of which are expected to be expatriates or migrants. It is therefore likely there will be a population increase within the local areas for a short period of time over the construction phase of the Park. While the workers will be housed within a specifically constructed accommodation camp, services will be required for the construction population, including provision of catering, and transportation, which may therefore provide economic opportunities for local and regional businesses, and directly benefit the community both in the income generated, and the residual spending impact to local vendors. However, given the self-contained nature of the construction camp, together with the recreational facilities provided therein, it is not anticipated that an increased demand for services across the whole commercial sector will be realized.

Construction materials will also be required, and while the Project is committed to sourcing materials locally where possible, for the purposes of this impact assessment, it is assumed that the solar PV modules and mounting structures will be manufactured and procured from a supplier based outside the Kingdom of Saudi Arabia. The level of economic growth during this period is therefore considered likely to be relatively low, though it has the opportunity to have direct benefits to the local community.

Impact SE01 – Low Significance

14.5.1.2 Increased employment opportunities during construction

The General Authority for Statistics revealed that of the 497,509 total population in the Al Jouf region, 123,847 were non-Saudi origin. Phase one of the Park is expected to require approximately 2,500 people to construct within the required timeframe. It is anticipated that a significant proportion of these will be expatriates or migrants; therefore the local non-Saudi population is expected to grow by 1-2%. While Saudi Aramco promotes local hire, the nature of the employment during this phase may not see significant numbers of local residents employed. However, in businesses supplying the construction camp, it may be expected that an increase in local employment opportunities will follow growth in these businesses.

Impact SE02 – Low Significance

14.5.1.3 Education opportunities during construction

The construction stage of the Park is unlikely to create impacts related to education; however, offering employment opportunities to the local and provincial population during the construction stage of the Park will help to promote local knowledge of the construction industry. This experience would enable creation of a local/provincial workforce capable of supporting the future construction of other projects within the National Renewable Energy Program as part of the Kingdom of Saudi Arabia's Vision 2030 representing a positive impact to the community.

Impacts SE03 – Low Significance

14.5.1.4 Increased pressure on municipal and social services

The proposed population increase during the construction stage of the Park has the potential to place additional pressure on local municipal and social services, which have not been able to accommodate the rapid population growth of the area. However, the construction population will be temporary and is estimated to be 2,500 persons. The workforce will be housed in a self-contained camp which supplies all municipal services, including waste disposal, and wastewater treatment. Basic first aid facilities will also be made available on site. There may be intermittent demand for medical services in the event of an accident however, the negative impact on existing services is assessed as low.

Impact SE04 – Low Significance

14.5.1.5 Reduced access to land

Baseline studies have identified that there is no evidence of historical land-use or development within the development site itself. However, there is evidence of unauthorized land use both within the development site, and the surrounding area. This includes seasonal herding, the erection of temporary shelters and other non-permitted recreational activities such as camel grazing. Whilst the users of this land are not indigenous peoples (Bedouin), many may be using traditional herding and grazing areas, and reduced access to the land for the activities with no formal authorization may represent a negative impact. Areas around the development site will remain available for use. The stakeholder and public consultation process shall be undertaken during the next phases of the project design, and therefore the impact on the existing users of the land has taken a precautionary approach until results from the consultation are available. Impact on the existing users access to land is therefore considered to be of Moderate Significance.

Impact SE05 – Moderate Significance

14.5.1.6 Impact on existing livelihoods

Baseline studies have indicated there are a variety of land uses within the area representing existing livelihoods. To the north, land use is predominately residential and light commercial. This includes housing, gas stations and forecourt shops, as well as Al Jouf Airport, and Al Jouf University. To the south, nomadic herding, temporary pre-fabricated accommodation and animal pens are the predominant land uses.

It is unlikely that the construction of the Project will have a negative impact on the livelihoods of those receptors to the north of the development. However, there is potential that the Project will have a negative impact on the existing nomadic herding as changes to the fabric of the site may displace these grazers and disrupt a traditional cultural practice. No other displacement of persons is expected as a result of the Project.

The stakeholder and public consultation process shall be undertaken during the next phases of the project design, and therefore the impact on the existing users of the land has taken a precautionary approach until results from the consultation are available. Impact on the existing users loss of livelihood is therefore considered to be of Moderate Significance.

Impact SE06 – Moderate Significance

14.5.2 Operation Phase

The Park will be implemented in Phases over a period of 10 years, with each Phase in operation for 25 years. The operation of the Park requires employment for 300 operations and maintenance jobs.

Specific impacts on the Socio-Economic environment due to operational activities are summarized in Table 14-9 and discussed in the following text.

Table 14-9: Operation Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE07	Local communities	High	Employment opportunities during operation	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		
				Permanence:	Reversible		
SE08	Al Jouf airport	Low	Impact on operational ability and expansion of airport	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Frequent		
				Duration:	Medium		
				Extent:	Provincial		
				Permanence:	Reversible		
SE09	Seasonal herders	High	Impact on existing livelihoods / change to land use	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		

14.5.2.1 Employment opportunities during operation

The operational activities of the Park require the creation of 300 operations and maintenance jobs. It is intended that the 300 staff will be based on site during the operation of the Park, however it is expected the Park will have a low impact on the employment opportunities to the local labor market as an expat workforce will be utilized.

Impact SE07 – Low Significance

14.5.2.2 Impact on operational ability and expansion of Al Jouf Airport

Al Jouf International Airport is located to the north of the development site. The Park has the potential to create a negative impact on the operation of the airport from glint and glare. A Glare Impact Study has been undertaken which concluded no glare occurrence at any of the Federal Aviation Administration's specified receptors, which included the existing Air Traffic Control Tower and the final flight path approaches

Impact SE08 –Low Significance

14.5.2.3 Impact on existing livelihoods / reduced access to land

A security fence will be installed around the perimeter of the Park. This would displace local herders and prevent access to approximately 16.38km² by the completion of the development. Although the grazing value of the land is not considered to be high, the permanent displacement of transient populations from the development site will result in a negative impact.

The stakeholder and public consultation process shall be undertaken during the next phases of the Park design, and therefore the impact on the existing users of the land and associated loss of livelihood has taken a precautionary approach until results from the consultation are available. Impact on the existing users is therefore considered to be of Moderate Significance.

Impact SE09 – Moderate Significance

14.5.3 Decommissioning Phase

The decommissioning of the Park following 25 years of operation is likely to involve the removal of the solar PV modules and reinstatement of the site.

The specific impacts on the Socio-Economic environment due to these decommissioning activities are summarized in Table 14-10 and discussed in the following text:

Table 14-10: Decommissioning Phase Impacts Assessment

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
SE10	Al Jouf power plant	Low	Pressure on utilities and services during demolition due to reduction in energy production from solar plant	Effect:	Negative	Moderate	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Provincial		

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
				Permanence:	Reversible		
SE11	Operational workforce	Moderate	Loss of employment opportunities	Effect:	Negative	Low	Low / Negligible
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		
SE12	Seasonal herders	High	Change of land use – opening up land so that it is available for use	Effect:	Positive	Moderate	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		

14.5.3.1 Pressure on utilities and services during demolition

During decommissioning of the Park, the Al Jouf power plant will be required to accommodate the increased demand for energy following the removal of local solar energy production. This is likely to result in a negative impact on the local utilities and services to compensate for the decommissioning of 1 GW solar PV power plant. However, it is understood that the Saudi Electricity Company is also planning on developing a 50 MW solar PV power plant to the west of the development site. While the specifications of this power plant are currently unknown, it is likely to reduce the pressure on existing utilities and services.

Impact SE10 – Low Significance

14.5.3.2 Loss of employment opportunities

During decommissioning there will be a loss of employment opportunities. However, the scale of potential redundancies to the local labor market is assessed to be low on the basis that the site will be operated by an expatriate workforce.

Impact SE11 – Low Significance

14.5.3.3 Change of land use

The decommissioning of the Park and restoration of the development site will involve the removal of the perimeter security fence. This will open up access to the site which was previously closed. This would represent a positive impact to the local herders that utilize the wider landscape.

Impact SE12 – Low Significance

14.6 Mitigation

Implementation of mitigation measures will be required during construction, operation and decommissioning of the Park to minimize potential negative impacts of the activities. The mitigation measures comprise primarily of management procedures and are described in the subsequent sections. The following text assesses the impacts predicted as being of moderate to high significance against appropriate mitigation measures and establishes the residual impact significance.

In accordance with the methodology outlined by Chapter 5 – Impact Assessment Methodology, where appropriate, consideration has been given to the Equator Principles and IFC Performance Standards, which are applicable to Socio-Economic factors, during the development of proposed mitigation measures.

14.6.1 Construction Phase

Table 14-11 provides a summary of the potential Socio-Economic impacts associated with the Sakaka Solar Energy Park, the mitigation proposed to lower the residual impacts and the significance following mitigation to confirm this.

Table 14-11: Construction Socio-Economic Impact and Mitigation Summary

ID	Impact	Potential Significance	Mitigation Measures	Residual Significance
SE05	Reduced access to land	Moderate	Contractor will minimize the area of land required for use during construction where possible. IPP will provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites.	Low
SE06	Impacts on existing livelihoods	Moderate	Contractor will minimize the area of land required for use during construction where possible. IPP will provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites. Where alternative sites cannot be identified and temporary loss of livelihood (or income) may result, compensation for the loss shall be identified and provided in accordance with IFC performance standard 5 and developed, documented and implemented through the use of a Livelihood Restoration Plan.	Low

14.6.1.1 Construction recommendations

The Contractor will be encouraged to make job opportunities during construction available to the local workforce, and promote engagement of the local population in the construction phase.

The IPP may consider the provision of training during the construction phase, to increase local knowledge of the construction industry and in particular at the Al Jouf University to advance training in skills required for construction and operation of renewable energy projects.

The Contractor will consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population.

Livelihood restoration plans should be developed in advance of construction following consultation with relevant stakeholders and community users to ensure the Implementation of IFC Performance Standard 5. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

14.6.2 Operation Phase

Table 14-12 below provides a summary of the Socio-Economic impacts associated with the operational phase of the Project, the mitigation proposed to lower the residual impacts and the significance following mitigation.

Table 14-12: Operation Socio-Economic Impact and Mitigation Summary

ID	Impact	Potential Significance	Mitigation Measures	Residual Significance
SE08	Impact on Al Jouf Airport	Moderate	The General Authority for Civil Aviation (GACA) and the Ministry of Defense will be consulted to determine the risk from the Park on aircraft. Consultation will be undertaken in accordance with the Stakeholder Engagement Plan. The GACA has issued a No Objection letter in principle and this objection will be reviewed as the design of the Park progresses.	Low / Negligible
SE09	Impact on existing livelihoods / reduced access to land	Moderate	The impact of the development on local herders and intangible cultural heritage will be managed through the implementation of the Stakeholder Engagement Plan. The IPP will maintain links with this Affected Community, respond to concerns and provide guidance and assistance regarding use of alternative sites. Where alternative sites cannot be identified and temporary loss of livelihood (or income) may result, compensation for the loss shall be identified and provided in accordance with IFC performance standard 5 and developed, documented and implemented through the use of a Livelihood Restoration Plan. However it is anticipated that seasonal holding pens and camps within the developable area can be relocated outside of the Park without any significant impact on	Low

ID	Impact	Potential Significance	Mitigation Measures	Residual Significance
			livelihoods.	

14.6.2.1 Operation recommendations

The Park is not anticipated to result in any significant beneficial Socio-Economic impacts due to the intention for remote operation with no permanent workers based on site. Therefore, through the implementation of the following recommendations it is expected that the community will benefit from the operation of the Park.

The project proponent should establish a number of Key Performance Indicators (KPIs) to monitor the success of proposed mitigation and the creation of anticipated benefits by the Park.

The project proponent should establish social performance criteria for their suppliers, to promote the maximization of local sourcing of materials, local employment, and implementation of sound sustainable business practices. The IPP should establish its supply chain, and enter into a period of supply chain management and engagement to drive value to the community through its supply chain.

The project proponent should consider establishing a training program for local students. This proactive approach will demonstrate the project proponent's commitment to local employment and training.

The project proponent will continue stakeholder and public engagement in accordance with the Stakeholder Engagement Plan.

Livelihood restoration plans, if determined necessary, should be developed in advance of construction following consultation with relevant stakeholders and community users to ensure the Implementation of IFC Performance Standard 5. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

14.6.3 Decommissioning Phase

The impacts identified in the decommissioning phase have been assessed as being of low significance. As such no residual impacts are anticipated; however the following recommendations should be taken into consideration.

14.6.3.1 Decommissioning recommendations

While the change in land use resulting from the closure of the Park opening up the area to seasonal herders is considered of low significance, the project proponent should provide on-going community engagement to address any concerns the community may have following the closure of the Park.

While the loss of employment resulting from the closure of the Park is considered of low significance, they nonetheless represent a considerable change for the individuals affected. Therefore, the project proponent should implement a proactive succession planning program in advance of closure to identify alternative roles. This will provide security for employees and reduce the skills and experience loss from closure of the Park.

14.7 Conclusion

This Socio-Economic assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available especially following stakeholder and public consultation, the Socio-Economic impact assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

A number of positive impacts during construction have been identified and recommendations have been identified to help maximize the economic, employment and education opportunities. Mitigation measures have been suggested to reduce negative impacts on existing livelihoods and reduced access to land, including on-going community engagement and providing guidance and assistance regarding use of alternative sites.

A number of negative impacts during operation have been identified due to the remote workforce not directly benefitting the community and potential impacts to surrounding Affected Communities due to displacement. Mitigation has been identified with an emphasis on stakeholder engagement as per the Stakeholder Engagement Plan to reduce these impacts to a level where they are not significant.

15. Utilities Infrastructure and Usage

15.1 Introduction

This chapter outlines the existing utilities infrastructure and usage relevant to the Sakaka Solar Energy Park, and describes the utility requirements for the Park, in order to identify and characterize impacts on the capacity of any existing utilities. The chapter describes services supply systems on a national, regional and local level based on utilities present in the area including: electricity provision, telecommunication services, water supply and wastewater management. The impact on waste facilities is discussed in Chapter 16 – *Waste Management*; the existing transport infrastructure is addressed in the Chapter 13 – *Traffic and Transport Infrastructure*.

The assessment of impacts related to utilities and infrastructure has been carried out utilizing the standard methodology outlined in chapter 5 - *Impact Assessment Methodology*.

15.2 International and National Standards and Guidance

15.2.1 IFC General EHS Guidelines

Section 1.3 Wastewater and Ambient Water Quality of the IFC EHS Guidelines (2007) applies to projects that have either direct or indirect discharge of process wastewater, wastewater, wastewater from utility operations or storm water to the environment; and includes measures for water conservation and reuse. The standard states that projects with the potential to generate process wastewater, sanitary (domestic) sewage, or storm water should incorporate the necessary precautions to avoid, minimize, and control adverse impacts to human health, safety or the environment.

The EHS Guidelines also cover occupational health and safety issues, including waste water treatment operations. Sanitary waste from the Park will be treated and disposed using a licensed waste water treatment facility.

Section 1.3 states that discharges of industrial wastewater, sanitary wastewater, wastewater from utility operations or storm water into public or private wastewater treatment systems should:

- Meet the pretreatment and monitoring requirements of the sewer treatment system into which it discharges;
- Not interfere, directly or indirectly, with the operation and maintenance of the collection and treatment systems, or pose a risk to worker health and safety, or adversely impact characteristics of residuals from wastewater treatment operations; and,
- Be discharged into municipal or centralized wastewater treatment systems that have adequate capacity to meet local regulatory requirements for treatment of wastewater generated from the project. Pretreatment of wastewater to meet regulatory requirements before discharge from the project site is required if the municipal or centralized wastewater treatment system receiving wastewater from the project does not have adequate capacity to maintain regulatory compliance.

15.2.2 IFC EHS Guidelines for Water and Sanitation

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP). The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs.

The EHS Guidelines for Water and Sanitation include information relevant to the operation and maintenance of:

- potable water treatment and distribution systems; and,
- collection of sewage in centralized systems (such as piped sewer collection networks) or decentralized systems (such as septic tanks subsequently serviced by pump trucks) and treatment of collected sewage at centralized facilities.

15.2.3 National Legislation

GAME has developed wastewater discharge standards for the Kingdom of Saudi Arabia, developed to control the quality of direct discharges from facilities and persons operating in the Kingdom. These standards are designed to contribute towards meeting the Kingdom's ambient water quality objectives. These standards utilize use-related criteria and specify limits on individual discharges designed to protect those uses.

The quality standards set out in Table 15-1 apply to discharges to a Central Treatment Works (CTW) or shared sewerage system. These standards shall not be exceeded without specific authorization from the operator of the CTW.

Table 15-1 : GAME Standards for Disposal to Municipal Collection System

Parameter	Units	Municipal Collecting System
Coarse material		
Temperature	Δ °C (from ambient)	45
pH	pH units	5-10
TDS	mg/l	3000*
Turbidity	NTU	
TSS	mg/l	600
BOD5	mg/l	500
COD	mg/l	1000
Total Oil & Grease ¹	mg/l	100
TKN (organic N)	mg/l	120
TOC	mg/l	1000
Phosphorus (total)	mg/l	50
Phosphate (PO ₄) ³⁻	mg/l	n/a
Ammonia (as NH ₃)	mg/l	40
Chloride (as Cl)	mg/l	
Total inorganic nitrogen(as (NO ₂ and NO ₃))	mg/l	n/a
Sodium	mg/l	1000

Parameter	Units	Municipal Collecting System
Sulfate	mg/l	500
Sulfide	mg/l	10

15.3 Baseline Environmental Conditions

15.3.1 Power

Electricity for the Kingdom of Saudi Arabia (KSA) is provided by Saudi Electricity Company (SEC). SEC was formed as a result of the merger of all existing electricity providers in April 2000. According to the latest available data, SEC generated 207,022 GWH of energy, and imported 97,218 GWH, for a total of 304,240 GWH pumped into the power generation network of the Kingdom of Saudi Arabia in 2014 (SEC,2014).

15.3.1.1 Al Jouf Power Plant

The Al Jouf Power Plant is owned and operated by Saudi Electrical Company (Figure 15-1). The plant has an installed capacity of 382 MW and an average thermal efficiency of 25.8% the power plant is estimated to consume 1,555 MBOE (thousand barrels of oil equivalent) per annum. The Power Plant is located approximately 2.7km north-west of the development site, adjacent to Road 80.



Figure 15-1: Al Jouf Power Plant

15.3.1.2 Al Jouf Bulk Plant

Al Jouf Bulk Plant is owned and operated by Saudi Aramco, and is located approximately 13km north-east of the development site, along Road 80. This bulk plant is used for the storage and distribution of gasoline. Figure 15-2 shows Al Jouf Bulk Plant.



Figure 15-2: Al Jouf Bulk Plant

15.3.1.3 Power Transmission Infrastructure

Power transmission infrastructure is found within the Study Area running from east to west along the northern perimeter of the development site and continuing north to south to the west of the development site. This infrastructure consists of two 132kV (east to west), one 13.8kV and one 380kV (north to south) overhead power lines which are shown in Figure 15-3, these lines supply electricity from the Power Plant at Al Jouf to Sakaka and its peripheral settlements.



Figure 15-3: 132kV (left of image) and 13.8 kV (right of image) Power Transmission Lines

15.3.2 Telecommunication

Telecommunications in the Kingdom of Saudi Arabia are provided by Saudi Telecommunications Company. Fixed telephone lines stood at 3.7 million at the end of 2015. Mobile communications within the Kingdom of Saudi Arabia are provided by four main suppliers;

- Bravo,
- Mobily,
- STC, and;
- Zain

Mobile carriers are regulated by the Communication and Information Technology Commission. The total number of mobile subscriptions grew to around 53.1 million at the end of 2012, with a penetration rate of 186%. Prepaid subscriptions constitute the majority (over 87%) of all mobile subscriptions (CITC 2012). No underground cables are known to be present at the development site, either over or under the ground, and there are no mobile masts in close proximity to the development site. Mobile coverage across the development site is good.

15.3.3 Water Supply

Water is supplied in the Kingdom of Saudi Arabia by the National Water Company. An existing municipal supply is located to the north of the development site, adjacent to Road 80.

15.3.3.1 Wastewater Collection and Treatment

There are currently two existing waste water treatment plants in Al Jouf Province, with a combined capacity of 38,000m³/day. Two plants are currently under construction, with a further capacity of 57,500m³/day, and one additional plant is planned for construction in the future, with a capacity of 22,000m³/day. (Tandfonline, 2015).

15.3.4 Baseline Survey - Methodology

A field walkover survey was carried out to confirm the findings of the desk based investigation and identify any additional infrastructure not picked up during the desktop review.

15.3.5 Receptor Identification

The existing utilities and infrastructure within and adjacent to the development site are listed in Table 15-2 and Figure 15-4 and are described further in the following sections.

Table 15-2: Utilities and Infrastructure Receptors

Aspect	Northing	Easting
Saudi Aramco Bulk Plant	29°49'49.10"N	40°10'32.66"E
Saudi Electricity Company (SEC) Power Plant	29°46'32.11"N	40° 0'42.68"E
Saudi Electricity Company (SEC) Sub Station	29°46'48.21"N	40° 0'1.31"E
SEC Transmission Lines	East-West orientation, north of development site	
Water Main Installation adjacent to Road 80	29°46'39.46"N	40° 2'15.14"E

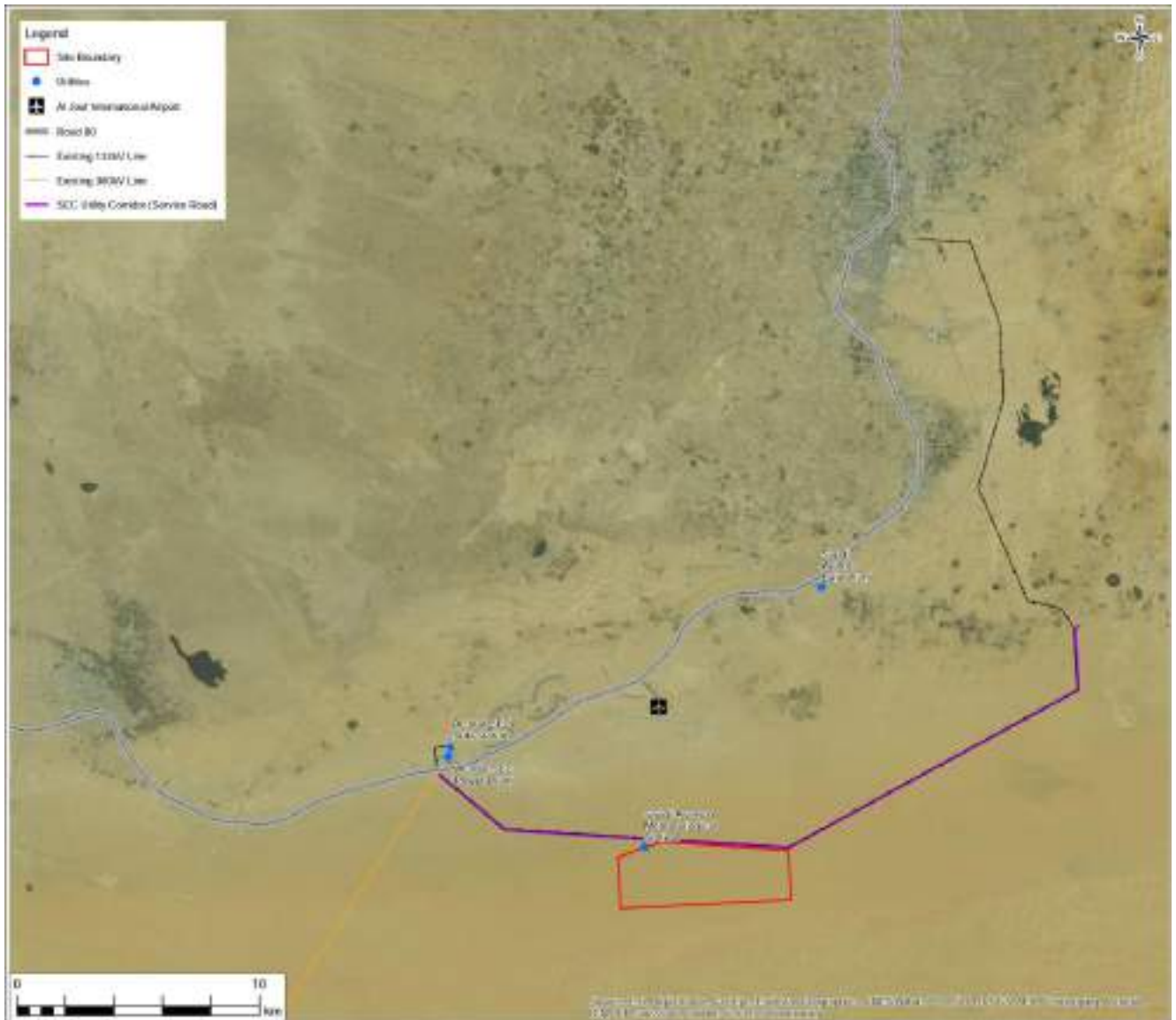


Figure 15-4: Utilities and Infrastructure Receptors

15.3.6 Baseline Survey - Results

The results of the desk based survey were confirmed, and no additional infrastructure was identified. At this stage, stakeholder consultation has not identified any additional utility infrastructure and it has not been possible to verify the capacity of existing utility supplies. Stakeholder consultation undertaken by the IPP during the next stage of development will identify the capacity of existing supplies and infrastructure.

15.4 Assessment Methodology

15.4.1 Approach

The assessment of impacts was carried out according to the standard methodology described in chapter 5: *Impact Assessment Methodology*.

Note that the assessment below is of the impact on existing utilities infrastructure where it exists only; potential impacts on subjects such as air quality, noise or on the proposed transport infrastructure are addressed in the relevant sections of this ESIA.

15.5 Impact Assessment

15.5.1 Construction Phase

Potential impacts upon utilities and utility infrastructure expected to arise during the construction phase of the Park are summarized in Table 15-3

15.5.1.1 Power

Power at the construction camp will be provided by four 500kw generators running for 720 hours per month each. Based on an average consumption of 33 gallons of diesel fuel per 24 hour day, this equates to an average monthly running utilization of 1000 gallons per generator per month. These figures are based on conservative estimates of fuel utilization and do not account for summer cooling of buildings and other uses which may place additional demand upon the generators.

15.5.1.2 Telecommunications

A temporary connection will be made to the existing telecommunications network for the duration of the Park, from construction, to decommissioning. Due to the anticipated infrequent use of this system, it is not anticipated that any impacts upon the existing network will arise as a result of the introduction of the Park.

15.5.1.3 Potable Water

Bottled potable water will be supplied for the construction phase of the Park.

15.5.1.4 Non Potable Water

The estimated requirement of the construction workforce is based on an average per person per day water usage of 0.325m³. The construction workforce is expected to comprise of approximately 2,500 persons, and therefore, the daily water requirement for the construction camp is expected to be approximately 810m³.

Water used for dust damping, and other construction activities will be supplied via connection to municipal water supply adjacent to Road 80 the town of Sakaka. Water supplied will be in compliance with the requirements of SAES-A-104 - *Wastewater Treatment, Reuse and Disposal* and all relevant Saudi Aramco Sanitary Codes.

All water storage and discharge systems to be used during the construction phase of the Park will be designed with reference to IFC EHS Guidelines: Environmental 1.3 *Wastewater and Ambient Water Quality*.

15.5.1.5 Wastewater Collection and Treatment

Wastewater will be stored on site and collected by tankers for disposal at local wastewater treatment plants. It is anticipated that septic and wastewater tanks will be emptied daily during the construction phase.

Sanitary waste is expected to be generated at a rate of 0.325m³ per person per day as defined in Table 4 of the Saudi Aramco Engineering Standard SAES-A-104. It is anticipated therefore that 97.5m³ of sanitary waste will be generated on site each day.

Sanitary waste will be stored in underground tanks in designated storage areas and disposed of through a closed system. Detailed design of these storage areas and this system will be undertaken during the next phase of the development and will be compliant with IFC EHS Guidelines 1.3 *Wastewater and Ambient Water Quality*.

Table 15-3: Construction Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
UI1	Supply Infrastructure	Moderate	Disruption or overloading of the Supply Infrastructure	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low

15.5.1.6 Disruption or overloading of the supply infrastructure

Stakeholder consultation with the Amana and local utility providers has not yet been approved by the Ministry of Energy, Industry and Mineral Resources (MEIM), and an understanding of utility supplies and networks remains undeveloped. However the construction phase workforce for each phase (i.e. 2,500 workers) represents only 0.5% of the population within Al Jouf Province and is not considered a significant increase on a temporary basis. Until consultation with the Amana and utility providers has been undertaken, it has reasonably been assumed that capacity is available within the municipal supply to accommodate the utility requirements of the Park and the significance of this impact is assessed as low.

Impact UI1 – Low Significance

15.5.2 Operation Phase

15.5.2.1 Power

Power for the operation of the office buildings and developer compounds at the Park shall be supplied through a grid connection with the SEC Power Plant. Due to the minimal amount of power required to operate the developer compounds, it is not anticipated that any impact upon the existing power infrastructure will be experienced as a result of the introduction of the Park. The Saudi Electrical Company (SEC) has been consulted with regard to the power requirements for the operational phase to assess demand and capacity to supply. The result of this consultation was positive and confirmed that no impact would be expected as a result of the introduction of the Park during the construction phase.

15.5.2.2 Telecommunications

Temporary telecommunication facilities will be installed at the development site office. A temporary extension of telephone connection from the existing telecommunication facility including Telephone sets and associated cabling shall be installed. Due to the infrequent use expected of this system, no impact upon existing infrastructure is expected.

15.5.2.3 Potable Water

Bottled water will be provided at the development site for drinking purposes. Therefore, there will be no impact upon existing municipal water supplies expected to arise as a result of the Park.

15.5.2.4 Non Potable Water

Non potable water will be supplied to the Park via a connection to existing municipal supply adjacent to Road 80. It is assumed that existing municipal water facilities have capacity to absorb this increased usage. Based on this assumption no impact is predicted.

15.5.2.5 Wastewater Collection and Treatment

Wastewater will be stored on site in septic tanks, and removed via tanker to be disposed of at a licensed wastewater treatment plant. Due to the low number of on-site staff required during the operation phase of the Park, it is not expected that a significant quantity of waste water will be generated. Therefore, no significant impact upon existing wastewater collection and treatment is expected to arise as a result of the Park.

Table 15-4: Operation Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
UI2	Supply Infrastructure	Moderate	Disruption or overloading of the Supply Infrastructure	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Continuous Duration: Short Extent: Local Permanence: Reversible	Low	Low
UI3	Supply Infrastructure	Moderate	Reduction of pressure on existing infrastructure	Effect: Positive Action: Direct Likelihood: Certain Frequency: Continuous Duration: Medium Extent: Local Permanence: Reversible	Moderate	Moderate

15.5.2.6 Disruption or overloading of the supply infrastructure

The operational workforce is expected to be 300 personnel. The additional demands on the utility infrastructure associated with this workforce is considered negligible, and impacts upon existing infrastructure are expected to be of low significance.

Impact UI2 – Low Significance

15.5.2.7 Reduction of pressure on existing infrastructure

The introduction of the Sakaka Solar Energy Park will reduce the operational requirements of the SEC Power Plant at Al Jouf by displacing 4,600 MBOE of oil. This will have a positive effect on the Power Plant and its associated infrastructure.

Impact UI3 - Moderate Significance

15.5.3 Decommissioning Phase

During the decommissioning of the Park, impacts experienced are expected to be identical to those experienced during the construction of the Park. See section 15.5.1 for details.

15.6 Mitigation

No significant impacts during the construction, commissioning and operational phase were identified therefore, no specific mitigation is proposed. It is however recommended that the utilization of utilities (e.g. water, power) is monitored during each phase of the project to develop an understanding of utilization and enable the implementation of continuous improvement measures to reduce consumption. The implementation of such measures will contribute towards the objectives of IFC Performance Standard 3 and resource efficiency.

15.7 Conclusion

No significant impacts upon existing utilities and infrastructure are expected to occur as a result of the construction, operation of decommissioning of the Sakaka Solar Energy Park.

This Utilities and Infrastructure assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

15.8 References

Tandfonline (2015), *Treated wastewater use in Saudi Arabia: challenges and initiatives* [Available Online] at: <http://www.tandfonline.com/doi/full/10.1080/07900627.2015.1116435>

16. Waste Management

16.1 Introduction

This chapter provides an overview of the waste management facilities available during the construction, operation and decommissioning of the Sakaka Solar Energy Park (The Park), and an evaluation and assessment of the potential impacts upon them which may arise as a result of the development of the Park.

16.2 International and National Standards and Guidance

16.2.1 International Conventions

16.2.1.1 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted internationally on 22 March 1989. The Kingdom of Saudi Arabia ratified the Convention in 1990.

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Its scope of application covers a wide range of wastes defined as “hazardous wastes” based on their origin and/or composition and their characteristics, as well as two types of wastes defined as “other wastes” - household waste and incinerator ash (www.basel.int).

The provisions of the Convention center around the following principal aims:

- the reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, wherever the place of disposal;
- the restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management; and
- a regulatory system applying to cases where transboundary movements are permissible (www.basel.int).

This Convention is relevant to the disposal of decommissioned solar panel modules which contain hazardous materials.

16.2.2 IFC EHS Guidelines

Sections 1.5 Hazardous Materials Management and 1.6 Waste Management of the IFC EHS Guidelines (2007), apply to projects which generate, store or handle any quantity of waste, including hazardous waste. The main objectives of the guidelines are the protection of the workforce and the prevention and control of releases and accidents.

The guidelines state that facilities that generate and store wastes should practice the following:

- Establishing waste management priorities at the outset of activities based on an understanding of potential Environmental, Health, and Safety (EHS) risks and impacts and considering waste generation and its consequences;

- Establishing a waste management hierarchy that considers prevention, reduction, reuse, recovery, recycling, removal and finally disposal of wastes;
- Avoiding or minimizing the generation waste materials, as far as practicable;
- Where waste generation cannot be avoided but has been minimized, recovering and reusing waste; and,
- Where waste cannot be recovered or reused, treating, destroying, and disposing of it in an environmentally sound manner.

Section 1.6 Waste Management states that waste management should be addressed through a waste management system that addresses issues linked to waste minimization, generation, transport, disposal and monitoring.

The treatment and disposal of waste should only be undertaken by qualified commercial or government-owned waste vendors.

16.2.3 Performance Standard 3 Resource Efficiency and Pollution Prevention

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. Resource efficiency is the central tenant of this standard, and implementing technical and financially feasible and cost effective measures for improving efficiency in consumption of energy, water as well as other resources and material inputs (IFC, 2012).

The standard provides guidelines for the management of wastes and hazardous material management. It states that the projects will avoid the generation of hazardous and non-hazardous waste materials. Where waste generation cannot be avoided, the client will reduce the generation of waste, and recover and reuse waste in a manner that is safe for human health and the environment. Where waste cannot be recovered or reused, the client will treat, destroy, or dispose of it in an environmentally sound manner that includes the appropriate control of emissions and residues resulting from the handling and processing of the waste material. If the generated waste is considered hazardous, the client will adopt GIIP alternatives for its environmentally sound disposal while adhering to the limitations applicable to its transboundary movement IFC, 2012).

16.2.4 National Legislation

The GAME has a series of Environmental Standards that cover the management of waste materials, specifically those relating to Waste Acceptance, Waste Classification, Waste Control, Waste Handling & Storage and Waste Transportation.

The Waste Acceptance Standard (Environmental Standard 8) requires waste producers to undertake an audit of their waste in order to establish the characteristics and appropriate disposal routes for the wastes. All hazardous wastes destined for landfill should be subjected to treatment to allow the waste to meet the waste acceptance criteria for hazardous waste landfills. In the case of non-hazardous wastes an evaluation of the treatment options should be made. However, the evaluation of treatment options is not required if the treatment would not reduce the quantity of the waste or any hazards that it may pose to human health or the environment. Operators of landfills are required to undertake compliance testing on waste materials to ensure that they comply with the Waste Acceptance Criteria for the landfill.

The Standard Waste Control (Environmental Standard 12) establishes a framework for the management and transport of wastes within KSA, which includes:

- i. the assignment of a Duty of Care to Waste Handlers;
- ii. tracking systems, which provide information to assist agencies and emergency services and ensure wastes are directed to appropriate facilities;
- iii. prior notification systems for hazardous waste activities, which provide participating Enforcing Authorities with access to information to assess the appropriateness of proposed movements of hazardous wastes in terms of facility selection;
- iv. systems for registering Waste Transporters and the regulation of Generators and TSD facilities so that tracking and notification functions are compatible throughout KSA; and
- v. a waste licensing regime for storage, treatment and disposal facilities so that a uniform method of waste control is adopted throughout KSA and site operators are accountable for their waste activities.

The Waste Handling & Storage Standard (Environmental Standard 13) outlines good practice for the storage and handling of wastes and is applicable to all waste handlers from waste generators and its onward transfer for recycling, treatment or disposal.

The Waste Transportation Standard (Environmental Standard 15) provides vehicle specifications required for safe transportation of waste and the requirements for labelling (including international standards and trans-frontier movements) though these labelling requirements do not supersede the waste classifications. Standard 13 considers transportation of wastes by road, rail and sea, but does not extend to radioactive wastes or explosives or the on-site transportation of wastes.

The Standard on the Design and Operation of Landfills (Environmental Standard 16) outlines the three classifications of landfill, three types of landfill; Class I, Class II and Class III for hazardous, non-hazardous and inert materials. It provides the design requirements that should be followed in the development and operation of a landfill facility.

16.2.5 Saudi Aramco Guidelines

Saudi Aramco Engineering Procedure (SAEP)-1661 Waste Minimization Assessments formalizes Saudi Aramco's waste minimization mandate. The document describes the procedures for the implementation of a waste minimization assessment (WMA) to:

- encourage and assist facilities in applying waste minimization initiatives;
- provide guidance in understanding and meeting Saudi Aramco waste minimization goals;
- provide guidance on conducting Waste Minimization Assessments;
- minimize the environmental impact of waste generated from Company operations; and
- Promote cost effective waste minimization through source reduction, reuse and recycling.

A WMA is typically undertaken at least three years after the commissioning of a facility.

Saudi Aramco Sanitary Code (SASC) Section 3 – Solid Waste Management, provides guidance on storage, management and disposal of waste. It is a Saudi Aramco requirement that all wastes will be manifested in SAP EH&S Waste Management module and will be collected for disposal by an approved waste management contractor, to be selected and appointed prior to commencement of operations.

The Saudi Aramco Hazardous Waste Code (SAHWC) (GI-0430-001) outlines all requirements for storage, handling, transportation, and tracking of hazardous waste. Storage in containers requires leak control or secondary containment. Hazardous waste can be stored at a rig location for a maximum of 90 days, and will be segregated and stored appropriately as per the SAHWC. A record of accumulated hazardous waste shall be recorded and maintained at the rig. Containers that hold hazardous waste must be inspected weekly. Tanks must be visually inspected for leaks on a daily basis.

All wastes are required to be disposed in landfill in accordance with SAES-S-007.

16.3 Baseline Environmental Conditions

16.3.1 Baseline Review

16.3.1.1 National Context

The Kingdom of Saudi Arabia has experienced rapid industrialization, urbanization, and high population growth all of which have cumulatively resulted in increased generation of waste. The Ninth Development Plan notes that population growth over the last 40 years has increased pressures on the environment, and goes on to identify that environmental pollutants generated by human activity, most notably solid and liquid waste, have increased in recent years (Ministry of Economy and Planning, 2009a).

The World Bank average waste generation per capita (kg/capita/day) for the Middle East is 1.1kg/cap/day (World Bank, 2012). The World Bank predicts that in the Kingdom of Saudi Arabia, per capita waste generation will be 1.7 kilograms per day by 2025, resulting in a total of 50,424 tonnes per day of municipal solid waste (World Bank 2012).

Municipal solid waste in the Kingdom of Saudi Arabia is currently collected by the local municipality and taken to landfill sites. A number of waste management companies operate within the Kingdom of Saudi Arabia, collecting commercial and industrial wastes under contract.

Management of the increasing amount of solid waste is an ongoing problem in the Kingdom of Saudi Arabia. According to the Presidency of Meteorology and Environment, the proper management of waste is prevented by the following factors:

- Absence of institutional infrastructure capable of planning, regulating, and implementing an integrated waste management system.
- Lack of capacity for waste collection and transport.
- Operational problems, including inadequate maintenance capabilities;
- Lack of qualified and trained technical staff for management and operation, coupled with low pay;
- Shortfall in financing;
- Lack of public landfill spaces that adhere to environmental regulations;
- Lack of legal and regulatory system to facilitate integrated waste management; and
- Low-level public awareness regarding the issues surrounding solid waste.

Initiatives are underway in the Kingdom of Saudi Arabia to reduce greenhouse gas emissions in solid waste management. These include landfill gas collection, the development of flaring systems and

transformation of waste materials to organic fuels. The strategic plans for major cities have adopted the concept of waste minimization. The strategic plan for Jeddah which was initiated in 2005 emphasized waste management programs, in order to reduce landfill requirements by waste reduction technologies including composting. The key projects included in this initiative are the Jeddah Oil Landfill, Jeddah New Landfill and the Jeddah Municipality recycling initiative (Third National Communication, 2016).

In 2012, more than 40 recycling companies were working at different levels and with different types of waste in the Kingdom of Saudi Arabia (Alameer, 2014). In 2012, Exitcom concluded a contract with International Computer Company (ICC) to build the first e-scrap recycling plant in Saudi Arabia. E-Scrap is comprised of electronic waste components such as computer parts and other circuitry. It is estimated that Saudi Arabia produces more than 3 million tonnes of e-scrap per annum. Company level initiatives have also been introduced in recent years, Saudi Aramco recycled approximately, 960 tons of paper and carton in 2013 (Saudi Aramco, 2013).

The GAME distinguishes three physical forms of waste; liquid waste, solid waste and sludge, and characterizes these as hazardous waste, non-hazardous waste and inert waste. The following sections identify the wastes anticipated to be generated as a result of the Park.

16.3.1.2 Local Context

16.3.1.2.1 Waste Management Facilities within Al Jouf Province

There is a landfill site located at the eastern periphery of Sakaka. It is assumed that this facility will be used in order to dispose of waste generated at the development site. It is also assumed that there is sufficient capacity at this facility to absorb the additional waste expected to be generated as a result of the Park.

GEMS also operate a waste management plant within Jouf Province.

Ongoing stakeholder consultation is to be carried out during the next phases of the development. Through this, detailed locations and capacities of waste handling facilities in the vicinity of the development site will be confirmed.

As more details become available, the baseline description of waste management facilities will have to be re-visited with any updates reported in an Addendum to this ESIA.

16.3.1.2.2 Fly Tipping

Roadside tipping and unlicensed disposal of wastes is common throughout the Kingdom of Saudi Arabia. Figure 16-1 shows unlicensed fly tipping found in the vicinity of the development site.



Figure 16-1: Unlicensed Roadside Fly Tipping Near Sakaka

16.3.2 Project Details

16.3.2.1 Construction Phase

The estimated workforce during the construction phase is approximately 2,500. Construction work hours will typically be 10 hours/day for 6 days/week with a total of approximately 240 hours/month (5 week month).

Phase one of the Park will be constructed over a time period of 20 months. During this period, the following activities will take place;

- Site preparation,
- Installation of temporary facilities;
- Allocation of work and laydown areas;
- Installation of concrete foundations;
- Construction of mounting structures and installation of solar panels;
- Link up to existing power generation infrastructure; and,
- Civil and structural activities including the construction of new foundations.

16.3.2.1.1 Waste expected to be generated

During the construction phase of the Park, a number of different types of waste will be generated. These will include non-hazardous construction wastes such as packaging and general refuse,

hazardous wastes such as paints and lubricants and liquid wastes such as sanitary waste from the construction camp.

It is anticipated that packaging from the solar panels, will form a significant contribution to the waste generated at the development site during the construction phase of the Park, and this will require its own specialized management plan.

Table 16-1 shows wastes anticipated to be generated during the construction phase of the development.

Table 16-1: Anticipated Construction Wastes

Phase	Activity	Waste Generated	Anticipated Approximate Quantity Generated During 20 Month Construction Period
Construction	Installation of Solar Panels	Solar Panel Packaging	126,000m ³
Construction	Normal Operation of Construction Camp	Sanitary Waste	494,000m ³
Construction	Normal Operation of Construction Camp	Domestic Waste (office consumables etc.)	1,672,000 kg
Construction	Construction of Sakaka Solar Energy Park	General non-hazardous construction wastes including drums, cabling, damaged	18,000 kg
Construction	Construction of Sakaka Solar Energy Park	General hazardous construction wastes including damaged solar modules, excess asphalt, empty paint tins	19,000 kg

16.3.2.2 Operational Phase

During the operation phase of the Park a workforce of approximately 300 workers is expected to be employed. The workforce will be responsible for maintenance of the Park, the replacement of expired modules and management of site cleaning and maintenance.

16.3.2.2.1 Waste expected to be generated

During the operational phase of the Park, very little waste will be generated; this is due to the low number of operational staff required on site. The most significant waste will be domestic waste from the office buildings at the Park, and a small amount of sanitary waste which will be stored on site in septic tanks and emptied daily.

Table 16-2 shows wastes anticipated to be generated during the operational phase of the Park.

Table 16-2: Anticipated Operational Wastes

Phase	Activity	Waste Generated	Anticipated Approximate Quantity
Operation	Normal Operation of Contractors Offices	Sanitary Waste	97.5m ³ per day
Operation	Normal Operation of Contractors Offices	Domestic Waste	330kg per day
Operation	Maintenance of Solar modules	Expired panels/modules	10 modules per week

16.3.2.3 Decommissioning Phase

During the decommissioning phase of the Park, the majority of waste generated will comprise the physical structure of the Park, including solar panels, broken up concrete and other decommissioning wastes.

16.3.2.3.1 Waste expected to be generated

The decommissioning phase of the Park will generate similar wastes to those expected to arise during the construction phase of the Park. The disposal of solar panels will be the responsibility of the Independent Power Producer (IPP) and will require a specific management and coordination plan.

Table 16-3 shows wastes anticipated to be generated during the decommissioning phase of the development.

Table 16-3: Anticipated Decommissioning Wastes

Phase	Activity	Waste Generated	Anticipated Approximate Quantity
Decommissioning	Removal of Solar Modules	Solar Modules	2,908,800 no.
Decommissioning	Removal of Solar Module Mounting Structures	Stainless Steel Mounting Structures	129,000 no.
Decommissioning	Breaking up of concrete solar panel foundations	Rubble	77,000 Tons
Decommissioning	Breaking up of operational compound concrete foundations	Rubble	510 Tones
Decommissioning	Removal of Operational Compound	General construction waste	58,000kg
Decommissioning	Removal of Roads/Asphalt, fencing and lighting columns	Broken up asphalt, gravel and gatch, foundations for lighting	67,000 Tons

Phase	Activity	Waste Generated	Anticipated Approximate Quantity
		structures and fencing	

16.4 Assessment Methodology

16.4.1 Approach

This section will describe and assesses the predicted impacts upon existing waste management systems, expected to arise as a result of the introduction of the Sakaka Solar Energy Park, during the construction, operation and decommissioning phases of the Park. Potential impacts from dust generation are assessed in Chapter 6 *Air Quality and Meteorology*, those from leaching and spillage are assessed in Chapter 7, *Soils and Geology*, and potential impacts on habitat are assessed in Chapter 9 *Terrestrial Biodiversity*. The assessment of impacts related to waste management has been carried out utilizing the standard methodology outlined in chapter 5 - *Impact Assessment Methodology*.

16.4.2 Sensitive Receptors

Stakeholder consultation will confirm the sensitive receptors expected to be affected by the introduction of the Park.

16.5 Impact Assessment

16.5.1 Assumptions

The assessment of impact is based on the assumption that the IPP will comply with the IFC EHS Guidelines Section 1.5 Hazardous Waste Management and Section 1.6 Waste Management and the national requirements developed by GAME for waste collection, handling and disposal. Chapter 20 of the Environmental Impact Assessment; *Environmental Management and Monitoring Plan (EMMP)* includes details of the suggested approach to waste management.

The IPP shall ensure systems for the management of waste are implemented, audited and maintained, including the Environmental Management and Monitoring Plan (EMMP) and an Environmental Emergency Response Plan (EERP) in accordance with regulatory requirements and good industry practice.

Environmental management and monitoring plans should include:

- Waste and recycling objectives and targets;
- Waste segregation, storage, recycling and management procedures;
- Maximum storage times, and details of waste handling and labelling requirements;
- Selection, monitoring and auditing of waste contractors, and off site waste management facilities;
- Waste vehicle requirements;
- Competencies and training requirements of staff with responsibilities for managing waste storage areas;

- Procedures and lines of communication to be followed in the event of an emergency (including accidental releases of hazardous substances);
- Procedures to be implemented following an accidental release of hazardous substances, including details of containment and recovery measures to be applied; and
- Procedures for the monitoring of waste generation, and collection and reporting of data on this.

It is the responsibility of the IPP to ensure that staff are trained on the on-site waste management systems (as appropriate), use of spill mitigation materials and equipment, and procedures to be followed in the event of emergency incidents, such as accidental releases of hazardous substances.

It is also recommended that the IPP undertake regular audits of the above management plans, to confirm their ongoing effectiveness.

16.5.2 Construction Phase

The potential environmental impacts that could result directly from waste management relate to the potential releases of waste substances, the hazards presented by such releases and the effect that the releases may have on the environment and human health. The principal releases associated with waste management are liquid and solid discharges to land and water.

This section describes and assesses the impact on existing waste management systems and those resulting from the generation of waste by the project during construction, operation and decommissioning. Potential impacts from leaching and spillage are assessed in *Chapter 7: Soils and Geology* and potential impacts on habitat are assessed in *Chapter 11: Biological Resources*.

In addition to release, the generation of waste during the construction, operation and decommissioning phases of the Park has the potential to impact on the operational capacity of existing landfill and waste management infrastructure within the Al Jouf Province.

Table 16-4: Impact Assessment During Construction and Commissioning

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM1	Human Being & Environment	Moderate	On site storage and offsite disposal of non-hazardous waste generated during construction	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM2	Human Being & Environment	Moderate	On site storage and offsite disposal of hazardous waste generated during construction	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low
WM3	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities due to excess packaging material.	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Moderate

16.5.2.1 Storage and disposal of non-hazardous wastes

The estimated quantity of non-hazardous waste generated during the construction phase is expected to be 1690 tons of solid waste, an additional 126,000m³ of solar panel packaging and 342m³ of sanitary waste, over the 20 month construction period, equivalent to approximately 1014 tons per year of solid waste (excluding solar panel packaging) and 205.2m³ of sanitary waste. Non-hazardous solid wastes may cause contamination of the soil environment or potential human health impacts if stored or disposed of improperly. The non-hazardous wastes derived from the construction activities will be stored temporarily on site prior to being disposed of in an authorized GAME Sanitary Landfill – Class II.

Specific details of the waste storage conditions and management at the development site will be developed by the Engineering Procurement and Construction (EPC) contractor during the detailed engineering phase, and a Construction Site Waste Management Plan will be required. The plan will be prepared in accordance with the recommendations of GAME Environmental Standard 18: *Waste Disposal* in order to minimize the potential for impacts to occur.

The magnitude of impacts related to on-site storage and disposal of non-hazardous waste during the construction phase, on human health and the environment, is expected to be low, given the type of the materials involved (non-hazardous, short term effect), on-site storage duration, and the assumption that the on-site storage, transfer and ultimate disposal of such non-hazardous wastes will be undertaken in accordance with GAME Environmental Standard 13 *Waste Handling & Storage* and Sections 1.5 Hazardous Materials Management and 1.6 Waste Management of the IFC EHS Guidelines (2007). In accordance with Section 1.6, waste management should be addressed through a waste management system that addresses issues linked to waste minimization, generation, transport, disposal and monitoring.

Considering the sensitivity of the receptor, the significance of impacts on human beings and the environment, from non-hazardous waste generation during construction, is expected to be low.

Impact WM1 – Low Significance

16.5.2.2 Storage and disposal of hazardous wastes

The quantity of hazardous wastes generated during construction is likely to be 100 tons. Solid waste streams mainly relate to empty chemical/paint containers and asphalt from the road construction. Liquid waste streams relate mainly to fuel and fluids required for machinery operation such as diesel, greases, lubricants and oils.

It is anticipated that a small percentage of solar modules will potentially be damaged during transportation and installation. On the basis of their composite materials, solar modules are assessed as a hazardous waste.

Hazardous wastes generated during the construction and commissioning phases of the Park have the potential to cause significant harm to human and environmental receptors through direct contact, discharge, leaks and spills.

The hazardous wastes derived from the construction activities will be stored temporarily on site prior to being disposed of in an authorized GAME Sanitary Landfill – Class I. The Contractor will be required to prepare and implement a GAME approved emergency response procedure, in line with the EERP developed as part of this EIA, to ensure that accidental discharges of hazardous waste are promptly contained and the wastes and any control materials disposed of correctly. The magnitude of the impacts related to accidental discharge of wastes leading to impacts on human health and the environment is expected to be low during construction given the small quantity of materials involved and the assumption that the on-site storage transfer and ultimate disposal of such wastes will be undertaken in accordance with the GAME Environmental Standards. Therefore, considering the sensitivity of the receptor the significance of impacts on human beings and the environment from hazardous waste generation during construction is expected to be low.

There are currently no facilities in the Kingdom of Saudi Arabia that can receive and dispose of solar modules. There is an assumption that the supplier of the panels implements a voluntary take-back system for damaged modules. This will enable valuable materials to be recovered and reused in the manufacture of new modules. Damaged modules will be temporarily stored on-site within one of the storage buildings, under controlled environmental conditions and on hard-standing, until return of the is implemented.

Therefore, considering the sensitivity of the receptor the significance of impacts on human beings and the environment from hazardous waste generation during construction is expected to be low.

Impact WM2 – Low Significance

16.5.2.3 Exceedance of operational capacity at local waste management facilities

At this stage the capacity and availability of existing waste management infrastructure remains uncertain, subject to further stakeholder consultation by the IPP. It is anticipated that significant volumes of non-hazardous waste will be generated during the construction phase of the Park, primarily associated with the safe transportation of solar modules. There is therefore a potential for exceedance of the maximum capacity of local waste management infrastructure. It is anticipated that a total volume of approximately 126,000m³ of packaging will be generated during the construction phase of the development.

Impact WM3 – Moderate Significance

16.5.3 Operational Phase

Impacts associated with the operation of the Park include the generation of non-hazardous, domestic and other wastes such as sanitary waste and general office waste.

Table 16-5: Operational Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM4	Waste Management Infrastructure	Moderate	Generation of non-hazardous waste during normal operation of the Park	Effect: Negative Action: Direct Likelihood: Likely Frequency: Frequent Duration: Short Extent: Local Permanence: Reversible	Low	Low
WM5	Waste Management Infrastructure	Moderate	Generation of sanitary waste during normal operation of the Park	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low
WM6	Waste Management Infrastructure	Moderate	Waste arising from failed modules during operation of the Park including damaged or broken modules.	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low

16.5.3.1 Generation of non-hazardous waste

Small quantities of non-hazardous waste will be generated during the normal operations of offices and workshops at the Park. This will include office consumables such as paper, and other general domestic waste, and small quantities of waste associated with cleaning fluids such as containers, drums and other peripherals.

All non-hazardous waste streams will be separated and stored on-site within a designated waste collection and storage area, and facilities will be designed in accordance with IFC General EHS Guidelines 1.6: *Waste Management*. Due to the non-hazardous nature, and small quantities of waste, this impact is assessed as being of Low significance.

Impact WM4 - Low Significance

16.5.3.2 Generation of sanitary waste

Sanitary waste will be securely stored in septic tanks on site, which will be emptied periodically. Where sanitary waste is stored on site, this will be carried out in compliance with the requirements of Section 1.3 of the IFC General EHS Guidelines. Septic tanks will also comply with Section 1.5 of the IFC General ES Guidelines and have secondary containment to minimize the risk of leaks and accidental releases.

Due to the small quantities of waste anticipated to be generated during this phase of the Park, and the proposed management of it, this impact is assessed as being of Low significance.

Impact WH5 - Low Significance

16.5.3.3 Waste arising from failed modules during operation of the Park

Failed panels will represent a waste stream during operation of the Park. These panels will be stored in the workshop area at the contractor's compound before being returned to the manufacturer for repair or disposal. There is currently no safe means of disposal of Solar Panels within the Kingdom of Saudi Arabia.

Based on the assumed take-back of expired panels, this impact is assessed as being of Low significance.

Impact WM6 - Low Significance

16.5.4 Decommissioning Phase

Impacts experienced during the decommissioning phase of the Park are expected to be similar to those experienced during the construction phase.

Table 16-6: Decommissioning Phase Impacts

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM7	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities due to excess waste generated through demolition of buildings/breaking up of concrete at development site.	Effect: Negative Action: Direct Likelihood: Likely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Moderate	Moderate

ID	Receptor(s)	Sensitivity	Impact	Impact Characterization	Magnitude	Significance
WM8	Waste Management Infrastructure	Moderate	Exceedance of operational capacity at local waste management facilities due to excess waste generated through disposal of solar panels.	Effect: Negative Action: Direct Likelihood: Unlikely Frequency: Infrequent Duration: Short Extent: Local Permanence: Reversible	Low	Low

16.5.4.1 Exceedance of operational capacity at local waste management facilities

It is anticipated that approximately 280,000 tons of waste material will be generated at the development site as a result of the demolition of buildings and other infrastructure at the development site. This will include broken up concrete, rubble and used concrete masonry units (cinder blocks), mounting structures, fencing and other general demolition waste. There is a potential for exceedance of normal operating capacity at local waste management facilities as a result of the disposal of this quantity of material.

Due to the large volume of waste and the potential for an exceedance of operational capacity at local waste management facilities, subject to further stakeholder consultation by the IPP, this impact is assessed as being of moderate significance.

Impact WM7 - Moderate Significance

16.5.4.2 Exceedance of operational capacity at local waste management facilities (Solar Panels)

It is assumed that a takeback scheme will be operated by the solar panel manufacturer and therefore no impact will be sustained by local waste management infrastructure.

Impact WM8 – Low Significance

16.6 Mitigation

Mitigation measures to be implemented at the Park are focused around the production and implementation of proper waste management plans. These will include recommendations for the safe disposal of certain wastes and methods for takeback and recycling wherever possible.

Table 16-7: Mitigation Measures

ID	Potential Significance	Mitigation Measures	Residual Significance
WM3	Moderate	Contractor to prepare a waste management plan to account for the disposal of packaging related to transport of solar modules.	Low
WM7	Moderate	Contractor to prepare a waste management plan to ensure proper phased recycling and disposal of construction wastes.	Low

There is potential for significant damage to the environment of the development site due to the improper storage and handling of wastes. In order to mitigate this risk, the contractor is required to develop and implement a construction phase waste management plan.

It is recommended that a panel supplier is selected who offers voluntary take-back system of expired and decommissioned solar modules. This will ensure proper collection and disposal of panels as and when they fail. Engaging with such a supplier will also ensure that on decommissioning, the Park will not pose a significant impact upon local waste management infrastructure.

There is potential for exceedance of capacity at local waste management facilities due to the large quantities of construction waste expected to be generated during the decommissioning of the Park. The contractor shall prepare and implement a decommissioning waste management plan in order to ensure that wastes are disposed of in such a way as to avoid such exceedance.

Significant volumes of packaging are anticipated to be generated at the development site as the solar modules are unloaded. The contractor shall prepare a specialized waste management plan for the disposal of packaging related to the transport of solar modules to the development site. This could involve the specification of reusable or recyclable packaging material, or arrangements with local waste disposal sites to receive the packaging.

16.7 Conclusion

This Waste Management impact assessment has been based on a precautionary approach using data from desk-based review and current available design assumptions. As the design progresses and more details become available, the assessment will have to be re-visited with any updates reported in an Addendum to this ESIA.

The main impacts on waste management infrastructure are expected to occur during the construction and decommissioning phases of the Park and will be associated with the use of hazardous and non-hazardous construction materials. Limited waste is expected to be generated during the operational phase of the Park; this will be associated with small quantities of domestic waste generated within the ancillary and support buildings. It is assumed that existing waste management facilities have capacity to absorb the quantities of waste expected to be generated as a result of the introduction of the Park. This assumption will be confirmed following the completion of stakeholder consultation.

16.8 References

Saudi Aramco (2013). Citizenship Report. 2013.

SAES-S-007 Solid Waste Landfill Requirements

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World Bank (2012) What a Waste: A Global Review of Solid Waste Management.

Ministry of Economy and Planning (2009) Ninth Development Plan, Water and Sanitation, available at: <http://www.mep.gov.sa/themes/GoldenCarpet/index.jsp;jsessionid=990A54C524B996195483ABD194F0C1EA.beta> [accessed on 19/03/13].

17. Health and Safety Aspects

17.1 Introduction

This chapter presents a description of the potential health and safety issues associated with the Sakaka Solar Energy Park (the Park), an overview of the international and national health and safety legislation and standards, and information regarding regional and local health infrastructure.

Baseline health data is presented for the Kingdom of Saudi Arabia as a whole and the Al-Jouf Region in which the Park is located to give an understanding of the overall context of health issues and to provide a basis for the evaluation of potential impacts in relation to health and safety for the construction/decommissioning and operation phases of the Park.

The World Health Organization defines health as: *"A state of complete physical, mental and social well-being, and not merely the absence of disease"*. It also states that *"Good health is essential to human welfare and to sustained economic and social development"*.

The maintenance of a good health status is promoted within the Qur'an. Hygiene is a prominent topic in Islam, and the Qur'an advises Muslims to uphold high standards of physical hygiene whenever possible. The health sector is a key priority of the Government to provide all Saudi citizens and residents with access to free and high standards of health care.

17.2 International and National Standards and Guidance

This section sets out the international development standards set by the World Bank Group (including the IFC) and national legislation and regulatory standards which have informed the assessment of impacts on health and safety.

17.2.1 World Bank and IFC Performance Standards

The World Bank has defined the principles for the assessment of health in Environmental and Social Impact Assessment. Guidance is provided through the Environmental Assessment Sourcebook (2007) for the systematic integration of public health and safety concerns through early screening of proposed developments and implementation of appropriate measures to address risks during project preparation, implementation, and beyond.

Health aspects of particular interest are the potential risks associated with communicable and non-communicable diseases, accidents and injury, malnutrition (direct and indirect through land-use change), health infrastructure and the impact of the project on its capacity, integration into the project design, and monitoring of potential effects.

In addition, the World Bank has produced Environmental, Health and Safety (EHS) Guidelines (2007) which detail specific requirements for Occupational and Community Health, Safety and Welfare. The document sets out the minimum requirements for compliance with international best practice, provides exposure limits for various groups in terms of noise, radiation and other factors, and details minimum expectations for the provision of welfare facilities on site, and in accommodation camps. The guidelines also detail recommendations for the protection of workers and the community against the transmission of diseases, including the provision of screening and vaccination programs.

Sector EHS guidelines have been developed to address particular aspects associated with different types of development. Of particular relevance to the Park are:

- IFC EHS General Guidelines (2007).

- IFC EHS Guidelines for water and sanitation (2007)
- IFC EHS Guidelines for Electric Power Transmission and Distribution (2007)

The IFC have also produced “A Project Developer’s Guide to Utility-scale Solar Photovoltaic Power Plants” (IFC 2015), which recommends the adoption of the EHS guidelines for all utility scale solar installations.

The IFC performance standards (as described in Chapter 2 *Policy, Legal and Administrative Framework*) also highlight the importance of health and welfare in Environmental and Social Sustainability. The following performance standards are particularly relevant to this chapter:

- IFC Performance Standard 1 – Assessment and Management of Environmental and Social Risks and Impacts;
- IFC Performance Standard 2 – Labor and Working Conditions; and
- IFC Performance Standard 4 – Community Health, Safety and Security.

Performance Standard 2 requires the adoption of human resources policies and procedures to provide workers with clear documented information as to their rights under National Labor Laws and any relevant collective agreements. These include their rights relating to working hours, wages, overtime, compensation, breaks, rest days, and any benefits including leave for illness, maternity leave, annual and statutory holidays etc.

Where accommodation is being provided, policies on the quality and management of the facilities should be implemented to ensure the provision of basic services which are defined as:

- Minimum space;
- Supply of water;
- Adequate sewage and waste disposal;
- Protection against heat, cold, damp, noise, fire, and disease carrying animals;
- Adequate sanitary and washing facilities;
- Cooking and storage facilities;
- Natural and artificial lighting; and,
- Basic medical services where appropriate.

The accommodation should also not restrict workers’ freedom of movement or of association.

The IFC with the European Bank for Reconstruction and Development (EBRD) have published the guidance note: *Worker’s Accommodation: Process and Standards* (IFC 2009) with associated checklist which details the level of required facilities, layout and expectations for the provision of all workers accommodation both during construction and operation.

The performance standard also states the minimum expectations under Occupational Health & Safety for employees, third party contractors, and workers in the supply chain. The standard requires the implementation of policies and procedures to good international industry practices which minimize the risks to workers from hazards including physical, biological, chemical, radiological and specific threats to women. The procedures should include the identification of hazards, their prevention or protective measures, reporting and documentation of accidents, diseases and incidents, and emergency

preparedness. Training of workers should also be undertaken.

Policies and procedures should also be developed and implemented for the management and monitoring of third party contractors and the primary supply chain, and incorporate these where appropriate into their contractual obligations.

IFCPS 4 has the following objectives:

- To anticipate and avoid adverse impacts on the health and safety of the affected community during the project life from both routine and non-routine circumstances; and
- To ensure the safeguarding of personnel & property is carried out in accordance with relevant human rights principals and in a manner that avoids or minimizes risks to the affected communities.

The implementation of the actions required to comply with this standard is managed through the Environmental and Social Management System (ESMS) outlined in IFC Performance Standard 1. The Standard requires the evaluation of the risks and impacts to the Health and Safety of any affected communities during construction, commissioning, operation and decommissioning. Measures to prevent, minimize and manage these risks in line with international best practice are required to be implemented, and any mitigation measures should be commensurate with the nature and magnitude of the impact. Importantly, the standards call for the avoidance of risks and impacts over minimization and mitigation. The standard highlights the following aspects:

- Infrastructure and Equipment Design and Safety;
- Hazardous Materials Management and Safety;
- Ecosystem Services;
- Community Exposure to Disease; and,
- Emergency Preparedness and Response.

The performance standard also provides guidance on the minimum requirements where security personnel are employed as part of the project (either directly or through contract). The requirements cover hiring, training, equipping, use of force, conduct towards affected communities, and monitoring. It also requires compliance with the United Nations (UN) Code of Conduct for Law Enforcement Officials, and the UN Basic Principles on the use of Force and Firearms by Law Enforcement Officials.

A grievance mechanism is also required to be provided for all parties.

17.2.2 The Equator Principles

The Equator Principles are a set of ten ethical lending principles which are aligned with the IFC Performance standards, and require the implementation of the IFC EHS guidelines as a minimum standard for all financed projects in non-designated countries. Key Equator Principles of relevance to this assessment include:

- Principle 4: Environmental and Social Management System and Equator Principles Action Plan.
- Principle 5: Stakeholder Engagement.
- Principle 6: Grievance Mechanism.

17.2.3 National Labor Law

Royal Decree No. M/51, 27 September 2005 is the principal legislation defining the occupational health and safety rights of all workers within the Kingdom of Saudi Arabia. The law sets out provisions concerning workers' rights in terms of pay, welfare, working hours and conditions and access to healthcare. Part VIII of the law sets out provisions for the protection against occupational hazards, major industrial accidents and work injuries, as well as health and social services.

17.2.4 General Authority for Meteorology and Environment (GAME) Environmental Standards

As identified in chapter 2 of this report, the General Administration for Meteorology and Environment (GAME) (formerly the PME) is responsible for issuing consent for projects to ensure compliance with the Public Environment Law and implementing regulations. Particular reference should be made to the General Environmental Regulations and Rules for Implementation (GERRI) which were enacted in 2001. Of particular relevance to this chapter is Article 2 of the GERRI which includes the aim to *'protect public health from activities and acts that harm the environment'*.

The GAME defines, through a series of standards, thresholds and criteria, measures to protect public and employee health from harmful air quality emissions, noise, contaminant and pollution sources (both land and water), and disposal of hazardous waste materials.

The regulations are supported by a series of Environmental Standards on air quality, noise, waste management, water quality (including drinking water), and the prevention of major accidents.

The GAME requires the facilities to be designed to meet these standards, and exemptions can only be provided by the relevant minister. Compliance with the standards through design, therefore, automatically confers a level of protection for public and employee health.

Environment Standard 5 – Prevention of Major Accidents, defines the requirements for developing, implementing, reporting and monitoring both an off-site and on-site emergency response plan which should be reviewed as a minimum every two years during construction and operation of the facility.

17.2.5 Saudi Aramco Policies, Procedures and Standards Relevant to Health and Safety

Saudi Aramco's standards are set out in chapter 2 of this report. Of specific relevance to this chapter are the following General Instructions and Sanitary Codes:

- GI-0150.000 Industrial Hygiene and Occupational Health Aspects of Environmental Protection Policy.
- GI-0151.006 Implementing the Saudi Aramco Sanitary Code.
- SAEHC-S-07 Camps & Communal Living Facilities.
- SAEHC-S-12 Places of Employment.
- SAEHC-S-18 Public Health Nuisance.

17.3 Baseline Environmental Conditions

The baseline conditions for the Al-Jouf Region have been identified through a desk-based review using statistics and datasets available on the Kingdom of Saudi Arabia's government Statistical Yearbook of 2015, which is available on the General Authority for Statistics website (<https://www.stats.gov.sa/en/4515> [Accessed February 2017]).

The Study Area has focused on Sakaka and the Al-Jouf Region in which the Park would be located.

17.3.1 Healthcare in the Kingdom of Saudi Arabia and the Al-Jouf Health Region

the Kingdom of Saudi Arabia has an estimated population of over 31 million⁸ with an approximate annual growth rate of 2.1%⁹. The population is spread between 150 cities and more than 2000 villages, often located in remote areas. The provision of Health Services in the Kingdom of Saudi Arabia falls under the remit of the Ministry of Health (MOH). The MOH operates a three tier approach to healthcare provision:

- Primary: Health Centers;
- Secondary: General Hospitals; and
- Tertiary: Specialist Hospitals.

The MOH provides approximately 60% of healthcare facilities, with the remainder being provided by other ministries with specific healthcare duties to discharge (e.g. Ministry of Defense, National Guard, Ministry of Interior, Ministry of Higher Education), with some private healthcare providers, and the King Faisal Specialist Hospital.

The MOH has published a ten year health care strategy (2009/10 to 2019) for the Kingdom of Saudi Arabia, to provide a patient centered healthcare service to meet “*patients’ health needs in the right place at the right time*”. The strategy provides for (and protects) the patients’ right to know and choose their health care treatment and provider, and is implemented through the MoH Integrated and Comprehensive National Healthcare Project.

Table 17-1 provides a summary of the health infrastructure within the Kingdom of Saudi Arabia and the Al-Jouf Region based on datasets from the 2015 Health Statistics Yearbook.

Table 17-1: MOH Health Infrastructure Data

MoH Health Infrastructure	Kingdom of Saudi Arabia (population 31,521,418)	Rate per 10,000 people	Al-Jouf Health Region (population 336,957)	Rate per 10,000 people
Number MOH Hospitals	274	0.1	8	0.2
Number MOH Beds	41,297	13.1	1280	38
Number Physicians (including dentists)	41,240	13.1	874	25.9
Number Nurses	95,379	30.3	3049	90.5
Number Pharmacists	3,184	1.0	58	1.7
Number Allied Health Personnel	55,080	17.4	1136	33.7
Health Centers	2,282	0.7	40	1.2

⁸ General Authority for Statistics, General Population and Housing Census, Population In The Kingdom by Single Age , Nationality (Saudi/Non-Saudi) and Gender In Mid Year 2015 A.D

⁹ World Bank Group, Population growth (annual %), Overview for Saudi Arabia:
<http://data.worldbank.org/indicator/SP.POP.GROW?locations=SA>

Approximately 32.6% of the physicians (including dentists) and 60% of the nurses are Saudi Nationals. 31% of physicians, 74% of nurses, 36% of pharmacists, and 23% of allied health personnel are female.

Each primary health care center provides services to an average of 13,813 people across the Kingdom of Saudi Arabia. Within the Al-Jouf Health Region each health care center provides services to an average of 8,424 people.

17.3.2 Communicable and Infectious Diseases

A comprehensive vaccination program over the last 20 years has been undertaken in the Kingdom of Saudi Arabia. Vaccination coverage was 97.6% for measles, mumps and rubella in 2014, and 98.3% for diphtheria, pertussis, tetanus, poliomyelitis (polio) and hepatitis B.

There have been no cases of polio, yellow fever, Rift Valley fever or plague between 2011 and 2015. There were three cases of rabies in 2015 but none in the previous four years.

The total number of new cases of pulmonary tuberculosis (TB) in 2015 was 2505 with an overall incidence rate of 7.95 cases/ 100,000 population, this reflects minimal increase compared to the figure reported in the previous year. There has been an improvement in case reporting and notification as well as health education programs including the World Day of TB. Total cases of non-pulmonary tuberculosis reached 841 with an overall incidence rate of 2.67/100,000 of the population. Table 17-2 sets out the incidence rate (per 100,000 people) of certain notifiable communicable diseases between 2011 and 2015. For most diseases, the Al-Jouf Region has much lower incidence rates, the exception being Brucellosis, where the rate was 44% higher than the Kingdom of Saudi Arabia average for 2015.

Table 17-2: Incidence Rates (Per 100,000 Persons) of Certain Notifiable Communicable Diseases across the Kingdom of Saudi Arabia 2011 - 2015 and Al-Jouf Health Region 2015 (MoH 2016)

Disease	2011	2012	2013	2014	2015	Al-Jouf Region 2015
Amoebic dysentery	7.00	7.44	6.06	7.73	5.98	0.00
Brucellosis	13.89	12.54	10.88	10.11	10.26	14.83
Chickenpox	68.61	64.06	36.45	26.66	18.97	1.48
Dengue fever	11.64	5.99	21.71	6.76	13.68	0.00
Diphtheria	0.0120	0.000	0.030	0.010	0.013	0.00
Hepatitis A	1.13	1.06	0.79	0.42	0.40	0.00
Hepatitis B	15.84	15.79	14.20	14.05	11.06	4.45
Hepatitis C	8.20	8.01	5.26	5.48	4.21	1.78
Measles	1.28	1.01	0.84	0.50	0.69	0.89
Meningococcal meningitis	0.02	0.01	0.01	0.01	0.02	0.00
Meningitis pneumococcal	0.04	0.01	0.01	0.01	0.02	0.00
Meningitis haemophilus	0.000	0.000	0.010	0.000	0.010	0.00
Mumps	0.09	0.22	0.12	0.06	0.01	0.00
Pulmonary tuberculosis	9.31	8.83	8.16	7.59	7.95	1.48
Rubella	0.00	0.06	0.22	0.07	0.02	0.00

Disease	2011	2012	2013	2014	2015	Al-Jouf Region 2015
Tetanus neonatorum	0.03	0.02	0.02	0.00	0.002	0.00
Tetanus, other types	0.04	0.02	0.06	0.04	0.03	0.00
Typhoid and paratyphoid	1.03	1.01	0.75	0.39	0.47	0.00

Malaria is present across the Kingdom of Saudi Arabia, however there is a wide regional variation in cases. Anti-malaria programs, which include spraying, have been in place since 1948. A total of 2,620 cases of malaria were notified in 2015. The regions with the highest number of malaria cases are Jazan (984 cases in 2015) and Eastern (427 cases in 2015). There were 9 notified malaria cases in Al-Jouf Region.

17.3.3 Non-Communicable Diseases

According to the World Health Organization (WHO 2014), non-communicable disease account for 78% of all deaths in the Kingdom of Saudi Arabia see Figure 17-1. Cardiovascular disease accounts for the largest proportion at 46%.

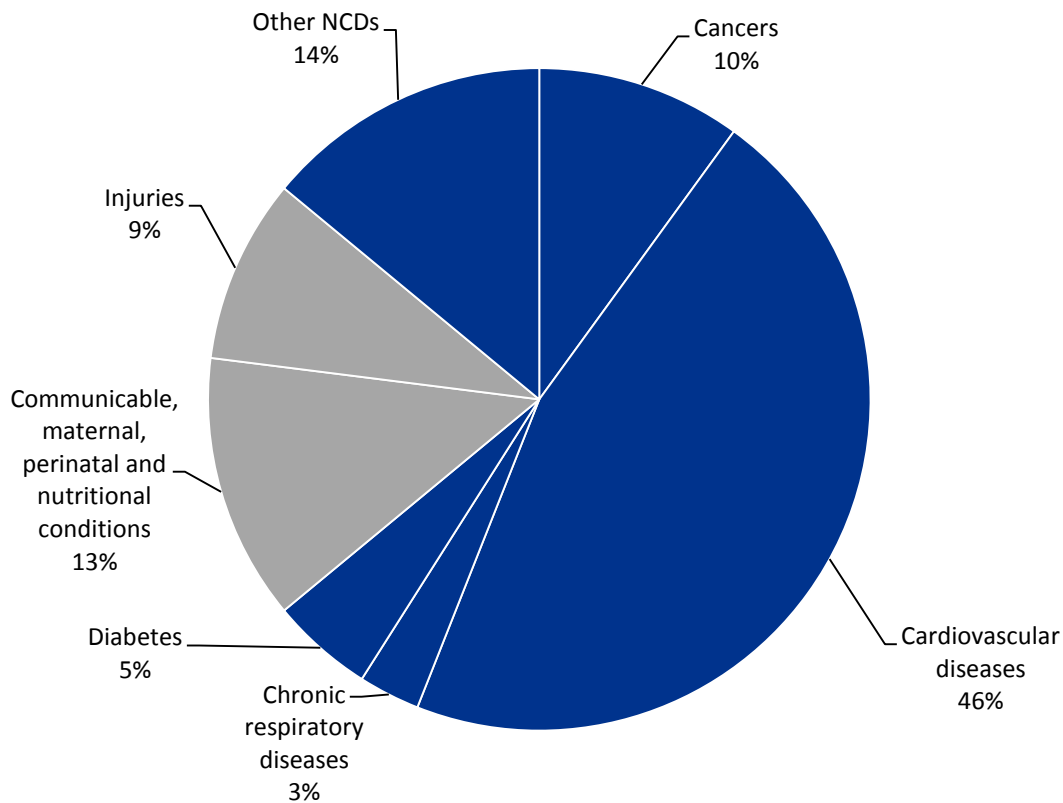


Figure 17-1: Proportion of total deaths in the Kingdom of Saudi Arabia for all age groups (WHO 2014)

17.3.4 Occupational health and accidents

Occupational Health in the Kingdom of Saudi Arabia is aimed at the prevention, treatment and monitoring of work related injuries and diseases. The General Organization for Social Insurance (GOSI) for Saudi Arabia is responsible for the protection of workers, treating and compensating work injuries under the Occupational Hazards Branch (OHB), developing and updating schedules of occupational diseases in accordance with relevant international laws and legislation, and preparing the Annual Statistical Report on the occupational injuries in the Kingdom of Saudi Arabia.

Work related injuries decreased steadily between 2005 and 2013, but show a fairly substantial upturn in 2014 (see Figure 17-2).

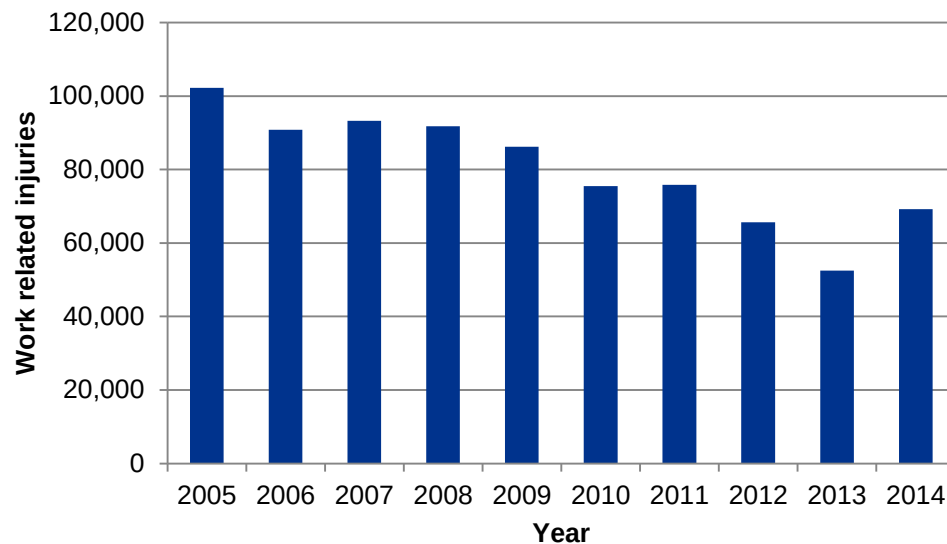


Figure 17-2: Work related injuries in the Kingdom of Saudi Arabia

A total of 69,241 cases of work related injuries were reported in the Annual Statistical Report for 2014, of which only 5.4% occurred to Saudi nationals. The majority of injuries (51.3%) occurred within the construction industry, with a further 18.7% within the building services trade and 16.5% within transformative industries. The remaining industries (trade, mining and quarrying, social services, agriculture and fishing, electricity and water, financing and real estate) each comprised less than 5% of reported injuries. The leading causes of injuries were falls, collisions and rubbing or abrasion (see Figure 17-3). The significant majority of injuries recorded were recovered without disability, however 10.9% were recovered with disability and 1.5% resulted in death.

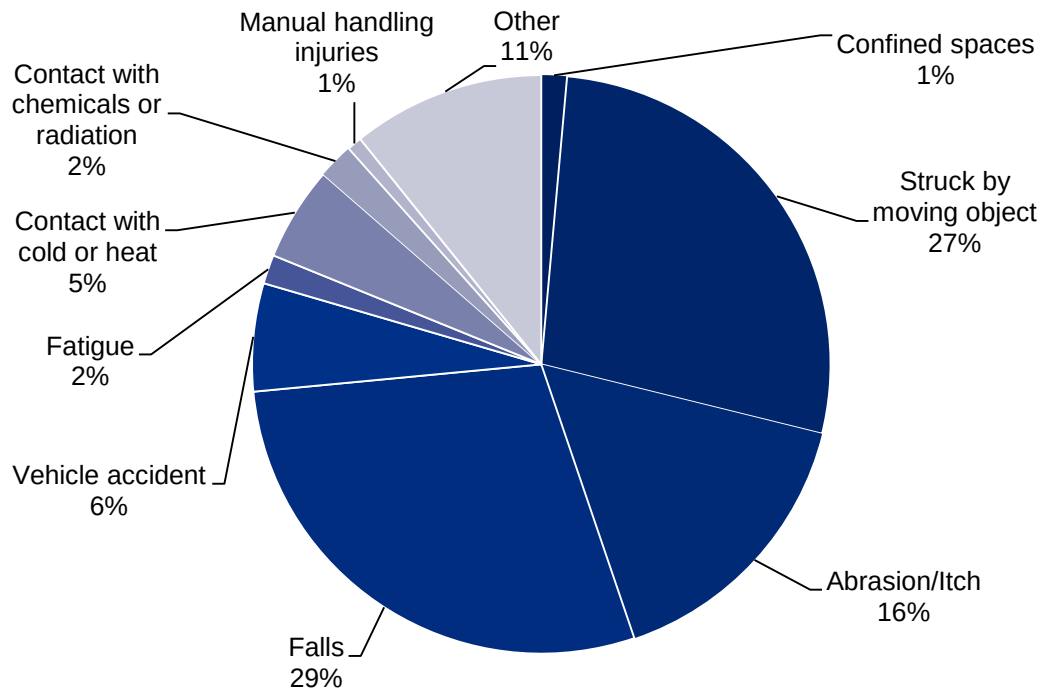


Figure 17-3: Causes of work related injuries

Road traffic accidents are known to be high in the Kingdom of Saudi Arabia compared to western countries. Collision rates increased sharply from approximately 280,000 in 2006 to 435,000 in 2007, and have continued to exceed 400,000 in the following years (Figure 17-4). Rates of injury and fatalities have remained relatively stable or gently increasing. DeNicola et al (2016) report 545,000 collisions in 2011, resulting in more than 40,000 injuries (7.3%) and approximately 7000 deaths (1.3%). For context, the number of registered vehicles in the Kingdom was circa 6.5 million in 2010 and 8 million in 2013 (data for 2011 not available).

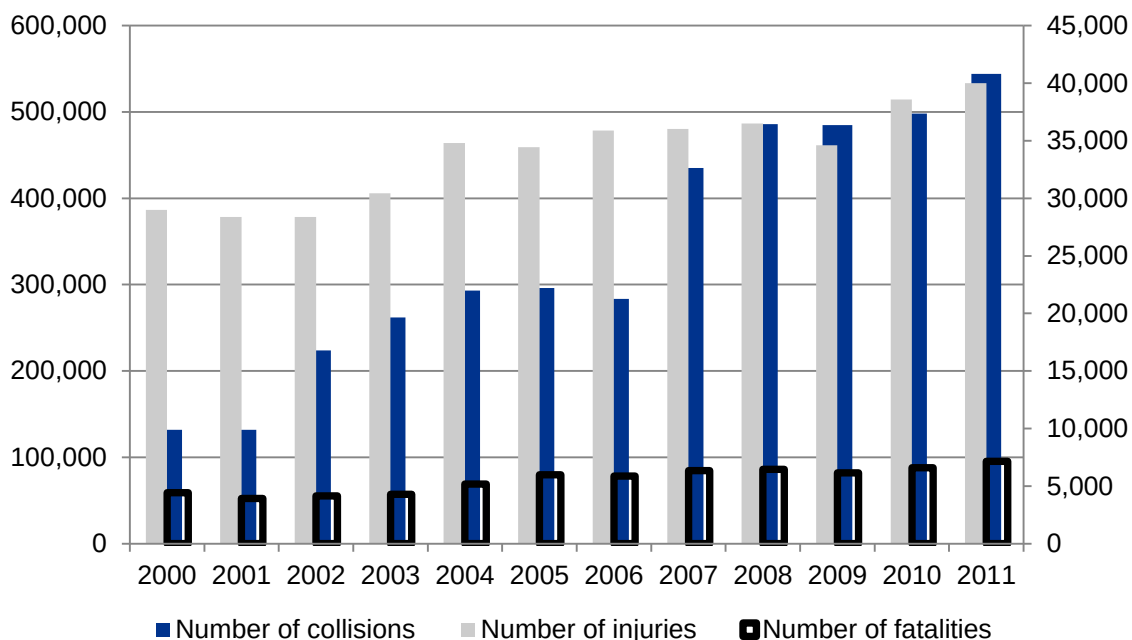


Figure 17-4: Annual data for road traffic collisions and resultant injuries and fatalities (data from DeNichola et al. 2016)

17.3.5 Local Healthcare Facilities

The Prince Mohammed Medical City is currently under construction on a site in Sakaka with the aim of providing tertiary healthcare services to the two million inhabitants of the Al-Jouf, Tabuk, Hail and the Northern Borders Regions. The Prince Mohammed Medical City is being delivered in two main phases and once complete will provide over 1000 beds. The Medical City will include the following centers providing the following specialist services:

The first phase of the Prince Mohammed Medical City, which will be the main hospital with 500 beds, is anticipated to be complete and ready to take patients in April 2017.

The second phase will see the delivery of the following specialist centers and hospitals, and is due for completion in April 2019:

- Ophthalmology hospital
- Rehabilitation hospital
- Oncology center
- Cardiology Center
- Neuroscience Center

17.4 Assessment Methodology

17.4.1 Approach

The impact assessment has been completed in accordance with the methodology outlined by Chapter 5 - *Impact Assessment Methodology*.

The assessment considers the potential impacts, both negative and positive, that the Park may have on the health, safety and welfare of both the employees and the local communities.

Consideration has been given to impacts associated with the construction, operation and decommissioning phases of the Park.

17.4.2 Sensitive Receptors Relevant to the Assessment of Health and Safety

The identification of sensitive receptors has been based on assumptions made relating to the likely geographical influence of the Park, and the pathways to which potential impacts could occur on people within the geographical area of influence. The identification of sensitive receptors is set out in Table 17-3. All receptors are considered to have 'high' sensitivity.

Table 17-3: Sensitive Receptors for Health and Safety

Sensitive Receptors	Location
Construction workers involved in enabling works (pre-construction activities)	Sakaka Solar Energy Park site
Construction workers involved in main construction phase	Sakaka Solar Energy Park site
Road users along transport routes	Transport routes from port to construction site (Road 80 and Road 85)
Residents of local communities	Sakaka and surrounding communities (including Al-Jouf University)
Seasonal and nomadic herders	Seasonal herder settlements
Pilots / aviation receptors associated with Sakaka Al-Jawf Domestic Airport	Approximately 5 km north of Sakaka Solar Energy Park site

17.5 Impact Assessment

17.5.1 Construction Phase

The influx of a large number of construction workers will be the primary source of health impacts on the local community during construction. The degree of interaction with the local community will determine the significance of the impact. In addition, potential sources of impacts during the construction phase include the following:

- Exposure to environmental factors (air quality, noise, water and contamination)
- Impacts of increased vehicle movement
- Occupational health and safety of construction workers (including accidents and injuries, and mental health)
- Communicable and non-communicable diseases.

Potential impacts from construction of an industrial facility were identified. These impacts are summarized in Table 17-5.

17.5.1.1 Construction Related Health Impacts from Air Quality and Noise (HS01)

The main environmental factors likely to occur during construction relate to emissions from the operation of mobile diesel plant (NO_x and particulate matter (PM₁₀ and PM_{2.5}), increases in traffic levels and an increase in dust particles.

Increased exposure to emissions from plant and vehicles can increase the sensitivity of individuals in vulnerable groups especially those diagnosed with chronic conditions such as asthma. However these impacts are not considered likely to occur for the following reasons:

- The site is located in an open area where emissions are likely to disperse rapidly, and background pollution levels are low
- Construction workers will have undergone a comprehensive health screening process, meaning the likelihood of individuals being susceptible to these conditions would be low
- The main permanent settlements are more than 5 km from the site and therefore risk of exposure to local communities is low
- Seasonal herders would only be subject to the risk of limited, short term exposure

Construction also has the potential to increase the levels of particulate matter in the form of dust. Increased exposure to dust can increase the incidence of non-communicable respiratory disorders and chronic respiratory diseases. These impacts are more likely to be seen in the workforce.

The increase in traffic movements and in particular those using the road through Sakaka (Highway 80) have the potential to adversely impact on the local air quality. There are at least two schools located alongside the main highway although construction traffic could take the alternative Prince Abdulalah Bin Abdulaziz Road which bypasses Sakaka to the east. The volume of traffic is not considered likely to be high enough to significantly affect air pollution levels over and above the existing traffic in the area (where a number of other construction projects are ongoing). Therefore, community impacts are considered to be low.

Construction noise and vibration from on-site plant and machinery, transportation, can adversely affect peoples' quality of life. However the noise likely to be associated with the construction of the Sakaka Solar Energy Park, which involves the use of pre-constructed modules, is not likely to be high or long in duration. Given the distance to permanent settlements, the likelihood of noise-related health effects on the local community from the construction of the Park is considered to be low.

The health effects of noise and vibration during the construction phase of the Park are more likely to be experienced by the construction workforce. These could include hearing loss caused by exposure to noise at work which continues to be a significant occupational disease, and hand arm vibration exposure. Factors that contribute to the health effects are: the noise level, level and type of vibration, and the length of exposure (e.g. daily or over a period of years). Exposure to noise is more common and it can take years for the health effects to be realized. Management of construction noise will follow international best practice and will include consideration in the detailed design phases of changes in the construction process, and plant to minimize noise impacts, organization of the program and workforce to ensure rotation of staff, development of a comprehensive training program and provision of PPE where required, and implementation of monitoring and health surveillance measures during construction. The implementation of these measures will reduce the impact to low significance.

Taking into account the location and local conditions, the type of construction project, and the health and safety management measures that will be in place, the effects from construction related air quality (impact HS01a) and noise (impact HS01b) are considered to be of low significance.

17.5.1.2 Construction Related Health Impacts from Water (HS02)

Potable water will be supplied as bottled water which will meet the required standards as defined by National Drinking Water Quality Standard for the Kingdom of Saudi Arabia (2012) and IFC Environmental Health, and Safety Guidelines for Water and Sanitation (2007), and therefore health risks to the workforce are considered negligible.

17.5.1.3 Increase in Construction Traffic Related Vehicle Accidents (HS03)

Traffic and transport details are presented in Chapter 13– *Traffic & Transport Infrastructure*. This section identifies the potential impacts associated with physical movement of vehicles especially where they relate to Motor Vehicle Accidents (MVA). The GOSI annual report suggests that 3.5% of all workplace injuries/accidents are caused by MVAs at least half of these are in the construction industry.

During the construction of the Park, road traffic will increase due to the volume of material required to be brought to site via road. This material will be transported along Road 80, which is the primary access to the development site. The location of the construction workers' camp has not yet been identified as part of the preliminary design but it will be assumed that they will be located within the boundary of the approved Land Use Permit (LUP). In the event workers are housed outside this, it is assumed the workforce will be brought to site via buses.

Road 80 has been assessed as being well within its capacity and is considered to be capable of supporting the increased volume of traffic expected to arise as a result of the Park. Given the uncertainties around volume of traffic, and types of vehicles, a moderate magnitude has been assigned to the impact due to the presence of human road users.

17.5.1.4 Occupational Health and Safety of Construction Workers (HS04)

Many aspects related to occupational health (e.g. Motor Vehicle Accidents) have been assessed in the previous sections. This section will therefore consider general workforce accidents and injuries, diseases, and issues such as mental health and stress. The national statistics for work force accidents, injuries and diseases are detailed in Section 18.3.4. In summary accidents and injuries in the construction industry, account for approximately half of all workforce injuries.

Workplace accidents and injuries can be reduced through the implementation of international best practice in training, monitoring, HSE guidelines and practices. Injuries and accidents can be further reduced through the introduction of a program which addresses culture and behaviors on site. Furthermore, Corporate Policy and engagement with staff, suppliers and contractors will have a major impact on the success of any safety practices implemented on site.

The Park will be implemented using processes and procedures designed to international best practice and be compliant with the IFC EHS General Guidelines (2007). First aid services and medical facilities will be provided on site during the main construction period, and workers will have access to the new hospital in the Prince Mohammed Medical City.

An Environmental Emergency Response Plan (EERP) will be developed as part of ESIA (see Chapter 20) which will detail the response to severe injuries/accidents. The provision of fully trained medical staff and comprehensive medical facilities will reduce this risk to low.

Mental health and stress is also an important consideration for any workforce. The accommodation camp will be designed to provide high standard accommodation with recreational facilities, and access to on-site health care staff, all of which will contribute to a reduction in stress and improved mental health. Working hours, holidays, pay, grievance mechanisms etc., will also be implemented according

to National Labor laws, ensuring the employment conditions are suitable and do not contribute to an increase in stress.

Audits of the worker accommodation should be undertaken in accordance with the IFC and the European Bank for Reconstruction and Development (EBRD) guidance note: *Worker's Accommodation: Process and Standards* (IFC 2009). This document includes checklists with the level of required facilities, layout and expectations for the provision of all workers accommodation both during construction and operation.

17.5.1.5 Communicable and Non-Communicable Diseases (HS05)

The baseline assessment suggests that the cases of many communicable diseases are relatively low, especially for cases of malaria which are primarily brought into the area through migration of workers. Transmission of such diseases amongst the construction workers themselves and transmission between the construction workers and the local community must both be considered.

The exact location, layout, and facilities will be determined in the next phases, however the construction workers are likely to be housed in shared accommodation with communal toilet and shower facilities. The close living quarters and communal kitchens could increase the spread of infectious diseases that may be present. The accommodation camps during construction will be designed to National Labor Law and in line with the guidance published in the IFC Workers Accommodation: Processes and Standards (IFC 2009). In addition, a comprehensive health screening program for workers will be developed in compliance with the Kingdom of Saudi Arabia regulations.

Interaction of construction workers within the local community will be reduced due to the establishment of the accommodation camps assumed to be located within the LUP boundary, approximately 13km from the southern outskirts of Sakaka. Worker needs and facilities will be provided within the accommodation areas, and this also reduces the potential interaction with the local community. The influx of approximately 2,500 workers is not likely to have a significant impact within Sakaka, which had a population of 242,813 according to the 2010 Census. Sakaka itself is seeing rapid growth as a consequence of the substantial recent government investment.

The transmission of communicable diseases, from workers associated with the Park, may reach families and the community at large, however the scale of this risk from the Park is likely to be low compared with the scale of inward migration from other development in and around Sakaka. The risk of transmission of communicable diseases is therefore expected to be higher among the workers themselves.

The incidence rate of a variety of commonly occurring infectious ailments and diseases, such as chickenpox, hepatitis, and diarrhoea diseases may increase. However the implementation of a comprehensive health screening program, compliance and implementation of international HSE standards and the World Bank EHS guidelines, provision of a medical facility with fully trained staff, and the introduction of a comprehensive information/training program will reduce the significance of the potential impact, which is considered to be low. The removal of herders, together with the provision of catering facilities for the workforce, which will ensure the supply of food is in line with health regulations, is likely to lead to a reduction in the prevalence of brucellosis in the local area. This is because the main cause of the infection (drinking unpasteurized milk) will be less likely to be an issue in the local area.

Table 17-4 Summary Assessment of Health Impacts During Construction

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
HS01a	Construction	High	Risk to health,	Effect:	Negative	Low	Low

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
	workers		especially respiratory disorders and chronic respiratory diseases, from exposure to air pollution including dust, diesel particulates and NOx.	Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible and Irreversible (chronic conditions)		
HS01b	Construction workers	High	Risk of hearing loss as a result of operation of construction plant	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Continuous		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
HS02	Construction workers	High	Risk to health from contaminated water supplies	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Reversible		
HS03	Road users	High	Motor vehicle accidents (with associated risks of injuries, fatalities and effects on mental wellbeing)	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		
HS04	Construction workers	High	Impacts on occupational health and safety	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Short		

ID	Receptor	Sensitivity	Impact	Impact characterization		Magnitude	Significance
				Extent:	Local		
				Permanence:	Irreversible		
HS05a	Construction workers	High	Increased risk of contracting communicable or non-communicable diseases	Effect:	Negative	Moderate	Moderate
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short – Medium		
				Extent:	Local		
				Permanence:	Reversible (for most diseases) Irreversible (for some diseases)		
HS05b	Residents of local communities	High	Increased risk of contracting communicable or non-communicable diseases	Effect:	Negative	Low	Low
				Action:	Direct and Indirect		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short – Medium		
				Extent:	Regional		
				Permanence:	Reversible (for most diseases) Irreversible (for some diseases)		

17.5.2 Operation Phase

The potential impacts considered in this assessment from the operation are:

- 'Glint and glare' from the solar PV system
- Motor vehicle accidents from occasional maintenance visits

17.5.2.1 Glint and Glare from Solar PV System (HS06)

A glint and glare assessment was carried out in relation to the Park. In the absence of specific Saudi Arabian aviation guidelines on the development of solar PV plants near airports, this study was carried out in line with the United States Federal Aviation Administration's (FAA) interim policy "Review of Solar Energy System Projects on Federally Obligated Airports (78 FR 63276)" which specifies the obligations a solar development must fulfil before it can be granted consent by the FAA. This policy is

considered to be the most comprehensive guideline available on glare assessment near airports and has been adopted as best practice in the solar industry.

In this study, the Solar Glare Hazard Assessment Tool (SGHAT) was used, which was developed by the FAA in collaboration with the United States Department of Energy (DoE). The tool incorporates and meets the FAA's criteria for the assessment of solar glare impact on aviation safety.

The study established an SGHAT model for the proposed solar PV development at Sakaka incorporating the following parameters:

- Solar PV array design: the study considers 3 solar PV array design variations that could potentially be considered for this project at a later stage.
- Sensitive receptors: the study considers the aviation receptors specified by the FAA which are the Air Traffic Control Tower and the final flight path approaches (east and west). The study also considers other potential sensitive receptors in the vicinity of the solar energy park location such as Al Jouf University and the proposed Modon Industrial City for Women.
- Irradiance and ocular parameters that are required for the classification of the glare risk level.

Based on the assumptions and design parameters taken into account in this study, the model did not predict glare occurrence at any of the FAA specified receptors for any of the modelled system design variations.

For non-aviation receptors the model predicted a 'low potential for temporary after image' in the case of a dual axis tracking system only. The identified glare is predicted to occur at Al Jouf University, the proposed Modon Industrial City for Women and at the Saudi Electricity Company (SEC) Power Plant and is predicted to occur at sun elevation angles of approximately 1° to 3.5° (from horizontal). If necessary, trackers can be programmed to avoid reaching elevation angles at which glare is predicted to occur. Furthermore, it is noted that due to the low ocular hazard level and the relatively small duration of the predicted glare, the resulting planning risk of a dual axis tracking system appears to be low.

17.5.2.2 Motor vehicle accidents from occasional maintenance visits (HS07)

The Sakaka Solar Energy Park will involve automated infrastructure, and will not require intensive maintenance operations. For this reason, the impact on road safety is anticipated to be minimal compared with the existing conditions.

Table 17-5 Summary Assessment of Health Impacts During Operation

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HS06a	Local community residents	High	Glint and glare from PV panels	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		

ID	Receptor	Sensitivity	Impact	Impact Characterization		Magnitude	Significance
HS06b	Road users	High	Glint and glare from PV panels	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		
HS06c	Pilots / aviation receptors	High	Glint and glare from PV panels	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Reversible		
HS07	Road users	High	Motor vehicle accidents (with associated risks of injuries, fatalities and effects on mental wellbeing)	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Rare		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Irreversible		

17.5.3 Decommissioning Phase

The impacts associated with the decommissioning of the Park with regard to health and safety, are expected to be similar to those expected to occur during the construction phase. Refer to section 18.5.1.

17.6 Mitigation

This section details the mitigation which should be included as part of the detailed design, construction and operational stages to reduce potential impacts further and/or realize further benefits.

A hierarchical approach to mitigation development has been adopted to manage impacts identified for the construction, operational and decommissioning phases of the Park.

- Avoid – Alter the design of the project such that an effect is avoided
- Reduce – Alter the design of the project so that an effect is reduced

- Abate – Abate the effect either at source or at the receptor
- Repair – Restore or reinstate a feature after effects have occurred (i.e. temporary construction impacts)
- Compensate – Compensate for permanent loss or damage of a feature

Implementation of mitigation measures will be required during construction, commissioning, operation and decommissioning of the facility to minimize potential negative impacts of the activities on health and safety aspects. The mitigation measures comprise a combination of, management procedures and further assessments to be undertaken at detailed design and are described in the subsequent sections. The following text assesses the impacts predicted against appropriate mitigation measures to predict the residual impact significance.

17.6.1 Construction Phase

Construction phase impacts will be mitigated through the application of measures set out in Table 17-6.

Table 17-6 Construction Impact and Mitigation Summary

ID	Potential Significance	Mitigation Measures	Residual Significance
HS01a	Low	A dust management plan (DMP) is recommended as outlined in chapter 6 Air Quality and Meteorology.	Negligible
HS01b	Low	No additional measures over and above adherence to the international best practice and correct use of PPE have been identified.	Low
HS02	Low	No additional measures over and above adherence to quality control measures for tanked water supplies have been identified.	Low
HS03	Moderate	Training and awareness on issues such as defensive driving will be provided to the workforce.	Low
HS04	Moderate	Early engagement with local service providers to assess the capacity of the region to absorb any potential issues should be undertaken, and this will inform the design and staffing of the facilities to ensure local services are not adversely affected. This consultation should include all emergency services to ensure agreement is reached on the most effective mechanisms to deal with any major incident. Worker accommodation should be developed in accordance with: • Environmental, Health and Safety (EHS) Guidelines (2007) which detail specific requirements for Occupational and Community Health, Safety and Welfare. • IFC Performance Standard 2 – Labor and Working Conditions. • IFC Performance Standard 2 handbook for	Low

ID	Potential Significance	Mitigation Measures	Residual Significance
		Labor and Working Conditions. IFC and European Bank for Reconstruction and Development (EBRD) guidance note: Worker's Accommodation: Process and Standards (IFC 2009).	
HS05a	Moderate	In addition to the health screening and measures in place for establishing worker accommodation, training and awareness raising on issues such as infection control and health promoting activities will help mitigate the effect further.	Low
HS05b	Low	No further measures have been identified other than the health screening and measures in place for establishing worker accommodation.	Low

17.6.2 Operation Phase

Operation phase impacts will be mitigated through the application of measures set out in Table 17-7.

Table 17-7 Operation Impact and Mitigation Summary

ID	Potential Significance	Mitigation Measures	Residual Significance
HS06a	Low	In the event that local concerns from the community are raised in relation to glint and glare, fencing or other forms of visual barriers could be implemented to screen the solar panels from nearby community receptors.	Negligible
HS06b	Low	In the event that local concerns from the community are raised in relation to glint and glare, fencing or other forms of visual barriers could be implemented to screen the solar panels from nearby roads.	Negligible
HS06c	Moderate	Due to the proximity of the Al-Jouf International Airport, a Geometric Glint and Glare assessment has been undertaken to inform the design of the Park and address concerns regarding the possibility of solar reflections affecting aircraft on the approach/departure to/from the airport. No glint and glare impact was identified as a result of the introduction of the Park.	Low
HS07	Low	Training and awareness on issues such as defensive driving will be provided to the workforce.	Negligible

17.6.3 Decommissioning Phase

The mitigation measures required and recommended for decommissioning are the same as those set out for construction phase impacts (refer to Table 17-6).

17.7 Conclusion

This chapter has assessed health and safety aspects of the construction, operation and decommissioning of the Sakaka Solar Energy Park. Due to the relatively isolated location of the Park and the type of construction involved, the main potential impacts relate to the risk of transmission of communicable diseases between workers, construction related accidents and injuries, and increased risk of traffic accidents during operation. Adherence to international best practice and national labor law and Saudi Aramco policies will help to mitigate these impacts.

The glint and glare assessment revealed the no impacts from this issue are expected to occur as a result of the Park.

17.8 References

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18. Sustainable Development

18.1 Introduction

As a part of the Environmental and Social Impact Assessment (ESIA), it is important that the sustainability of the proposed development is evaluated against a range of recognized criteria, giving consideration to economic, social and ecological processes as well as the optimization of trade-offs across the three systems. The assessment of sustainability provided by this section has been undertaken by analyzing how elements of sustainable development were integrated into the ESIA process and into the design and planning of the Park itself. The sustainable development assessment is designed to ensure that the entire lifecycle of the Park is taken into consideration.

18.2 Sustainable Development Context

18.2.1 Sustainable Development as a Policy Context

The modern concept of sustainable development emerged from a series of meetings and reports during the 1970s and 1980s. The most significant step in recognition of the concept of sustainable development came in 1987 when the UN-sponsored Brundtland Commission drafted '*Our Common Future*', which detailed widespread concerns about poverty and the environment in different regions of the world. The report stated that whilst economic development cannot stop, it must change course to ensure that it fits within the ecological limits of the planet. The Brundtland Commission defined sustainable development as: "*Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (UNWCED, 1987).

The Brundtland report also noted that; "*Major unintended changes are occurring in the atmosphere, in soils, in waters, among plants and animals. Nature is bountiful but it is also fragile and finely balanced. There are thresholds that cannot be crossed without endangering the basic integrity of the system. Today we are close to many of those thresholds.*"

The Commission identified a number of "common challenges" facing the earth:

- population and human resources;
- food security, species and ecosystems;
- energy;
- industrial development; and
- urbanization.

At the time of the Brundtland Commission, water sustainability and climate change were also identified as related/contributory issues, however these issues have since been acknowledged as serious global problems in their own right. The Commission went on to outline a series of "strategic imperatives," or "critical objectives," inherent in their concept of sustainable development. In response to the Commission's report, the need to respond to the concept of sustainable development gained momentum in organizations around the world. In 1992 the UN Conference on Environment and Development (also known as the 'Earth Summit') was held in Rio de Janeiro and attended by 172 of the world's governments. The Earth Summit achieved a broad political consensus around the concept of sustainability as articulated in the adopted 27 principles Rio Declaration, which provided a framework for governments to improve environmental and economic conditions around the world. The Summit also initiated Agenda 21, which introduced a comprehensive program of action for global

action in all areas of sustainable development. The establishment of the Millennium Development Goals (MDGs) at the Millennium Summit in 2000 continued the global movement towards the elimination of poverty and achievement of sustained development.

Since its inception four decades ago, the adoption of sustainable development principles has become factored into decision-making at all levels in government, public and private sector organizations throughout the world.

18.3 Sustainable Development in Saudi Arabia

Sustainable development is inherent in the principles of Islam, which hold that the protection, conservation and development of the environment and its natural resources are a mandatory duty to which every Muslim should be committed". In December 1994, the Kingdom of Saudi Arabia's Council of Ministers approved the Kingdom's National Agenda 21 implementation plan to achieve sustainable development goals, formalizing this inherent concept. The 9th National Development Plan (NDP) (2010-2014) has the overall theme of sustaining national development and supports an overarching goal of having the Kingdom of Saudi Arabia become: "A developed, thriving and prosperous economy, built on sustainable foundations. It will extend rewarding work opportunities to all citizens, will have a high-quality education and training system, provide excellent healthcare for all, and offer all necessary services to ensure welfare of all citizens; all while safeguarding social and religious values and preserving national heritage."

The modern concept of sustainable development (environmental, social and economic factors) is also enshrined within the legislation and policies of the General Administration for Meteorology and Environment, and the Royal Commission (RC). Recognition of sustainable development is also evident in the policies, procedures and activities of other organizations within the Kingdom, such as the Ministry for Energy, Industry and Mineral Resources, and Saudi Aramco.

The Kingdom's focus on diversification of industry, and expansion of the employment opportunities, is in keeping with the concept of sustainable development, and has increased focus on improving efficiency of resource use and taking advantage of green economy concepts.

Most recently, the government of the Kingdom of Saudi Arabia have produced their vision for the future of the country within the document 'Vision 2030'. Within this document, is a section entitled 'Achieving Environmental Sustainability', which lays out the foundations of the vision for the Kingdom of Saudi Arabia as it moves towards a more sustainable future.

The document draws on similar themes to the Bruntland report and the National Agenda 21. The document states that *"By preserving our environment and natural resources, we fulfill our Islamic, human and moral duties. Preservation is also our responsibility to future generations and essential to the quality of our daily lives. We will seek to safeguard our environment by increasing the efficiency of waste management, establishing comprehensive recycling projects, reducing all types of pollution and fighting desertification. We will also promote the optimal use of our water resources by reducing consumption and utilizing treated and renewable water. We will direct our efforts towards protecting and rehabilitating our beautiful beaches, natural reserves and islands, making them open to everyone. We will seek the participation of the private sector and government funds in these efforts."* Vision 2030 also includes a section related to Renewable Energy which puts forward the target for 9.5GW of renewable energy by the year 2023.

18.4 IFC and Sustainable Development

The International Finance Corporation (IFC) considers multiple dimensions of sustainability in its approach to risk management with regards to decision-making on its investments. This is articulated through the Sustainability Framework, an integral part of the IFC's strategic commitment to sustainable

development. The Sustainability Framework consists of the Policy on Environmental and Social Sustainability (IFC, 2012), which defines the IFC's commitments to environmental and social sustainability, and the Performance Standards, which define a client's responsibilities for managing the environmental and social risks associated with their project (IFC, 2012). This applies to all clients whose projects go through the IFC's initial credit review process, and therefore the Sustainability Framework applies to the Sakaka Solar Energy Park.

18.5 Assessing Sustainable Development

Although renewable energy projects such as the Sakaka Solar Energy Park, by their nature represent a shift from unsustainable, to more sustainable means of energy production, there exists an opportunity, through sustainable assessment to manage and mitigate the risks associated with the construction and decommissioning of the projects, to ensure that the entire project lifecycle is carried out in the most sustainable way possible.

There is no single methodology for assessing the incorporation of sustainable development principles by a project. In the case of the Sakaka Solar Energy Park, it is important that the assessment incorporates consideration of the sustainable development requirements of the Parks interested parties, namely the Lending Institution (World Bank/International Finance Corporation) and the General Administration for Meteorology and Environment (GAME), as well as the three core fundamentals of sustainable development (consideration of environmental, social and economic factors).

The assessment considers the incorporation of sustainable development in the various sections of the ESIA and the incorporation of sustainable development into the Park itself. The sustainability assessment assists in determining the extent to which sustainable development has been considered and incorporated into the ESIA process, which then in turn enables a more thorough assessment of sustainable development for the Park.

18.6 Sustainable Development Assessment Methodology

The ESIA has been prepared to address the environmental, social and economic requirements of the World Bank and IFC performance standards. Environmental, social and economic requirements as stipulated by the Kingdom of Saudi Arabia and GAME, as well as those of Saudi Aramco have been given due consideration in the preparation of the ESIA.

Table 2-1 within Chapter 2 - Policy, Legal and Regulatory Framework, demonstrates how the ESIA addresses the performance standards, and thus the integration of sustainable development principles. Therefore the sustainable development assessment shall focus on the extent to which the project may be considered sustainable. The sustainability of a development can be judged in terms of the extent to which it meets the needs of the present, without impinging on the needs of future generations. The principles of intra-generational and inter-generational equity can be used to evaluate this on the basis of the temporal and spatial extent of the impacts. Intra-generational equity is the principle of equity between different groups of people alive today. Similarly to inter-generational equity, intra-generational equity implies that consumption and production in one community should not undermine the ecological, social, and economic basis for other communities to maintain or improve their quality of life (International Institute for Sustainable Development (IISD), 1997). Examples of intra-generational equity include identifying impacts that may affect different social groups and ensuring suitable mitigation exists and giving consideration to the comments made by members of the public with regards to the project and ESIA.

Inter-generational equity is the principle of equity between people alive today and future generations. The implication is that unsustainable production and consumption by today's society will degrade the ecological, social, and economic basis for tomorrow's society, whereas sustainability involves ensuring

that future generations will have the means to achieve a quality of life equal to or better than today's (IISD, 1997). Examples of intergenerational equity include identifying ecosystems that may be affected by the development and assessing the risk of irreversible damage occurring to them and ensuring that an integrated assessment approach has been applied by the ESIA, weighing environmental, social and economic factors against one another.

Consideration is also given to global impacts for example climate change, loss of biodiversity, the depletion of natural resources and human rights.

The methodology employed for the sustainable development assessment of the project will consider the residual impacts identified within the ESIA of the Sakaka Solar Energy Park using the criteria of timescale and extent. The principles of intra-generational equity and inter-generational equity will be used to take account of the duration associated with each significant impact identified. The likely extent of the impact, in terms of geographical area, is also considered. Together these factors provide a means to evaluate the sustainability of the project.

The matrix presented as

Table 18-1 which has been developed using the principles of a risk assessment, and will be used to assess the sustainable development implications of the significant environmental, social and economic impacts of the Park.

Table 18-1: Criteria for Sustainable Development Assessment

TIMESCALE	Extended				
	Long				
	Medium				
	Short				
		Local	Regional	National	International
		EXTENT			

The definitions provided in Table 18-2 apply to each of the criteria for the sustainable development assessment.

Table 18-2: Definitions for Sustainable Development Assessment

Extent	Local	Within a 2km radius of the immediate Project area
	Provincial	Outside the local area, but within 200km
	National	Within the borders of the Kingdom of Saudi Arabia
	International	Outside the borders of the Kingdom of Saudi Arabia
Timescale	Short	Less than one year
	Medium	More than one year, but less than or equal to the operational lifetime of the project (25 years for the Sakaka Solar Energy Park)
	Long	Greater than the lifetime of the project, but less than or equal to 100 years
	Extended	Greater than 100 years

All residual environmental, social and economic impacts, regardless of significance, identified by the ESIA will be assessed against the sustainable development assessment criteria in order to give an indication of the sustainability of the project and plotted into the matrix illustrated in Table 18-1.

Those impacts which are grouped towards the bottom left of the table (i.e. shorter-term, localized impacts) can be considered to have a reduced impact on sustainable development (i.e. the project is more sustainable), whereas those residual impacts grouped towards the top right of the table (i.e. longer-term, widespread impacts) can be considered to have a greater impact on sustainable development (i.e. the project is less sustainable).

Positive impacts identified by the ESIA will also be plotted to identify the positive impacts on sustainable development generated by the Park. However, in the case of positive impacts, those grouped towards the top right can be considered more sustainable and those grouped towards the bottom left can be considered less sustainable.

18.7 Sustainable Development Assessment of the Sakaka Solar Energy Park

As discussed in ESIA Chapter 3 *Consideration of Alternatives*, the alternatives to the project considered environmental, social and economic factors.

This ESIA and its associated studies, such as the air dispersion modelling and noise study, have been performed during the design phase. These studies evaluate the effects of the project from an environmental, social and economic perspective. Predictions of potential significant impacts on both social and environmental components help to establish appropriate mitigation and enhancement measures at an early stage of the project. Through the consideration of environmental and social aspects in the various studies undertaken, the Park is integrating the principles of sustainable development.

Throughout the ESIA, at the end of each chapter, measures required to prevent, minimize or mitigate the identified impacts have been suggested. Implementation of the proposed measures is anticipated to minimize, negative impacts and enhance positive impacts in order to maximize the sustainability of the project. The residual impacts identified throughout the ESIA have been classified in terms of their temporal and spatial extent. These are presented in the following tables, by reference to the impact Identification Code (ID Code), which is consistent with the coding presented in each respective section of the ESIA. Colors used to indicate the significance of each residual impact are included within the key below each table.

Table 18-3 and Table 18-4 show the residual negative and positive effects of the Park classified according to their timescale and extent.

Table 18-3: Sustainability Assessment: Residual Negative Effects

TIMESCALE	Extended				
	Long	NO7 NO8			
	Medium	SG2 SG3 SG4 SG6 HH4 LA02 LA03 LA04 LA05 LA06 LA07 LA08 LA09 TB02 TB03 TB04 TB05 TB06 TB07 TB09 TB10 TB11 TB12 TB13 TB14	TB01 TB08 TB15		
	Short	SG1 SG5 SG7 SG8 HH1 HH2 HH3 HH5 HH6 HH7	SE01 SE02 SE03 SE04		

		NO1 NO2 NO3 NO4 NO5 NO6 LA01 CH01 TT01 TT02 TT03 TT04 UI01 UI02 WM01 WM02 WM03 WM04 WM05 WM06 WM07 WM08 HS01 HS02 HS03 HS04 HS05 HS06 HS07 SE06 SE10 SE11 SE12 AQ01 AQ02 AQ03	SE05 SE07 SE08 SE09		
		Local	Regional	National	International
		EXTENT			

Table 18-4: Sustainability Assessment: Residual Positive Effects

TIMESCALE	Extended				
	Long				AQ03
	Medium	UI03			
	Short				
		Local	Regional	National	International

The spatial and temporal classification of negative residual impacts identifies that the majority of residual negative impacts are localized to the area surrounding the development site, and are of low significance. The duration of these local impacts extend from the short term to medium term. This indicates that these impacts are anticipated to cease on completion of the Project life. The majority of negative residual impacts from the Project affect environmental factors associated with the modern concept of sustainable development.

18.8 The Sakaka Solar Energy Park and Stakeholder Engagement

One of the three core principles of sustainable development focuses on the social elements of projects. The purpose of stakeholder engagement is to understand and manage social impacts of projects, and is key. Chapter 14 *Socio-Economic Aspects*, and the stakeholder engagement plan addresses the social element of sustainability in more detail. The ongoing implementation of the Stakeholder Engagement Plan will further support the Project in understanding and responding to the social dimension.

18.9 Conclusion and Recommendations

In terms of long term environmental sustainability, the Sakaka Solar Energy Park represents a shift in traditional energy generation in the Kingdom of Saudi Arabia, away from fossil fueled power generation, towards the use of sustainable technology. This is a significant positive impact for the sustainability of the nation as a whole.

While there are negative impacts associated with the construction and decommissioning of the Park, these are far outweighed by the long term sustainability benefit of shifting the energy generation mix of

the Kingdom of Saudi Arabia away from fossil fuels, towards more sustainable forms of energy generation.

18.10 References

United Nations, (1987) Our Common Future - Brundtland Report. Oxford University Press, p. 204.

United Nations World Commission on Environment and Development (UNWCED) (1987) Our Common Future, Brundtland Report, Oxford University Press.

19. Cumulative Impact Assessment

19.1 Introduction

As part of the ESIA process, it is important to consider cumulative impacts. The objective of this chapter is to assess these impacts through consideration of the impacts of the Park as identified in the preceding chapters, and other projects taking place in the vicinity which could affect the same social and environmental resources and receptors that can expected to have a combined effect.

The cumulative impact assessment responds to the requirements of the International Finance Corporation (IFC) Performance Standard 1 Assessment and Management of Environmental and Social Risks and Impacts, which requires that environmental and social risks and impacts are identified in the context of a project's area of influence, including *"cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from other existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted."*

The IFC provides the following definition for cumulative impacts:

"Cumulative impacts are limited to those impacts generally recognised as important on the basis of scientific concerns and/or concerns from Affected Communities. Examples of cumulative impacts include: incremental contribution of gaseous emissions to an airshed; reduction of water flows in a watershed due to multiple withdrawals; increases in sediment loads to a watershed; interference with migratory routes or wildlife movement; or more traffic congestion and accidents due to increases in vehicular traffic on community roadway".

19.2 Existing and Future Proposed Projects

19.2.1 Stakeholder Consultation

Typically, proposed projects in the vicinity of a development would be confirmed during stakeholder consultation exercises. Stakeholder consultation will be an ongoing process to be carried out by the IPP during the development of the Park. The understanding of proposed nearby projects is expected to develop as stakeholder consultation progresses.

19.2.2 MODON City for Women

The Saudi Industrial Property Authority (MODON) have plans to develop an industrial city for women to the north of the development site. No further details of this project are currently available. Modon will be engaged through the stakeholder consultation exercise, in order to ascertain the details of this project.

19.3 Cumulative Impact With Other Projects

19.3.1 Meteorology, Climate & Air Quality

Chapter 6 *Meteorology, Climate & Air Quality*, identifies that the existing air quality at the development site is good, and that the impacts associated with the Park meet emission standards and do not impinge on ambient air quality outside the boundary of the Park, or at the nearest sensitive receptors either during construction/decommissioning or operation.

Due to the potential offset of diesel power generation at local fossil fuel power plants created by the Park, the ambient air quality headroom (and associated capacity for future development) is increased

by the Park. There are low levels of greenhouse gas emissions associated with the operation of the Park, and these are offset by the generation of renewable energy.

As the pioneering solar PV project within the Kingdom of Saudi Arabia, the Park has the potential to set a precedent for future development in the Kingdom of Saudi Arabia and begin a cumulative trend towards cleaner energy generation.

Impact CI01 – Moderate Significance

Table 19-1: Cumulative Air Quality Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI01	Air Quality	High	The current trend is towards degradation of air quality through the burning of fossil fuels at diesel powered power plants. The Park counteracts this trend by introducing renewable energy into the energy generation mix.	Effect:	Positive	Moderate	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Long		
				Extent:	National		
				Permanence:	Permanent		

19.3.2 Soils & Geology

Chapter 7 *Soils and Geology* identifies the minimal impact which the Park is expected to have upon the soils and geology of the local area.

There is no identified current trend of impact upon soils and geology in the local area arising from existing development.

Due to the reversible nature of impacts associated with the Park, the cumulative impact upon soils & geology is considered to be of low significance.

Impact CI02 - Low Significance.

Table 19-2: Cumulative Soils & Geology Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI02	Local Soils	Moderate	The Park will be entirely deconstructed and removed upon decommissioning.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Temporary		

19.3.3 Hydrology & Hydrogeology

Chapter 8 *Hydrology & Hydrogeology* identifies the predicted impacts upon local hydrology and hydrogeology expected to arise as a result of the Park. Impacts are expected to be minimal and limited to minor impacts associated with runoff of small quantities of cleaning fluids.

The current trend is towards the exploitation of aquifers within the Kingdom of Saudi Arabia. The Park does not draw on, nor is it expected to impact upon any groundwater resources, and therefore does not contribute towards the trend of exploitation.

The trend towards further development within the Kingdom of Saudi Arabia and the area surrounding the development site, will increase pressure on existing water resources such as desalination plants. The construction and operation of the Sakaka Solar Energy Park will contribute towards this trend, however, the impact is not expected to be major, and will be most significant during the construction phase of the park, which is temporary. Operation of the Park will require a very small amount of water and is not expected to contribute in a meaningful way to the continued increases in pressure on local water production facilities. No groundwater abstraction is to be carried out in relation to the development of the Park, contribution to cumulative trends would be through the utilization of existing supplies.

Surface water flow at the development site, and in the surrounding area is infrequent. The Park will have minor impacts upon these flows and therefore is not considered to contribute towards the cumulative trend of alteration of surface water flows within the Study Area.

Cumulative impacts are considered to be of low significance.

Impact CI03 - Low Significance

Table 19-3: Cumulative Hydrology & Hydrogeology Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI03	Local Soils	Moderate	The Park is expected to make a minimal contribution to the current trend of impacts upon hydrology & hydrogeology	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.4 Noise & Vibration

As identified in Chapter 9 *Noise & Vibration*, there are no sensitive receptors in the vicinity of the Park, and therefore no significant impacts are expected to arise from the Park in this regard. The development of the Park can be expected to result in increased noise levels at the development site during the construction phase however, during operation, noise levels are expected to be very low.

The significance of cumulative impacts associated with the Park upon the local noise environment is expected to be low.

Impact CI04 - Low Significance.

Table 19-4: Cumulative Noise & Vibration Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI04	Receptors in the surroundings of the development site.	Moderate	The Park is expected to make a minimal contribution to noise levels within the area surrounding the development site.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.5 Landscape & Visual

Low impacts were assessed in relation to the Park. The Park would represent the introduction of infrastructure into an environment which already contains significant infrastructure. Glint and Glare has been assessed and concluded to be no issue.

Impact CI05 - Low Significance

Table 19-5: Cumulative Landscape & Visual Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI05	Local Landscape	Moderate	The Park is expected to make a minimal contribution to the current trend of impacts upon landscape impacts	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.6 Terrestrial Biodiversity

As identified in Chapter 11 *Terrestrial Biodiversity*, all predicted impacts are too minor or negligible in the absence of mitigation. On the basis that the Park will not impact on any features of ecological value, no cumulative impacts are predicted.

Impact CI06 - Low Significance

Table 19-6: Cumulative Terrestrial Biodiversity Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI06	Local ecological receptors	Moderate	The Park is expected to have no impact upon ecological receptors in the local area.	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	International		
				Permanence:	Temporary		

19.3.7 Archaeology & Cultural Heritage

Chapter 12 *Archaeology & Cultural Heritage* identifies the predicted impacts of the Park upon known and unknown assets within the area surrounding the development site. There are no sensitive receptors within the development site, and therefore no significant cumulative impacts are expected to arise from the Park.

The potential for properly managed ‘chance find’ of assets during the development of the Park could result in a positive impact upon the understanding of archaeology and cultural heritage within the development site, and within the Kingdom of Saudi Arabia as a whole and the world.

The cumulative impacts associated with archaeology and cultural heritage are considered to be of low significance.

Impact CI07 - Low Significance

Table 19-7: Cumulative Archaeology & Cultural Heritage Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI07	Receptors in the surroundings of the development site.	Moderate	The Park is expected to have no impact upon known assets within the surrounding area and could potentially unearth new assets.	Effect:	Positive	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	International		
				Permanence:	Temporary		

19.3.8 Traffic & Transportation Infrastructure

Chapter 13 *Traffic & Transport Infrastructure* identifies the increases in traffic movements associated with the Park. The construction phase of the Park is expected to result in increased traffic on the roads surrounding the development site, however, the existing road network will provide more than the necessary capacity to accommodate the additional vehicles.

During the operational phase of the Park, the impact upon traffic and transport infrastructure is expected to be minimal, as it is restricted to occasional deliveries and a small number of workers travelling to and from the development site.

The current trend within the surrounding area is towards an increased volume of traffic making use of local roads. Although the Park will contribute to this during the construction phase, it is not likely to impact significantly upon this during the operation phase.

There is a potential for cumulative impacts upon local traffic and transportation infrastructure where projects are scheduled to be constructed simultaneously. Stakeholder consultation will confirm the program for other projects proposed within the local area.

The cumulative impact upon traffic & transport infrastructure is therefore considered to be low.

Impact CI08 - Low Significance.

Table 19-8: Cumulative Traffic and Transportation Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI08	Local roads	Moderate	There will be increased traffic during the construction phase of the Park.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Frequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.9 Socio-Economic Aspects

Chapter 14 *Socio-economic Aspects* identifies the socio-economic benefits of the Park in terms of job creation, economic development, and knowledge and skills enhancement for people within the local community in Sakaka. It is expected that the Park would make a positive contribution towards job creation and the economy of the town of Sakaka.

Impact CI09 - Low Significance

Table 19-9: Cumulative Socio-Economic Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI09	Local population	Moderate	Increased employment opportunities.	Effect:	Positive	Medium	Medium
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Continuous		
				Duration:	Medium		
				Extent:	Local		
				Permanence:	Temporary		

19.3.10 Utilities & Infrastructure Usage

Chapter 15 *Utilities & Infrastructure Usage* identifies the minimal impacts upon local utilities and infrastructure which are expected to arise as a result of the Park.

The current trend towards increased development in the local area suggests that local utility supplies will be subject to greater usage over coming years, although it is noted that capacity is expected to increase relative to demand.

There is sufficient headroom to accommodate the Park as the impacts expected to arise as a result of the Park are assessed as low significance, and therefore the contribution these make to the cumulative trend, are also assessed as low significance.

Impact CI10 - Low Significance

Table 19-10: Cumulative Utility and Infrastructure Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI10	Local Utilities & Infrastructure	Low	Increased strain upon existing capacity of local infrastructure	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Unlikely		
				Frequency:	Frequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.11 Waste Management

Chapter 16 *Waste Management* identifies potential waste expected to be generated by the Park during construction, operation and decommissioning. The construction phase of the Park will generate significant quantities of waste in the form of packaging used to transport panels from the manufacturing facility to the development site. Additionally, the decommissioning phase will generate significant quantities of expired rubble. There will be a requirement for management and careful disposal of these waste streams during the both the construction and decommissioning phases of the Park.

The current trend within the Kingdom of Saudi Arabia is towards increased waste generation, the Park will contribute to this during the temporary construction and decommissioning phases, however, due to the temporary nature of these impacts, and the very low levels of waste expected to be generated during the operational phase, they are not considered to represent a significant contribution to the cumulative impact and have therefore been assessed as low significance.

Impact CI11 - Low Significance

Table 19-11: Cumulative Waste Management Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI11	Local waste management infrastructure	Low	Increased volume of waste during the construction phase of the Park.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.3.12 Health & Safety Aspects

The Park is not expected to contribute towards Health and Safety Impacts in the local area. This is due to the low number of operational staff and the proposed management systems to be implemented.

Table 19-12: Cumulative Health and Safety Impacts

ID	Receptor(s)	Sensitivity	Contribution to Trend	Impact Characterization		Magnitude	Significance
CI11	Local waste management infrastructure	Low	Increased volume of waste during the construction phase of the Park.	Effect:	Negative	Low	Low
				Action:	Direct		
				Likelihood:	Likely		
				Frequency:	Infrequent		
				Duration:	Short		
				Extent:	Local		
				Permanence:	Temporary		

19.4 Conclusions

The environmental and social impacts of the Park are marginal and therefore do not represent any significant contributions towards cumulative impact trends within the surrounding area.

There are numerous identified positive cumulative trends associated with the development of the Park, particularly related to the precedent which it is hoped the Park will set in terms of the progression from fossil fuels to renewable energy sources and the change this will represent for the Kingdom of Saudi Arabia's energy generation mix.

20. Environmental Monitoring and Management Plan

20.1 Introduction

20.1.1.1 Purpose of this chapter

This chapter provides the outline and draft structure of the Environmental Management and Monitoring Plan (EMMP) that will be developed over the life of the Sakaka Solar Energy Park (the Park). The Independent Power Producer (IPP) will develop a detailed EMMP for the construction phase for approval by Ministry of Energy, Industry and Mineral Resources prior to implementation, and the EMMP for the operation phase of the Park will be developed during detail design.

20.1.1.2 Purpose of the EMMP

The purpose of the EMMP is to help facilitate and manage the identified environmental aspects and impacts of the proposed development as it progresses from detailed design through to the construction, commissioning, operation and decommissioning phases.

The EMMP translates the findings and recommendations of the ESIA, into a set of procedures and plans for implementation on the ground, and identifies those parties responsible for implementing them.

Guidance and instruction provided by the EMMP aims to reduce the risk of adverse effects to both the environment and those involved in the Park. The commitments recommended within the ESIA are provided in Appendix B-E.

The EMMP is consistent with the current design, which will be further developed over the life of the project. It has therefore been prepared as a dynamic document that will be reviewed and amended to a final EMMP for operation of the Park.

20.1.1.3 Scope of the EMMP

The scope of the EMMP includes the following:

- Identify environmental management responsibilities and assign individuals to them;
- Identify statutory obligations;
- Develop incident management and corrective action procedures;
- Identify complaint handling responsibilities;
- Provide an outline of environmental action plans, and staffing and training recommendations;
- Provide auditing requirements; and,
- Identify and provide guidance on training programs.

20.1.1.4 Objectives of the EMMP

The primary objectives of this EMMP are to provide an environmental management manual for use by management and staff involved in the Project and to provide information to regulatory authorities

regarding the environmental management practices that will be implemented throughout the life of the project.

The EMMP has the following main objectives:

- To provide a framework that facilitates Project compliance with environmental policy commitments and regulation through documentation of the mitigation measures that will be applied during the construction, commissioning and operational phases of the Project;
- To define the environmental action plan required to implement the various mitigation measures and recommendations outlined in the ESIA;
- To identify the monitoring programs that will be implemented to verify and manage predicted effects and confirm performance of mitigation measures;
- To describe resources that will be made available to implement the recommendations of the EIA including staffing and training requirements; and
- To manage environmental risk through training, audit and review.

20.1.1.5 Regulations and Guidance

The EMMP will be developed, in accordance with the following regulations and guidance:

- GAME General Environmental Regulations and Rules for Implementation (2001);
- GAME Supplementary Environmental Standards (2012);
- KSA Labor Law (2005).
- World Bank Environmental Assessment Sourcebook Update: Volume 3 – guidelines for environmental assessment of energy and industry projects.
- IFC (International Finance Corporation). January 2012. Performance Standards 1 – 8.
- IFC (2007), Environmental, Health and Safety (EHS) Guidelines, General EHS Guidelines.
- IFC (2007), Environmental, Health and Safety Guidelines for Electrical Power Transmission and Distribution.
- IFC (2012), Utility Scale Solar Power Plants: A Guide for Developers and Investors.
- A legislative overview is provided in Table 20-1.

20.1.1.6 Relationship to other plans

The EMMP shall be used in conjunction with actions plans, such as the Waste Management Plan, which address specific project-related risks and impacts and will guide the implementation of the Park so that it is undertaken in a safe, cost effective, planned and environmentally responsible manner.

EPC Contractors will be required to draw on the requirements of the EMMP and incorporate these into the Construction Environmental Management Plan (CEMP).

The EMMP seeks to integrate with existing documents including corporate and site specific management policies wherever possible.

20.2 Implementation of the Plan

20.2.1 Statutory Environmental Regulations

The Sakaka Solar Energy Park Environmental Manager and Construction Environmental Manager shall ensure compliance with all applicable Regulations and Guidelines, and shall ensure that new regulations are monitored and implemented as applicable and required.

The Park will be located within a Saudi Aramco reservation. The environmental permitting jurisdiction for this development therefore falls under the General Authority of Meteorology and Environmental Protection (GAME). Renewable energy developments in the Kingdom are required to achieve compliance with national regulations and standards, including the GAME Appendix 2.1 General Environmental Regulations and Rules of Implementation (GERRI) (2001). Under GERRI, GAME is responsible for issuing consent for projects and must ensure that an ESIA is prepared for any project that may have a negative environmental impact.

In addition, and where relevant, the Park must adhere to the requirements of the World Bank Group, specifically the IFC's World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines). These guidelines provide technical reference documents with general and industry-specific examples of good international industry practice, and are used by the IFC as a technical source of information during project appraisal activities. The following guidelines are of relevance to the Park:

- General Environmental, Health, and Safety Guidelines, April 30 2007;
- Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution

The IFC requires that when host country regulations differ from the levels and measures presented in the IFC Environmental, Health, and Safety Guidelines or World Health Organization standards, projects are expected to achieve whichever is more stringent.

In the event that the GAME do not specify a standard relevant to a project site, then the project shall use for reference other recognized regulations as a basis for technical justification in the following order:

- The U.S. Environmental Protection Agency (US EPA);
- U.S. State environmental rules and guidelines;
- European Union (EU) members environmental rules and guidelines; and,
- Other internationally recognized and accepted regulatory bodies.

A full summary of legislation relevant to this EMMP is included in Table 20-1.

20.2.2 Roles and Responsibilities

The Contractor(s), in consultation with the Client, is required to define the roles of the Construction Team, with specific reference to roles and responsibilities as they relate to the environmental management of their specific tasks. Responsibilities of the Construction Manager are shown in sections 20.2.2.1 to 20.2.2.3.

20.2.2.1 The Client

The Client's role (inclusive of a Project Management Team) includes but is not limited to the following:

- Outlining the environmental requirements for the project pursuant with company policy, standards and procedures, and providing copies of these;
- Advising of any changes to their environmental requirements especially those that may influence planning and permitting activities;
- Specifying any relevant site specific targets, impacts or mitigation measures (over and above GAME requirements known to the Construction Team) to be incorporated into permit applications;
- Providing information to enable the Project to meet its environmental objectives;
- Reviewing and approving deliverables and subsequently submitting these to the relevant authorities as appropriate, e.g. compliance reports and environmental performance reports;
- Being accountable for overall delivery and compliance with regulatory requirements including the GAME conditions of approval;
- To review and approve the Construction Environmental Management Plan (CEMP);
- To review and approve the Construction Manager's induction and training program (and monitor implementation);
- To attend Health, Safety & Environmental Management meetings as required;
- To train supervisors / managers to maintain communication of the provisions of the EMMP to all employees in order to enable employees to conduct their work in a sustainable manner and adhere to the environmental requirements outlined in the EMMP; and,
- To develop and operate a plant in accordance with relevant environmental regulations and commitments made within the ESIA and EMMP.

20.2.2.2 The Construction/Operational Manager

The Construction/Operational Manager is responsible for overall delivery of the project, including day to day activities on site, and performance of all activities and disciplines.

The duties and responsibilities of the Construction Manager shall include, but not be limited to, the following:

- The implementation and performance of the Site Health Safety and Environment (HSE) Plan;
- The implementation of the Construction Execution Plan;
- To input into the planning of the site temporary facilities, and manage the establishment of these facilities;
- To input into the scheduling of mobilization (and subsequent de-mobilization) of the construction supervision team;

- To input into the development of the construction schedule;
- To monitor site industrial relations and provide feedback to the construction director;
- To co-ordinate the construction supervision team and construction subcontractors within his/her area;
- To monitor the subcontractors compliance with their quality and inspection and test plans;
- To ensure the site co-ordination and performance of all construction subcontractors;
- To monitor subcontractors performance against their approved contract program and the overall construction schedule, and provide feedback to the construction director and the site team;
- To chair the weekly/monthly progress meetings as agreed with the construction director;
- To liaison with site engineering for the resolution of site technical queries;
- To prepare, and initial for agreement site instructions in accordance with the project applicable Terms & Conditions and C&C Procedures;
- To monitoring construction costs against approved budgets for the portions defined by the construction director. To identify and report any changes or potential changes to the work that may impact on construction costs and/or schedule, and initiate corrective action as instructed by the site manager;
- To input into the construction weekly and monthly reports; and,
- To maintain a daily diary and monitor the upkeep of the construction supervisors daily logs.

20.2.2.3 The Environmental Manager

The environmental manager will report to the construction manager and health and safety manager. Responsibilities include (but are not limited to):

- To develop, implement and adhere to a construction EMMP, to be approved by the health, safety and environment manager;
- To obtain all relevant statutory and non-statutory licenses that are the responsibility of the contractor for the construction phase;
- To coordinate and manage training of all staff in their respective project aspects prior to the commencement of commissioning and construction activities including coordination with the health, safety & environment manager.
- To ensure that all subcontractors are aware of their environmental management responsibilities;
- To manage day-to-day implementation of this EMMP;
- To undertake audits of all sub-contractors in accordance with the construction EMMP;
- To manage all monitoring in accordance with the construction EMMP;

- To establish environmental and social considerations during construction including environmental constraints on the project;
- To report directly and promptly to the health, safety & environment manager on all environmental and occupational health and safety matters including incidents and non-conformances;
- To conduct site inspections to ensure environmental management measures are effectively in place;
- To liaise with the health, safety & environment manager on and respond pro-actively to requests and instructions;
- To construct individual facilities in compliance with the clients environmental policy, and in accordance with relevant construction regulations, standards and best practice guidelines;
- To consider environmental and sustainability credentials in the procurement of materials, equipment and additional services (liaising with the HSE manager and client as appropriate);
- To ensure stakeholder consultation is conducted in alignment with the stakeholder engagement plan, liaising with client as appropriate;
- To identify key stakeholders and messages that need to be communicated;
- To contribute to the development of mitigation proposals;
- To consult with regulatory bodies regarding both the informal and formal permission and consent process;
- To evaluate, select, and work with sub-contractors to ensure management of environmental issues on the project;
- To be responsible for environmental considerations in working methods for all construction activities; and,
- To liaise/consult with local authorities and local communities.

20.3 Communication

Communications can be divided into internal communications, such as communications within the project team and design team and external communications, such as communications between the project team and other interested parties that may include regulators, contractors, the local community and local businesses.

The construction/operational project manager is responsible for monitoring on a weekly/monthly basis all communications between team members and other parties, and for ensuring that all matters relevant to the project are communicated to team members as quickly as possible.

The contractor project manager is responsible for implementing and monitoring internal communication on site.

Effective co-ordination and liaison on project activities is paramount to the successful implementation of the EMMP. The project management team should be committed to ensuring all issues requiring

liaison and co-ordination are identified, and a responsible person (e.g. Project Manager) with the required skills and experience should be appointed to resolve any issues.

For the successful implementation of the EMMP, it is essential that all persons working for, or on behalf of, the Project who have responsibility to undertake work activities that have the potential to cause significant environmental impacts, including those arising from the design process are:

- Aware of this EMMP and associated management and monitoring plans;
- Aware of the relevant environmental regulations and guidelines, as outlined in Table 20-1 and detailed in the ESIA;
- Aware of the details and commitments outlined in the relevant permits and approvals; and,
- Appropriately trained and competent to fulfil their roles within the Project.

20.3.1 Internal Communication

Environmental information will predominantly be communicated by ensuring that all relevant parties have a copy of the EMMP and associated plans. The contractor environmental manager will keep a register of all issued copies of the plans and will circulate any amendments to copy-holders.

The project management team will develop additional means of communication wherever necessary which may comprise meetings between disciplines, presentations, workshops, and training where applicable.

A register of all appropriate internal environmental communication will be compiled and a process will be implemented to allow all actions to be dealt with accordingly. All relevant internal communications will be stored for the duration of the project and should be made available for audit on a monthly basis.

20.3.2 External Communication

An environmental communications register will be used to track incoming and outgoing external environmental communications and will include defined responsibilities and timescales for responding to communications.

The following measures should be undertaken as a minimum to ensure that all relevant parties are kept informed about the works during implementation:

- Stakeholders and the local community should be informed of and provided information on the works program. This can take the form of meetings, letters, and other means of communication as appropriate;
- Notice boards should be erected, as appropriate, at the perimeter of the site to inform local residents, businesses and commuters about the progress of the works and of upcoming construction activities;
- Contact details, including physical address and telephone numbers should be placed on the notice boards for general public enquiries and complaints; and,
- Where communities are likely to be subject to significant impacts or disturbance during construction then consultation should be undertaken with those likely to be affected to explain the nature and timing of the works.

20.3.3 External Complaints Procedure

An external complaints procedure will be developed to respond to any complaints received by the project during the construction works. This will be a documented system to respond to complaints received by letter, by telephone or in person. All complainants will receive an appropriate response within a defined period. The IPP will suitably consider each justified complaint, developing mitigation measures if necessary and alter the site environmental method statement, in discussion with the contractor project manager.

A complaints register will be kept by the construction/operations project manager and made available during any audits and inspections as required. The register will contain all the justified complaints that have been received (including summaries of complaints received orally), a copy of the response will be sent to the complainant and a summary of how the complaint was responded to (e.g. the imposition of a further mitigation measure), if relevant.

20.4 Induction and Training

For the EEMP to be successfully implemented, it is essential that all persons working for, or on behalf of the project, who have responsibility to undertake work activities that have the potential to cause significant environmental impacts are appropriately trained and possess the required competencies to fulfil their designated roles within the project.

The construction/operations project manager in consultation with the environmental manager will be responsible for ensuring all personnel working on site have received an initial site induction. Records of induction will be maintained in a training register. Ultimate responsibility for identifying all environmental training needs rests with the construction/operations project manager, who is also responsible for ensuring that all key staff and personnel responsible for environmental management working on the project are competent in their roles.

As part of the commitment to achieving effective management of the environment, awareness training will be provided to all appropriate project management and site personnel. The primary focus of this training will be to ensure that all team members understand the key environmental issues and requirements associated with the project and the importance of compliance with environmental management documents. Training will generally include briefing on environmental issues of concern as part of induction training and toolbox talks, and cover general and specific environmental responsibilities with respect to:

- The overall functionality of the CEMP;
- The importance of conformance with the environmental policy and procedures and with the requirements of environmental management documents (e.g. risk of prosecution, requirements to discharge planning conditions etc.);
- Roles and responsibilities in achieving conformance with environmental policy, and with the requirements of environmental documents, including emergency preparedness and response training;
- The potential consequences of departures from specified operating procedures;
 - o General site issues;
 - o Traffic and access;
 - o Reporting procedures and reporting accountabilities;

- o Relevant environmental legislation and responsibilities;
 - o Environmental aspects and potential impacts, including:
 - o Air quality, including dust and odor;
 - o Noise and vibration;
- Protected species/areas;
- Waste disposal and recycling;
- Soils and geology;
- Water quality;
- Hydrogeology.
- Housekeeping requirements;
- Pollution prevention; and,
- Incident management and use of the Environmental Emergency Response Plan (EERP).

Job specific training including competency assessment shall also be provided to staff carrying out activities with environmental implications such as waste or hazardous materials handling and disposal operations. This will be developed following a detailed training needs analyses.

Environmental awareness among site personnel should also be promoted through media such as notice boards and newsletters. All site personnel will be made aware of the structure and individuals by which environmental issues are managed.

The HSE manager will be responsible for training on hazards, risks, and emergency response connected to the EMMP.

20.5 Audit, Corrective Action & Reporting

The environmental performance of the Project will be monitored and evaluated by carrying out regular environmental audits/inspections of the project. The information from these reviews will be documented in an audit report passed to the IPP project management team for action in the event of non-compliance.

Environmental audits will be conducted to evaluate the actual environmental performance of the project. The audit frequency will vary according to the environmental impact, legislative requirements and the auditor's assessment of the project team's competence.

Audits will be undertaken throughout the construction phase on a weekly/monthly basis by the IPP environmental manager and will focus on the following aspects of performance:

- Management system verification;
- Site arrangements, working conditions and site behavior (to ensure these are not damaging or posing risk to the environment);

- Relevant consents and permissions have been obtained; and,
- Work is being performed in accordance with the relevant environmental policies, objectives, management system requirements, licenses and consents, specifications and approved CEMP and method statements as applicable.

20.5.1 Non-Conformance, Corrective and Preventative Action

Non-conformances will be defined as one or more of the following:

- There is evidence of a serious failure or breakdown of a process or system;
- Lack of a procedure defining a particular process or activity, which, is required by a standard, legislation or EMMP and associated plans;
- Evidence of a lack of awareness or compliance with the requirements of an existing procedure, EMMP and/or method statement;
- A one off contravention of the requirements of a procedure or rule;
- Potential damage to the environment; or
- Evidence of or the potential for breach of, environmental legislation.

In accordance with IPP corporate policy, preventive action should occur either to prevent re-occurrence and/or to prevent potential non-conformities in the future. A project non-conformance, corrective and preventative action procedure form should be compiled in the event of a non-conformance. This details how the project will identify, handle and investigate non-conformances; will take action to mitigate any adverse impacts caused; and will be used for initiating and completing corrective and preventative action.

The IPP and construction/operations management teams will be responsible for ensuring that all non-conformances are appropriately investigated and for ensuring that the appropriate corrective actions are developed and implemented.

The construction/operations project management team will report all significant environmental non-conformances to the project management team. Agreed actions arising from any non-conformances raised by the site inspection/audit will be completed within an agreed timescale, monitored through to completion and in line with the requirements of the procedures.

A register will be kept by both the IPP environmental manager and the contractor project manager, of all non-conformances that will include, but not be limited to;

- a copy of the non-conformance report,
- a summary of the ensuing investigation; and,
- details of the proposed corrective action and evidence of its implementation.

20.5.1.1 Reporting

A report on each aspect-specific environmental audit will be produced on a monthly basis.

Each of the aspect-specific environmental audits will require a separate audit report, which will highlight;

- Any environmental legislative non-conformities;
- Any non-compliance to environmental method statement;
- Any required improvement;
- Any training requirements; and,
- Any other issue of concern identified by the audit.

Any environmental or social issue of significance identified during the audit, even if not related to the specific topic covered, will be highlighted as part of the audit report.

20.6 Associated Monitoring and Management Plans

Table 20-2 provides the environmental action plans for the various mitigation proposals described in the ESIA. These tables will be updated as the project proceeds through detailed design.

The action plans should be supplemented with all good practices as recommended throughout the ESIA.

The EMMP will be supported by a series of management plans. An outline of these plans are given in sections 20.6.1 to 20.6.8, and will be developed and updated through the project accordingly.

It should be noted that these are recommended plans based on the current phase of the Park, and other plans should be developed as appropriate.

20.6.1 Construction Environmental Management Plan

The IPP shall develop, implement and maintain a construction and commissioning phase Environmental Emergency Response Plan (EERP) and Construction Environmental Management Plan (CEMP) as supporting documents to this Environmental Management and Monitoring Plan (EMMP).

The plans will detail responsibilities and procedures for environmental management during construction, including (but not limited to):

- Minimum technical standard of construction plant;
- Competencies and training requirements of staff with environmental responsibilities, and lines of communication in the event of an emergency (including accidental releases of hazardous substances);
- A dust management strategy to reduce dust emissions from construction activities. This will include dust suppression of haul routes and covering loads on construction vehicles;
- Speed restrictions to reduce dust emissions from construction vehicles;
- A 'chance find' procedure in the event that previously undiscovered archaeological or cultural heritage artifacts are recorded.

- Site clearance procedures that allow species to move away before clearance, rather than being trapped within the construction area;
- A construction site waste management plan and erosion and pollution prevention measures to reduce the risk of contaminants entering the natural environment;
- Identification and control of water discharges, to ensure the drainage capacity of the location, and to minimize erosion potential;
- Procedures to be implemented following an accidental release of hazardous substances, e.g. during refueling, including details of containment and recovery measures to be applied; and,
- Availability of pumps and spill mitigation materials such as absorbent granules to contain and recover hazardous substances releases.

The contractor will undertake regular audits of the above management plans to confirm their on-going effectiveness.

20.6.2 Site Waste Management Plan

The EPC Contractor will develop a site waste management plan to identify in more detail anticipated wastes, and their quantities, and undertake waste planning for treatment and disposal. This will be prepared and implemented by the contractor before the production of any waste material.

The scope of the site waste management plan should cover the activities undertaken by contractors during the construction phase of the development. The management of waste on site will be undertaken in accordance with the waste management hierarchy. This hierarchy outlines that waste prevention and minimization are the first priority in managing wastes, followed by waste reuse and recycling. Disposal of waste will only be considered as a last resort.

The purpose of the site waste management plan is to facilitate the appropriate management of waste that will arise during the construction of the development. The plan will ensure that appropriate procedures are developed to prevent and/or reduce waste production, maximize recycling and minimize the potential adverse impacts associated with waste handling and disposal.

The site waste management plan will detail (but not be limited to):

- Waste and recycling objectives and targets;
- Waste segregation, storage, recycling and management procedures;
- Maximum storage times, and details of waste handling and labelling requirements;
- Selection, monitoring and auditing of waste contractors, and off site waste management facilities;
- Waste vehicle requirements;
- Competencies and training requirements of staff with responsibilities for managing waste storage areas;
- Procedures and lines of communication to be followed in the event of an emergency (including accidental releases of hazardous substances);

- Procedures to be implemented following an accidental release of hazardous substances, including details of containment and recovery measures to be applied; and
- Procedures for the monitoring of waste generation, and collection and reporting data on this.

Staff will be trained on the on-site waste management systems (as appropriate), use of spill mitigation materials and equipment, and procedures to be followed in the event of emergency incidents, such as accidental releases of hazardous substances.

Regular audits of the management plans to confirm their ongoing effectiveness will be undertaken.

20.6.3 Traffic Management Plan

The purpose of the construction traffic management plan is to control movement of vehicles, plant and pedestrians that are present both on the construction site and adjacent road network and to ensure that safety is not compromised. It is recommended that this plan is revised if traffic figures are updated.

The objectives of the construction traffic management plan are:

- To provide protection to workers and the general public from traffic hazards that may arise as a result of the construction activity;
- To manage potential adverse impacts on traffic flows;
- To ensure network performance is maintained at an acceptable level; and
- To minimize adverse impacts on users of the road and adjacent properties and facilities.

The IPP shall develop, implement and maintain a construction phase traffic and transportation management plan, for approval by IPP project management team prior to commencement of construction. This plan will detail as a minimum, the following:

- Responsibilities for traffic and transportation aspects, including daily transportation of workers and deliveries to site;
- Statement that only licensed and experienced drivers shall be employed;
- All vehicles, equipment and machinery shall undergo regular maintenance with manufacturer specifications;
- All drivers must adhere to speed limits;
- Procedures to be put in place for monitoring of increased traffic movements and associated environmental and safety concerns;
- Requirements for all drivers to be trained through third party agencies and possess competency certificates; and,
- Procedures to be implemented to monitor the condition of the roads used by the traffic associated with the Park, and a maintenance program to be implemented to ensure that roads remain in good condition.

The contractor will undertake regular audits of the management plan to confirm ongoing effectiveness.

In accordance with the IFC EHS general guidelines vehicles will not access the public highway wherever possible. Where vehicles must use the highway network, an appropriate access will be identified.

No vehicles shall leave the site with materials adhering to the wheels in a quantity which may result in its being deposited on the public highway, and creating nuisance, or hazard to vehicles. Suitable wheel washing equipment to avoid such problems shall be installed if appropriate, operated and maintained on the site until the development is completed.

20.6.4 Air Quality and Dust Monitoring and Management Plan

The EPC contractor will develop and implement a dust management plan (DMP), which may include measures to control other emissions, approved by the local authority. The level of detail will depend on the risk, and should consider (but not be limited to) the following:

- Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken;
- Make the complaints log available to the local authority when asked;
- Record any exceptional incidents that cause dust and/or air emissions, either on or off site, and the action taken to resolve the situation in the log book;
- Hold regular liaison meetings with other high risk construction sites within 500m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimized. It is important to understand the interactions of the offsite transport/deliveries which might be using the same strategic road network routes;
- Undertake daily onsite and offsite inspection, where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary, with cleaning to be provided if necessary;
- Carry out regular site inspections to monitor compliance with the DMP, record inspection results, and make an inspection log available to the local authority when asked;
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions; and
- Agree dust deposition, dust flux, or real time PM10 continuous monitoring locations with the Local Authority. Where possible commence baseline monitoring at least three months before work commences on site or, if it is a large site, before work on a phase commences. Further guidance is provided by the Institute of Air Quality Monitoring (IAQM) on monitoring during demolition, earthworks and construction.

20.6.5 Noise and Vibration Management Plan

The EPC contractor shall develop a noise and vibration management plan detailing measures to control noise and vibration emissions during construction and operation. This will include (but is not limited to):

- Details of the noise monitoring program and procedures for its implementation;

- Use of temporary sound-proof enclosures and anti-vibration measures, where appropriate, to reduce noise levels on site; and
- Maintenance procedures of all equipment in place to minimize noise from equipment.

The construction manager will undertake regular audits of the above management plans to confirm their ongoing effectiveness.

Prior to decommissioning/closure of the Park, the IPP shall evaluate potential noise and vibration sources associated with planned decommissioning activities, and establish measures to ensure these activities comply with the necessary noise guidelines at the sensitive receptors.

20.6.6 Chance Find Procedure

A 'chance find' procedure will be developed for the Park, to be implemented during construction, in order to identify any previously unrecorded archaeological sites or un-stratified archaeological finds. This procedure will be outlined and included within the construction environmental management plan. This procedure is in compliance with the requirements of IFC Performance Standard 8.

20.6.7 Closure and Decommissioning Plan

The IPP shall further develop the outline closure / decommissioning plan prepared for the ESIA, and attached to this EMMP over the life of the Park.

This will provide adequate detail for sound, and sustainable site decommissioning and closure. The closure / decommissioning plan should utilize the structure and content established within the outline closure / decommissioning plan, and build on this, refining and adding details as the Park develops. The structure and content of the outline closure / decommissioning plan shall be in compliance with IFC EHS general guidelines.

20.6.8 Social Impact Management Plan

Social impact management plans (SIMP) are generally prepared and implemented following completion of the project risk reviews and the ESIA process in cases where:

- Displacement of impact communities may occur and resettlement may be required;
- The project exists on indigenous lands, where customary or traditional land ownership applies and/or cultural heritage sites are located;
- There is potential for significant population influx;
- Significant health risks apply or are likely to apply; and,
- There is a requirement to undertake training of people from local communities to achieve local employment targets.

A number of positive socio-economic impacts have been identified as part of the impact assessment. These benefits may be maximized for the local community, through the implementation of the following recommendations:

- The contractor will be encouraged to make job opportunities during construction available to the local workforce, and promote engagement of the local population in the construction phase;

- The IPP should consider the provision of training during the construction phase, to increase local knowledge of the construction industry and in particular at the Al Jouf University to advance training in skills required for construction and operation of renewable energy projects;
- The contractor will consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population;
- The IPP should establish social performance criteria for their suppliers, to promote the maximization of local sourcing of materials, local employment, and implementation of sound sustainable business practices;
- The IPP should continue stakeholder engagement in accordance with the stakeholder engagement plan; and,
- The IPP shall provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites where appropriate.

20.6.8.1 Resettlement / Restoration Livelihood Plan

Livelihood restoration plans should be developed in advance of construction following consultation with relevant stakeholders and community users to ensure the Implementation of IFC Performance Standard 5. The plan should identify the level and type of compensation and should include non-monetary measures. The restoration plan should make special consideration of vulnerable groups and users, and ensure compensation is appropriate to their needs and is delivered in a manner which protects their right to any compensation.

The requirement for a resettlement / restoration livelihood plan should be further considered by the IPP as part of its commitment to ongoing consultation with the local community.

20.7 Key Performance Indicators (KPI)

The IPP shall implement a monitoring and reporting strategy in the form of KPIs. These can be grouped into four main categories:

- Resource use – water, raw materials
- Emissions to land – industrial waste (hazardous and non-hazardous)
- Emissions to air – Nitrogen oxide, sulfur dioxide, greenhouse gases
- Emissions to water – nutrients and inorganic pollutants, heat

The KPIs will be developed through detailed design and implemented for both construction and operation.

Example of applicable socio-economic KPIs can include:

- Percentage of construction workforce from within the local or provincial area;
- Number of students in receipt of The IPP sponsored training; and
- Percentage of operational workforce trained with transferable industry skills.

20.8 Action Plan

The environmental action plans (EAP) in Table 20-1 provide a detailed list of the environmental recommendations and mitigation identified in the ESIA, which should be implemented on site at each phase of the Park. The EAP is a live document and should be developed throughout the life of the Park to ensure the Park delivers to the required standards and objectives.

The EAP, where appropriate, includes assumptions that have been made in the development of the ESIA assessment where non-compliance with these assumptions may change the overall assessment (e.g. air quality, noise and mobile plant etc.). Recommendations and/or actions identified in the ESIA to deliver positive/beneficial impacts are also identified.

The EAP should be revised to include any recommendations or conditions from the GAME and/or lending institution upon authorization of the Park. It should also include any conditions relating to environmental protection, enhancement monitoring or management associated with any permits or permissions from other statutory authorities as the project progresses.

20.9 EMMP Conclusions

This chapter has been developed based on the current known design and associated Environmental and Social Impact Assessment of the Park.

The successful delivery of the EMMP is dependent upon:

- Effective communications, both internal and external;
- Comprehensive and ongoing environmental awareness training for all staff tailored to their role;
- Engagement of environmental engineers in all phases of the Park to design out potential environmental issues and design in effective mitigation and management procedures;
- Development of comprehensive management plans and method statements for specific environmental issues (e.g. air quality etc); and
- Rigorous on-site management of environmental issues and compliance with the site rules.

This EMMP should be reviewed and updated throughout the life of the Park to incorporate design and legislative changes.

Table 20-1: Relevant Legislation

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
Air Quality and Dust			
A01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 12
A02	GAME Environmental Standard 19: Ambient Air Quality (2012)	Defines the thresholds, standards, and monitoring for ambient air quality	All
A03	GAME Environmental Standard 2: Mobile Source Emissions (2012)	Defines the thresholds for various plant and vehicle emissions for construction and operation	All
A04	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of emissions and prevention of pollution.	All
A05	IFC General EHS Guidelines (2007)	Ambient Air Standards and standards for emissions	Section 1.1
		Air Quality Standards for Occupational Health	Section 2.4
		Guidelines for Construction Air Quality Management	Section 4.1
		Guidelines for Construction Dust Management (Occ. Health)	Section 4.2
A06	GAME Environmental Standard 3: Point Source Emissions (2012)	Defines the thresholds, standards, and monitoring for point source emissions to air	All
Noise and Vibration			
B01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 13
B02	GAME Environmental Standard 3: Noise Standards (2012)	Defines the thresholds, standards, and monitoring for Noise	All
B03	IFC General EHS Guidelines (2007)	Noise Standards and monitoring requirements	Section 1.7
		Noise and vibration Standards for Occupational Health	Section 2.3
		Guidelines for Construction Noise & Vibration	Section 4.1
B04	BS 5228:2009 Part 1	Guidelines for Construction Noise and mitigation	All
B05	BS 5228:2009 Part 2	Guidelines for Construction vibration and mitigation	All
Water Management			
C01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 13
C02	GAME Environmental Standard 10: Drinking Water Standards (2012)	Defines the water quality standards for potable water	All

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
C03	GAME Environmental Standard 17: Industrial and Wastewater Discharge Standards (2012)	Defines the standards for discharge of wastewater to treatment works and the environment, monitoring and permitting.	All
C04	GAME Environmental Standard 20: Ambient Water Quality Standards (2012)	Defines the baseline standard for all water bodies, and provides the basis for monitoring and requirements for restoration.	All
C05	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of water and prevention of pollutions.	All
C06	IFC General EHS Guidelines (2007)	Guidelines and standards for wastewater treatment and water quality management	Section 1.3
		Guidelines and standards for the recycling and re-use of water.	Section 1.4
		Guidelines for the supply of potable water, and water provision under occupation Health	Section 2.1
		Guidelines on the protection of water quality and quantity for the Community	Section 3.1
		Guidelines for the management of wastewater during construction.	Section 4.1
Contaminated Land			
D01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles;
		Minimization of environmental pollution, and restoration following incident	Article 11
		Minimize exposure to pollution, and handling of materials, chemicals or wastes	Article 12
		Pollution Prevention	Article 13
		Control of hazardous substances (storage and use)	Article 14
D02	GAME Environmental Standard 9: Waste Classification	Guidance on the composition of the classification of types of waste (including hazardous) including toxicity leaching standards.	All
D03	GAME Environmental Standard 13: Waste Handling and Storage	Guidance and standards for the segregation, storage on site (including storage receptacles) program for removal of waste, and pollution prevention.	All
D04	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution.	All
D05	IFC General EHS Guidelines (2007)	Guidelines and standards for the management of hazardous materials onsite (including pollution prevention)	Section 1.5
		Guidelines for the management of small quantities of hazardous materials (e.g. oils, batteries etc)	Section 1.6

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
		Management of Contaminated Land (principals and guidelines)	Section 1.8
		Management of hazardous materials (storage and use) for Occupational Health	Section 2.4
		Construction management of contaminated land and use of hazardous materials.	Section 4.1
Ecological Management			
E01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 8
E02	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution.	All
E03	IFC Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Guiding Principles for the protection and management of biodiversity, habitats, and ecosystem services	All
E04	KSA Royal Decree M/22 (1406)	Framework for the establishment of the Saudi Wildlife Authority	All
E05	KSA royal Decree M/12 (1415)	Provides legislation for the development of a system of protected areas, and regulations for the continued protection of wildlife and habitats.	All
E06	World Bank Environmental Assessment update 20: Biodiversity and Environmental Assessment (1997)	Guiding principles for assessing and mitigation biodiversity impacts from construction and operation.	All
Waste Management			
F01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All general articles; Article 12, 13 & 14
		Hazardous waste – rules and procedures	Appendix 4
F02	GAME Environmental Standard 1: Waste Recycling	Guidance on the types of waste appropriate for recycling and promotes sustainable waste management	All
F03	GAME Environmental Standard 8: Waste Acceptance Criteria	Guidance on the types of waste accepted at different waste facilities and the responsibilities of operators	All
F04	GAME Environmental Standard 9: Waste Classification	Guidance on the composition of the classification of types of waste (including hazardous) to be used in conjunction with other GAME Standards for defining waste management strategies.	All
F05	GAME Environmental Standard 12: Waste Control and compliance	Guidelines for the management, tracking and monitoring of waste from generation to disposal	All

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
F06	GAME Environmental Standard 13: Waste Handling and Storage	Guidance and standards for the segregation, storage on site (including storage receptacles) program for removal of waste, and pollution prevention.	All
F07	GAME Environmental Standard 15: Waste Transportation	Guidance, policies and procedures for the management, tracking and monitoring of waste transportation including hazardous and dangerous waste.	All
F08	GAME Environmental Standard 18: BPO Waste Disposal	Guidance for undertaking BPO assessment for determining the best method for disposing of waste utilizing the waste hierarchy.	All
F09	IFC General EHS Guidelines (2007)	Guidelines and standards for the management of hazardous materials	Section 1.5
		Guidelines and standards for the management of waste on site (including waste minimization, storage and transport)	Section 1.6
		Guidelines for the protection of community health from transport of hazardous waste	Section 3.5
		Emergency Preparedness	Section 3.7
		Construction management of waste, hazardous waste and occupational HSE.	Section 4.
F10	IFC Performance Standard 3: Resource Efficiency and Pollution Prevention	Guiding Principles for the management of resources and prevention of pollution (including management of hazardous materials.	All
General legislation			
G01	GAME General Environmental Regulations 2001	Provides definitions and general guidance on minimizing impacts	All
G02	IFC Performance Standard 1: Assessment and management of Environmental and Social risks and impacts	Provides general guidance on the processes and procedures for the assessment and management of environmental impacts including stakeholder consultation	All
G03	IFC Performance Standard 2; Labor and Working conditions	Provides definitions and general guidance on minimum standards for employment of workforce	All
G04	IFC Performance Standard 4; Community Health Safety and Security.	Provides definitions and general guidance on managing impacts on the local community including degradation of ecosystem services and emergency response.	All
G05	World Bank Environmental Assessment Sourcebook Update: Environmental Management Plans	Provides guidelines on the production, contents and implementation of environmental management plans	All

Reference Number	Legislation/ Guidance	Summary of relevant environmental aspects	Applicable Section
G06	World Bank Environmental Assessment Sourcebook Update: Public Consultation in the EA process: A Strategic Approach	Provides guidelines on the engagement of the local community and stakeholders	All
G07	IFC/EBRD: Workers' accommodation: processes and standards. A guidance note by IFC and the EBRD	Guidance on the standards and requirements on the provision of workforce accommodation	All
G08	IFC General EHS Guidelines (2007)	Guidelines for the provision of HSE training and Awareness, traffic management and safety	Section 2.2 Section 4.2
G09	KSA Labor Law (2005)	Defines the working conditions and minimum welfare required for employment of all people within KSA	All in particular Chapters 1-4.
G10	KSA 9 th Development Framework	Outlines the development program to ensuring sustainable economic growth in KSA.	All
G11	IFC Performance Standard 8: Cultural Heritage	Provides guidelines on identification of cultural heritage and outlines guiding principles for its' protection	All

20.9.1 Action Plan

The following Environmental Action Plans (EAP) provide a detailed list of the principal environmental mitigation and recommendations identified in the ESIA, which should be implemented on site at each phase of the Park. The EAP is a 'live' document and should be developed throughout the life of the Park to ensure the Park delivers to the required standards and objectives.

The EAP should be revised to include any conditions or recommendations from the GAME and/or lending institution upon authorization of the Park. It should also include any conditions relating to environmental protection, enhancement monitoring or management associated with any permits or permissions from other statutory authorities as the implementation of the Park progresses.

Implementation of this action plan supports compliance with regulatory requirements and the mitigation of impacts in latter phases of the Park development.

Table 20-2: Action Plan

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
General Project Wide							
N/A	Further detailed design information	C	Update impact assessments in line with new detailed design information and information gathered from stakeholder engagement. Report in an Addendum. This is applicable to all chapters.	High	IPP	ESIA all chapters	G01, G02
N/A	Management of construction impacts	C	Develop and implement Construction Environmental Management Plan and Environmental Emergency Action Plan (or update as appropriate).	High	IPP	CEMP, EERP	G05
N/A	Sustainable Development	C	Continue to identify potential sustainability benefits through construction including: - Prevent or minimize environmental pollution, conserve natural resources, minimize waste and value cultural heritage - Implementation of mitigations and recommended measures proposed within the ESIA, and the resultant EMMP and all procedures and action plans developed to support the EMMP	Medium	IPP	ESIA all chapters	G01, G10, G02, G06
N/A	Communications and Training	C	- Identify appropriate mechanisms for communication for each stakeholder, and engage prior to commencement of works - Implement stakeholder engagement plan - Provide contact details for complaints	High	IPP	Stakeholder engagement plan	G06

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			and violations				
Meteorology, Climate & Air Quality							
AQ1, AQ2	Potential dust inhalation/ nuisance resulting from construction activities. Increase GHG emissions from the construction of the Park	C	The effects during the construction phase are temporary and the impacts will be short term and will only arise during specific construction activities. Following the application of the good practice dust control and mitigation measures in Chapter 6. it is considered that impacts at all receptors would be 'not significant' in accordance with the IAQM guidance.	Low	IPP	ESIA Chapter 6	A02, A05, A06
Soils & Geology							
SG1, SG4	Potential contamination of soils resulting from inappropriate discharge of aqueous effluents from construction activities and poorly maintained construction plant and equipment	C	Contamination should not be allowed to enter any watercourse/drainage channel and should be re-used or treated on site where possible Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases Plant used by the contractor on site is within its	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			design life and has been properly maintained as per the manufacturer's instruction				
SG2	Loss of potential future land use due to alteration of surface material	C	Concrete foundations are pre-fabricated and will be placed atop the ground, rather than being installed into it.	Low	IPP	ESIA Chapter 7	D01
SG5	Risk of erosion of soils through wind blow	C	Minimize disturbance of ground conditions and soils. Avoid stockpiling soils.	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05
SG6	Degradation of soil quality due to continuous discharge of cleaning fluid from solar panels	O	- Compliance with conditions of authorizations, resource consents, and designations; - Awareness of and adherence to environmental objectives; - Proper management of environmental risks associated with the Park; - Maintenance of competence and training requirements of staff with environmental responsibilities; - Lines of communication in the event of an emergency; - Construction waste management plan, designed to eliminate the risk of	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05
SG7	Loss of soil due to storm water runoff and erosion	O		Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05
SG8	Impact upon soil from release of stored fluids on site	O		Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			contamination entering the natural environment; ▪ Identification and control of wastewater discharges, in particular the sanitary wastewater discharges from the temporary construction site offices; ▪ Ensure that all substances are stored in suitable, undamaged, containers; clearly marked with the type, nature and content of the material, to ensure that all staff are aware of the material and its properties; ▪ Ensure the availability of pumps and spill mitigation materials such as absorbent granules, to contain and recover hazardous substance releases; ▪ Procedure to be implemented following the accidental release of hazardous substances during refueling of vehicles, including details of containment and recovery measures to be applied; and, ▪ Washout from the cleaning of ready-mix concrete trucks contaminated with cement, is highly alkaline. This should not be allowed to enter any drainage channel and should be re-used on site where possible. Where this is not possible, the water should either be treated for pH and suspended solids and				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			discharged off-site, or transported untreated, for disposal off site. Untreated disposal is the least favored options for waste water. On site treatment of washout should be undertaken within a hard standing area which is bunded and contained. Water must then be collected and disposed of in a closed loop system, as per the requirements of IFC EHS standards 1.3 <i>Wastewater and Ambient Water Quality</i>. - It is additionally advised that maintenance and lifespan requirements of plant and other vehicles to be used on site are laid out in advance of construction. This will allow the contractor sufficient time to perform proper maintenance and upkeep on required plant in advance of construction. - With regard to cleaning of solar modules, bio degradable cleaning fluids should be are used, in order to minimize impacts upon soils resulting from runoff.				
SG9	Impacts upon soils and geology due to residual materials after breakout of concrete foundations and other demolition	D	See recommended actions for construction.	Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
	activities.						
SG10	Impacts upon soils and geology due to leaks of fluids used during demolition	D		Low	IPP	ESIA Chapter 7	D01, D02, D03, D04, D05
Hydrology & Hydrogeology							
HH1	Changes to groundwater as a result of leaks and spills during construction	C	Waste will be removed from site regularly, and treated at a nearby sanitary wastewater treatment plant.	Low	IPP	ESIA Chapter 8	C03, C06
HH2	Alteration of flood drainage pattern on development site due to introduction of hard surfacing	C	Mitigation of storm water impacts will be dependent on appropriate design of the Park, which will be addressed during the detailed design phase of the development, particularly surrounding the road structures and drainage channels. The hydrology and storm water management report has recommended the construction of rip rap and other protection measures to manage storm water run-off. This includes rip rap around tracks and hard surfaces, and an outfall to manage the discharge of storm water.	Low	IPP	ESIA Chapter 8	C03, C06
HH3	Increased infiltration due to runoff from cleaning of panels	C		Low	IPP	ESIA Chapter 8	C03, C06
HH4	Changes to groundwater as a result of leaks of stored fluids at the development site.	C		Low	IPP	ESIA Chapter 8	C03, C06
			Where hard surfaces have the potential to collect fluids with the potential to impact upon hydrological or hydrogeological resources (e.g. car parks or vehicle maintenance areas), oil interceptors will be				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			utilized as per the requirements of GAME Environmental Standard 6 - <i>Storage and Material Reclaim Facilities Design and Operation</i> . This will prevent the introduction, through interception of any harmful fluids into groundwater and hydrological resources.				
HH5	Changes to groundwater as a result of leaks of fluids stored at the development site during decommissioning.	O	See previous measures.	Low	IPP	ESIA Chapter 8	C03, C06
HH6	Changes to flood regime during decommissioning of the Park	O		Low	IPP	ESIA Chapter 8	C03, C06
Noise & Vibration							
NO1 – NO6	Impact of construction noise and vibration on sensitive receptors	C	The good practice guidance presented within the IFC Guidelines are presented below. <i>“Noise reduction options that should be considered include:</i> ▪ selecting equipment with lower sound power levels ▪ installing silencers for fans	Low	IPP	ESIA Chapter 9	B01, B02, B03, B04, B05

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			- installing suitable mufflers on engine exhausts and compressor components - installing acoustic enclosures for equipment casing radiating noise - improving the acoustic performance of constructed buildings, apply sound insulation - installing acoustic barriers without gaps and with a continuous minimum surface density of 10 kg/m² in order to minimize the transmission of sound through the barrier. Barriers should be located as close to the source or to the receptor location to be effective - installing vibration isolation for mechanical equipment - limiting the hours of operation for specific pieces of equipment or operations, especially mobile sources operating through community areas - re-locating noise sources to less sensitive areas to take advantage of distance and shielding - siting permanent facilities away from				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			community areas if possible ▪ taking advantage of the natural topography as a noise buffer during facility design ▪ reducing project traffic routing through community areas wherever possible ▪ planning flight routes, timing and altitude for aircraft (airplane and helicopter) flying over community areas ▪ developing a mechanism to record and respond to complaints” In addition to the example of good practice presented above, BS 5228: 2009 + A1: 2014 - Parts 1 and 2 provide further guidance on effective methods for controlling noise and vibration emissions. It is anticipated that the following mitigation measures would be employed on site to ensure that noise and vibration levels are adequately controlled (all of which are considered to be examples of Best Practicable Means (BPM)): ▪ appropriate selection of plant and equipment, construction methods and programming. Only plant conforming with or better than relevant national or international standards, directives or recommendations on noise or vibration emissions will be used. Construction plant will be maintained in				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			good condition with regards to minimizing noise and vibration emission; ▪ plant will be operated and maintained appropriately, with due regard for manufacturer recommendations. All vehicles, plant and equipment will be switched off when not in use; ▪ use of appropriate noise abatement site hoardings and screens, where appropriate. Where practicable, gates will not be located opposite noise sensitive receptors; ▪ careful selection of routes and programming for the transport of construction materials, spoil and personnel so as to reduce the risk of increased noise and vibration impacts during construction; ▪ vehicle and mechanical plant/ equipment used for the purpose of the works should be fitted with effective exhaust silencers, to be maintained in good working order and operated in such a manner so as to minimize noise emissions; ▪ the positioning of construction plant and activities to minimize noise at sensitive locations; ▪ equipment that breaks concrete by				

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			munching or similar, rather than by percussion, will be used where practicable; ▪ mufflers shall be used on pneumatic tools; ▪ the use, where necessary, of effective sound reducing enclosures. ▪ programming works so that the requirement for working outside normal working hours is avoided; ▪ piling will be bored to protect sensitive receptors; ▪ Minimize the potential for higher vibration levels from the vibratory roller (used within the installation of access roads scenario), by taking into account the guidance within TRL report 429 (ensure that the vibratory roller is not started, stopped, or the direction of travel reversed close to sensitive receptors).				
NO7, NO8	Operation noise and vibration impacts	O	Refer to IFC and BS 5228: 2009 + A1: 2014 - Parts 1 and 2 good practice measures.	Low	IPP	ESIA Chapter 9	B01, B02, B03, B04, B05
Landscape and Visual							
LA09	Alteration of the view from the	O	Stakeholder consultation will confirm the significance of this impact and should be undertaken ahead of	Medium	IPP	ESIA Chapter 9	G01, G02

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
	receptor. Introduction of Sakaka Solar Energy Park within desert landscape		construction to ensure appropriate mitigation measures are developed.				
Terrestrial Biodiversity							
TB01 – TB07	Habitat loss Habitat degradation Habitat fragmentation Direct mortality/injury Disturbance Pollution	C	Site clearance works will adhere to the following: - Any clearance works undertaken will be supervised by an appropriately qualified ecologist who will also undertake the pre-works checks - Pre-works checks will be undertaken to identify active bird nests no more than two days prior to clearance works. If found, clearance must be postponed in the vicinity of the nests until nest is no longer active - Any methods required to exclude and deter birds from breeding in working areas will be developed by a qualified ecologist and implemented ahead of the breeding bird season - The potential for translocation and exclusion of mammal or Egyptian spiny tailed lizard will be determined by a suitably qualified ecologist during pre-construction site checks.	Low	IPP	ESIA Chapter 11	E03, E05, E06

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
TB08, TB09	Bird collision with solar panels	O	It is recommended that if any bird carcasses are found during scheduled maintenance, species and suspected cause of death is recorded.	Low	IPP	ESIA Chapter 11	E03, E05, E06
TB15	Habitat restoration	D	A Site Restoration Plan should be developed for the decommissioning phase of the project to maximize opportunities for habitat creation and enhancement.	Low	IPP	ESIA Chapter 11	E03, E05, E06
Archaeology & Cultural Heritage							
CH01	Partial or total removal of any unknown buried archaeological remains or un-stratified archaeological finds, including those potentially associated with Zubayda's Road	C	The development of a 'chance find' procedure is proposed for the Park, to be undertaken during construction, in order to identify any previously unrecorded archaeological sites or un-stratified finds. This procedure will be outlined and included within the CEMP	High	IPP	ESIA Chapter 12, CEMP	G11
Traffic & Transport							
TT01	Increased traffic volume due to introduction of construction traffic	C	Develop and employ a traffic management plan in order to structure the required deliveries and vehicle movements around existing usage and capacity of Road 80. This plan may include a delivery schedule which is developed in accordance with current usage patterns of the road, and avoids peak traffic flows	Medium	IPP	ESIA Chapter 13, TMP	G08
TT02	Road traffic accidents	C	Develop and employ a traffic management plan in order to ensure road traffic accidents are minimized and avoided. The traffic management plan should	Medium	IPP	ESIA Chapter 13, TMP	G08

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			make allowance for the safe passage of pedestrians both across and around roads upon which deliveries are expected to increase normal traffic volume. This may include the introduction of crossing points or alternative routes for pedestrians.				
TT03	Increased traffic at development site restricting access to airport.	O	An operational traffic management plan should be prepared. This plan should include: - Procedures for monitoring increased traffic movements and anticipating and proactively managing potential traffic congestion at the junction between the site access road and Road 80 - Assessment of Hazard Identification and Risk Assessment during the operation phase A commitment for quarterly road safety training and annual defensive driving training for staff and operators. A decommissioning traffic management plan should be implemented, similar to the plan for the construction phase.	Medium	IPP	ESIA Chapter 13, TMP	G08
TT04	Increased traffic volume due to introduction operational traffic.	O		Medium	IPP	ESIA Chapter 13, TMP	G08
Socio-Economic							
SE06, SE07	Reduced access to land and impacts on existing livelihoods	C/O	Minimize area of land required during construction where possible. Provide on-going community consultation and in particular provide guidance and assistance regarding use of alternative sites.	High	IPP	ESIA Chapter 14	G02, G06, G10

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			The impact of the development on local herders and intangible cultural heritage will be managed through the implementation of the Stakeholder Engagement Plan. The IPP will maintain links with this Affected Community, respond to concerns and provide guidance and assistance regarding use of alternative sites. Where alternative sites cannot be identified and temporary loss of livelihood (or income) may result, compensation for the loss shall be identified and provided in accordance with IFC performance standard 5 and developed, documented and implemented through the use of a Livelihood Restoration Plan. However it is anticipated that seasonal holding pens and camps within the developable area can be relocated outside of the Park without any significant impact on livelihoods.				
SE01, SE02	Economic growth and employment opportunities during construction	C	Promote engagement with the local population Consider provision of training during construction Consider the extent to which infrastructure provided within the construction camp can provide ongoing benefit to the local population	Low	IPP	ESIA Chapter 14	G02, G06, G10
SE08	Economic growth and employment opportunities during construction and operation	O	Consider use of design specifications to promote use of local suppliers, and sourcing of materials from local, regional and national suppliers where possible to support economic growth and indirect employment. Work with the local community to promote	Low	IPP	ESIA Chapter 14, stakeholder engagement plan	G02, G06, G10

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
			employment opportunities for the Al Jouf residents. Consider establishing a training program for local students. Continue stakeholder engagement in accordance with the Stakeholder Engagement Plan.				
SE09	Operation impact on Al Jouf Airport	O	The General Authority for Civil Aviation (GACA) and the Ministry of Defense will be consulted to determine the risk from the solar farm on aircraft. Consultation will be undertaken in accordance with the Stakeholder Engagement Plan. The GACA has issued a No Objection letter in principle and this objection will be reviewed as the design of the project progresses.	Low	IPP	ESIA Chapter 14	G06, G10
SE10	Impact on existing livelihoods and reduced access to land	D	Implementation of Stakeholder Engagement Plan: Maintain links with communities, respond to concerns and provide guidance and assistance regarding use of alternative sites.	Low	IPP	ESIA Chapter 14, stakeholder engagement plan	G02, G06, G10
			Utilities Infrastructure				
UT1, UT2	Disruption or overloading of the Supply Infrastructure	C/O	No specific actions identified at this stage of design. Consultation with stakeholders should continue, in particular with utility providers. The SEC has already confirmed that there will be no restrictions to the power from the solar PV energy park feeding into the national grid.	Low	IPP	ESIA Chapter 15	

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
		Waste Management					
WM2	Storage and disposal of non-hazardous waste	C	Develop and employ a construction waste management plan	Low	IPP	ESIA Chapter 16, SWMP	F05, F06, F07, F08, F09, F10
WM3	Storage and disposal of hazardous waste	C	Prepare a waste management plan to account for the disposal of packaging related to transport of solar modules	Low	IPP	ESIA Chapter 16, SWMP	F02, F03
WM7	Exceedance of operational capacity at local waste management facilities due to excess waste generated through demolition of buildings/breaking up of concrete at development site	D	Prepare a waste management plan to ensure proper phased recycling and disposal of construction wastes	Low	IPP	ESIA Chapter 16, SWMP	F02, F03
Health and Safety							
HS01a	Risk to health, especially respiratory disorders and chronic respiratory diseases, from exposure to air	C	A dust management plan is recommended. Consideration of: - Changes to construction process and plant to minimize noise impacts - Organization of program and workforce to ensure rotation of staff	Low	IPP	ESIA Chapter 17, DMP	G03, G08, G09

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
	pollution including dust, diesel particulates and NOx		- Development of comprehensive training program - Provision of PPE where required - Implementation of monitoring and health surveillance measures during construction				
HS01b	Risk of hearing loss as a result of operation of construction plant	C	Adherence to international best practice and correct use of PPE	Low	IPP	ESIA Chapter 17	G03, G08, G09
HS02	Risk to health from contaminated water supplies	C	Adherence to quality control measures for tanked water supplies	Low	IPP	ESIA Chapter 17	G03, G08, G09
HS03	Motor vehicle accidents	C	Training and awareness on issues such as defensive driving will be provided to the workforce	Medium	IPP	ESIA Chapter 17	G03, G08, G09
HS04	Impacts on occupational health and safety	C	Implementation of international best practice in training, monitoring, HSE guidelines and practices. Introduction of a program which addresses culture and behaviors on site. Corporate policy and engagement with staff, suppliers and contractors on safety practices implemented on site. Early engagement with local service providers should be undertaken. This consultation should include all emergency services.	Medium	IPP	ESIA Chapter 17	G03, G07, G08, G09

Impact ID	Impact Description	Project Phase	Action	Priority Level	Responsibility	Further information	
						ESIA/other document	Legislation reference
HS05	Increased risk of contracting communicable or non-communicable diseases	C	Comprehensive health screening program for workers will be developed in compliance with the Kingdom of Saudi Arabia regulations. Training and awareness on issues such as infection control and health promoting activities.	Medium	IPP	ESIA Chapter 17	G03, G08, G09
HS06	Glare and Glint	O	A full glare and glint assessment has been undertaken. Refer to LA09.	Medium	IPP	ESIA Chapter 17	G03, G08, G09
HS07	Motor vehicle accidents	O	Training and awareness on issues such as defensive driving will be provided to the workforce	Low	IPP	ESIA Chapter 17	G03, G08, G09

20.10 Environmental Action Plans – Outline Closure / Decommissioning Plan

20.10.1 Introduction

The Outline Closure / Decommissioning Plan addresses the cessation of the Solar Energy Park, the decommissioning of solar panels and equipment and rehabilitation of land.

The impacts of decommissioning have been identified and assessed in the ESIA. This Outline Closure / Decommissioning Plan provides an initial high level view of how these impacts will be mitigated as part of the project closure strategy.

It must be emphasized that the expected life of the Park is 20 years, and the identification of mitigation measures is only indicative at this stage. The need for specific measures shall be regularly reviewed throughout the lifecycle of the Park. The Park closure strategy shall be regularly reviewed and a detailed closure plan developed and tailored in light of increased data and knowledge obtained through the various stages of the development.

The following sections provide the structure and outline detail of the Closure / Decommissioning Plan, which is to be further augmented and developed as the development progresses.

The IPP shall update this Outline Plan and prepare a Decommissioning Plan during detailed design which is to be made available prior to commencement of operations. The IPP will keep this under review throughout the life of the Park and progressively develop and update a Detailed Closure / Decommissioning Plan. This Detailed Closure / Decommissioning Plan shall provide adequate detail for technically sound and sustainable closure and decommissioning and be cognizant of the outcome of ongoing stakeholder engagement.

20.10.2 Contextual Information

The ESIA is the primary source of contextual information on the Park, providing information on detailed description and layout of the Park and in each aspect section. Future iterations of the Closure / Decommissioning Plan shall summarize relevant contextual information so as to allow the Plan to act as a standalone document.

20.10.3 Closure / Decommissioning Vision

While the closure / decommissioning vision will be developed further in consultation with stakeholders, it will essentially be to close the solar energy park. The following sections of this Outline Closure / Decommissioning Plan and its future iterations present the means by which this vision is to be achieved.

20.10.4 Legislative Requirements

Table 20-1 provides detailed of the legislative requirements of the Park. Future iterations of the Closure / Decommissioning Plan will outline the legislative requirements specific to the closure and decommissioning of the project.

20.10.5 Stakeholder Engagement

The Stakeholder Engagement Plan provides the plan for The IPP's ongoing engagement. Stakeholder engagement activities shall capture government, community and workforce views on closure and decommissioning, and the results of these shall be captured and summarized in future iterations of the Closure / Decommissioning Plan.

20.10.6 Closure / Decommissioning Objectives and Targets

Objectives are overall goals to be achieved through closure / decommissioning; targets represent the detailed performance requirements that need to be set and met to achieve the objectives. The following sections provide initial objectives and targets for the Project closure / decommissioning.

20.10.7 Closure / Decommissioning Objectives

The closure / decommissioning objectives for the Park are to:

- Undertake closure / decommissioning in accordance with all applicable national and international requirements; and,
- Leave a rehabilitated site that is stable and non-contaminating.

These objectives are to be revisited and updated in future iterations in light of ongoing stakeholder engagement during the development of the Park.

20.10.8 Closure / Decommissioning Targets

The closure / decommissioning objectives shall be developed into measurable targets against which the Project's performance can be measured. Proposed targets will be worked up following stakeholder engagement and reported in future iterations of the closure / decommissioning plan.

20.10.9 Closure roles and responsibilities

Responsibility for the development of the Closure / Decommissioning Plan lies with The IPP and its project management team through the lifecycle of the Park.

The roles and responsibilities detailed in section 3.2 of this EMMP shall be applied to closure / decommissioning activities, and augmented and updated as appropriate to reflect the activities to be undertaken as detailed in the Closure / Decommissioning Plan.

20.10.10 Anticipated closure and decommissioning activities

The closure / decommissioning activities are to be defined during detailed design and will be reported in future iterations of the Closure / Decommissioning Plan.

20.10.11 Assessment of environmental and social impacts / risks of closure / decommissioning

Each section of the ESIA includes consideration of the potential impacts associated with closure / decommissioning in accordance with the methodology. The impacts associated with closure and decommissioning identified by the impact assessments have been assigned mitigation measures as appropriate, and these are detailed within the relevant sections of the ESIA.

Future iterations of the Closure / Decommissioning Plan shall review and assess the potential environmental and social impacts associated with proposals for closure / decommissioning, identify risks, and assign mitigation measures to those impacts and risks. These shall form the basis of the specific closure / decommissioning activities to be undertaken and implemented through the Plan.

20.10.12 Final land use, form and access

The final land use is proposed to be returned to its previous state.

20.10.13 General closure / decommissioning activities

Through regular update and revision of the Closure / Decommissioning Plan throughout the lifecycle of the Park, The IPP shall progressively define and refine the closure and decommissioning activities required to achieve the closure / decommissioning vision, and associated objectives and targets. The following sections

provide the structure to document and communicate these activities. The outline provided may be updated and amended to suit the requirements of the Park as necessary.

Over and above the specific topics addressed in the following sections, The IPP shall update, implement, maintain and audit the EERP and EMMP to ensure the documents remain adequate and effective for the closure / decommissioning phase.

20.10.14 Site safety and security

This section of the closure / decommissioning plan should address the following:

- Closure / Decommissioning Risk Assessment
- Safety Procedures and installation of site safety and security measures
- Public information and education
- Emergency response

The IPP shall provide further details of its proposals for site safety and security in future iterations of the Closure / Decommissioning Plan.

20.10.15 Decommissioning

This section of the closure / decommissioning plan should address the following::

- Decommissioning, demolition and site clearance
- Site investigation and decontamination
- Management of decommissioning wastes

The IPP shall provide further details of its proposals for decommissioning in future iterations of the Closure / Decommissioning Plan.

20.10.16 Closure

This section of the closure / decommissioning plan should address the following:

- Final Park closure

The IPP shall provide further details of its proposals for closure in future iterations of the Closure / Decommissioning Plan.

20.10.17 Workforce retrenchment

This section of the closure / decommissioning plan should address the following:

- Consultations and planned workforce reduction
- Severance terms, non-discrimination, grievance and appeal procedures
- Re-assignment, resettlement and training support

The IPP shall provide further details of its proposals for workforce retrenchment in future iterations of the Closure / Decommissioning Plan.

20.10.18 Social management

This section of the closure / decommissioning plan should address the following:

- Managing cessation of local procurement
- Managing migrant outflows

The IPP shall provide further details of its proposals for social management in future iterations of the Closure / Decommissioning Plan.

20.10.19 Long term environmental management

This section of the closure / decommissioning plan should address the following:

- Post closure monitoring of soil, groundwater, ecological receptors

The IPP shall provide further details of its proposals for long term environmental management in future iterations of the Closure / Decommissioning Plan.

21. Environmental Emergency Response Plan

21.1 Introduction

This chapter represents the Environmental Emergency Response Plan for the Sakaka Solar Energy Park (the Park). The plan contributes towards meeting of the the International Finance Corporation (IFC) Sustainability Framework Performance Standards 1: *Assessment and Management of Environmental and Social Risks and Impacts*; and, 4. *Community Health, Safety and Security*.

21.1.1 Purpose of the Environmental Emergency Response Plan

The purpose of the EERP is to provide guidance to prevent major accidents, and where accidents do occur, set out a framework and controls for the mitigation of impacts on human health and the environment. The IPP will ensure these requirements are met by identifying process related risk, developing suitable control measures and implementing procedures to be followed in response to an emergency event or disaster situation during the construction or operation of the Park. The EERP will be communicated by The IPP and made accessible to all employees and personnel working on the on all phases of the Park.

The IPP will review and update the EERP as the design progresses and as more detailed information regarding the activities involved in the construction and operation of the Park become available, allowing for a more informative review of potential operational accident and emergency situations and preparation of more detailed control measures and response procedures. An EERP review schedule will be implemented, with review taking place during each new phase of the Park and/or following modifications to the activities involved in the construction and operational phases.

Procedures required by the EERP will be consolidated when undergoing development to provide clear instruction to IPP personnel on the step-by-step approach to be taken and implemented in the event of an accident or emergency situation occurring.

In compliance with the stakeholder engagement plan, stakeholder and community consultation will be ongoing during the development of the EERP. This will enable stakeholders and the community to influence the development and implementation of this plan, in particular the response procedures. This is in compliance with IFC Performance Standard 4.

21.1.2 Project Related Risks

There are a number of hazards associated with the construction, operation and decommissioning of the Park.

Activities involved in the enabling works are likely to include the following:

- Fabrication of access roads to and from the development site;
- Grading and levelling of the development site to prepare for the installation of foundations;
- Excavation of cable trenches and other ground works required to install electrical infrastructure; and
- Installation of developers compound and associated temporary infrastructure.

Activities involved in the construction works are likely to include the following:

- Allocation of work and laydown areas;
- Installation of concrete foundations;
- Assembly of solar panels (solar panels and mounting systems will constructed off-site by a third party)
- Link up to existing power generation infrastructure; and,

- Civil and structural activities including the construction of new foundations.

300 Operations and maintenance jobs will be created at the Park.

The IPP will take steps to identify the activities where the greatest risk of accident or emergency exists, before developing and implementing control measures to ensure the risk of harm to people, the environment and equipment is reduced, and where possible, eliminated. The identification of hazards and assessment of risk will be applied and reviewed at different stages of the development, initially at design, then during operation, and finally, at the decommissioning stage.

Prior to completing the risk assessment, a detailed review of the activities taking place during the construction, operation and decommissioning of the Park will be undertaken by The IPP to identify potential accident and emergency situations. Consideration will be given to factors including probability of occurrence and the greatest loss as a result of the accident or emergency situation happening. The scope of the risk assessment will cover both operational accidents and natural incidents.

Following detailed review of the activities associated with the Park to identify potential accident and emergency situations, a risk assessment will be completed. The assessment of risk will be reviewed on a periodic basis and whenever a change (for example, the introduction of new, or change to existing, people, infrastructure, plant or activities) introduces new potential accident and emergency situations.

Review of existing, or introduction of new, control measures will be undertaken if new or additional risk of accident or emergency situations occurring is identified. At intervals of no longer than two years, The IPP will test, review and update, where necessary, procedures associated with the management of risk and response to accident and emergency situations (i.e. operational control, immediate response, emergency response) to ensure continued effectiveness of the EERP. Records of the testing of the effectiveness of procedures will be produced and retained for inspection by appropriate authorities, as requested. The review of procedures associated with the management of risk and response to accident and emergency situations must include stakeholder and community engagement.

21.1.3 Types of Emergency

The scope of the EERP includes both accidents, (such as fire or vehicle collisions), and natural incidents, (such as sandstorms or earthquakes), and is intended to prevent injury to staff and personnel, damage to property, harm to the environment and impact upon neighboring communities.

There are a number of accident and emergency situations that have the potential to occur during operation of Park. The IPP will ensure consideration and discussion of the types of accident and emergency situations that may potentially be encountered whilst reviewing the activities associated with construction and operation of the Park and in identification and assessment of the associated risks and hazards. Consideration will also be given to emergency situations from neighboring activities that may affect the Park and from malevolent or unauthorized action/activity.

Examples of the types of accident and emergency situations that could potentially occur, and the resulting impacts are provided in Table 21-1. This is not an exhaustive list and further consideration of potential accident and emergency situations will be given by The IPP during completion of the assessment of process related risks.

Table 21-1 Potential accident and emergency situations associated with operation of Sakaka Solar Energy Park

Accident/Emergency	Potential Impact
• Motor vehicle accidents • Fire and explosion • Spillage or release of hazardous materials	Human health impacts including: • burns; • blindness; • respiratory difficulty;

• Plant or equipment failure or malfunction • Natural incidents (including flooding, sea level rise, high wind, heavy rainfall, sandstorm and earthquake) • Political/local instability • Disease	• electrocution; • trauma; and • injury.
	Environmental impacts including: • air pollution; • soil pollution; and • water pollution.
	Damage to infrastructure and assets
	Material loss

21.2 Processes and Procedures

21.2.1 Road Accidents

The IPP will assess the risks associated with potential accident and emergency situations that may occur either on-site or off-site as a result of motor vehicle accidents (MVA).

Road traffic levels within the vicinity of the development site will increase during the construction period of the Park. A substantial proportion of the material required for construction of the Park will be transported by road, and it may also be necessary to transport the construction workforce to site via a bus connection.

The main route into the development site (Road 80) has capacity to support this extra volume of traffic, however rates of MVA are still expected to rise during the construction phase, reflecting current trends in the Kingdom. The Independent Power Provider (IPP) will prepare a traffic management plan to mitigate the increased risk of MVA. The traffic management plan will include measures such as a requirement for all drivers to be licensed, experienced and trained through third party agencies, and for all vehicles, equipment and machinery to undergo regular maintenance with manufacturer specifications, for clear signage to be installed along route 80 demarcating site entrance with adequate space allowed for site ingress and egress, and broader training programs to be developed and implemented. These training programs should be made available to the local community. The management plan should be developed with key stakeholders (e.g. emergency services) to ensure response to MVAs can be undertaken quickly and efficiently.

would add something here about the management plan a being developed with key stakeholders to ensure reponse to MVAs can be undertaken quickly and efficiently etc etc.

Road traffic levels during the operational phase of the Park will be similar to existing levels. The IPP will prepare an operational traffic management plan which will include the requirement for Assessment of Hazard Identification and commitment to regular road safety training and defensive driving training for staff and operators.

21.2.2 Fire Fighting

When assessing the risks associated with the construction and operation of the Park, The IPP will also review the potential accident and emergency situations that may occur as a result of fire through identification of all potential fire hazards on-site and fire hazard characteristics that apply to fuel, raw material and waste with reference to Material Safety Data Sheets (MSDS), plant design and Occupational Safety and Health Administration (OSHA).

The IPP will address the following information requirements with regards to fire response:

- locations of fire alarm/systems/extinguishers;
- staff training in safe operation of fire extinguishers, isolation and extinguishing small fires;

- potential sources of fire;
- fire hose reel locations;
- required external support services;
- firefighting measures/instructions for each material handled on site as per MSDS; and
- emergency plant shutdown.

Requirements and methods to retain fire water and other firefighting material, such as foam and powder, to prevent discharge to drains, controlled waters or ground, will be reviewed by the IPP and added to accident and emergency procedures, where applicable.

21.2.3 Incident/Accident Management

Following the identification of potential accident and emergency situations, the IPP will develop procedures for management of potential incidents and accidents. Measures to eliminate and minimize hazards and avoid risk will be given preference in order to prevent potential emergency situations occurring. Where prevention or elimination of risk is not possible, control measures will be developed to reduce risk of an emergency situation and the associated consequences occurring, as far as possible.

Although steps to eliminate and reduce risk from the processes associated with the construction and operation of the Park as far as possible will be taken, The IPP recognizes that a degree of risk remains with regards to a potential accident or emergency situation occurring. Therefore, procedures will be developed which will be followed in the event of an accident or emergency situation, whether this is as a result of operational control failings or natural occurrences. This will include measures in response to the example situations outlined by Table 21-1 and also procedures relating to emergency shut-down of plant and equipment and other measures to prevent the potential escalation of emergency situations. Clean-up following containment, and rebuilding, if necessary, as a result of an accident or emergency situation will also be covered in the development of emergency response procedures.

Where risk prevention and elimination is not a viable option in the preparation of emergency response procedures, the IPP will then investigate ways of implementing control measures to minimize the level of risk. This will be done in consultation with stakeholders and the local community.

21.2.4 Alarms and Communication

An emergency notification system and alarm will be provided on-site, which will include prompt activation of the EERP team. The IPP will communicate with appropriate authorities and stakeholders the requirements of the EERP in its development, review and implementation. A directory of all appropriate authorities and organizations, from whom support is required or who require notification in the event of an accident or emergency, will be prepared by The IPP and held in appropriate locations at the Park. This will include fire and police services and appropriate government representatives. Emergency contact details will also be included in emergency response procedures.

21.2.5 Training Practices

The IPP will assess the training needs of individual site personnel and their roles within the construction and operation of the Park, giving due consideration to the completed risk assessment and the operational control and emergency response procedures prepared. Training requirements will then be tailored to the risks and hazards of the activities associated with each phase of the project and the potential accident and emergency situations that may be encountered. Training requirements for individuals performing specific roles in relation to accident and emergency situations will also be identified and addressed, for example, members of the EERP Team, fire fighting, spill response and emergency shut-down of plant and equipment.

All site personnel will receive training that is appropriate to their role in the construction and operation of the Park, which will include and address:

- hazard identification, risk evaluation and corrective measures to address safety and environmental concerns;
- risk prevention and mitigation;
- appropriate materials handling procedures;
- special hazards specific to their job/role; and,
- implementation of evacuation procedures.

All employees, regardless of their role/position at the Park, will receive an initial site induction into the safety rules of the development, which includes basic emergency response requirements and addresses the environmental issues associated with the different emergency situations that may be encountered. The IPP will also provide follow-up training to employees, as required, but in particular whenever there is a modification to the Park and/or its activities in any way.

21.2.6 Environmental Emergency Response Personnel (EERP Team)

As the development of the Park progresses, more detailed information will become available to allow The IPP to implement procedures for the selection of key site personnel who will form the EERP Team and for the development of emergency response organization (structure, authorities and responsibilities of the EERP Team) for the Park. Consideration will be given to the suitability of individuals based on their role within the operation of the Park and their ability to provide rapid and effective response to accident and emergency situations.

The names and contact details of all members of the EERP team will be listed in the emergency response directory using a format similar to that provide in Table 21-2, along with the authorities and organizations to be contacted in accident and emergency response situations.

Table 21-2 EERP Team Contact Details

Name	Position	Contact Number	Cell Phone Number

Training programs will be developed and provided to the members of the EERP Team to enable them to successfully fulfil their duties and obligations in responding to an accident or emergency situation. Training will include working jointly with external authorities or organizations, such as the fire services or government representatives, in assisting with the response to accidents and emergencies, including initial and on-going liaison with emergency services throughout an emergency situation.

21.2.7 Safety, Health and Environment (SHE)

The IPP will maintain an inventory of all chemicals and products stored/used at the development site, which will be reviewed on a quarterly basis. Hazardous materials will be labelled in accordance with Saudi Aramco's Hazardous Materials Communication Program (HAZCOM) program as shown in Figure 21-1. Material Safety Data Sheets (MSDS), Chemical Hazard Bulletins (CHBs), Saudi Aramco Construction Safety Manual and the

relevant General Instructions will be used to inform the development of operational control, emergency response and clean-up procedures, and the selection and use of personal protective clothing and equipment (PPE) appropriate to the requirements of task-specific conditions and the associated potential hazards.

The construction worker camp will be operated in accordance with the relevant Saudi Aramco General Instructions including GI 0151.006 Environmental Health Code.



Figure 21-1 Example Hazardous Material Label

21.2.8 Immediate Response Measures

Emergency response procedures prepared by the IPP following completion of the risk assessment and identification of potential accident and emergency situations will include actions for immediate response measures, as necessary. These measures will include clear instructions to be followed by the EERP Team to respond, contain or stop the situation without delay to avoid escalation. Such measures will include actions for emergency plant and equipment shutdown, arrangements with emergency services, responding to medical emergencies and responding to equipment failure emergencies.

21.2.9 Emergency Procedures

The IPP will undertake an evaluation of all activities undertaken on site that could create an accident or emergency situation which could cause danger to life or health, impact on the environment or damage to the site, surrounding communities or industrial installations. Procedures will be prepared providing instructions to be followed in the event of an accident or emergency situation occurring, wherever a risk of a potential accident or emergency has been identified following completion of the risk assessment process. Emergency procedures will be prepared in consultation with both the emergency services and employees and proposed site personnel, and other interested parties (e.g. neighboring industries), as appropriate. Stakeholders will also be consulted whenever amendments are proposed and made to the EERP during the different stages of the development of the Park.

21.2.10 Reducing Environmental Impacts

There are a number of adverse environmental impacts that can potentially occur following an accident or emergency situation. Key receptors in the vicinity of the Park include soils, groundwater and the local and regional atmosphere. The closest human receptors, excepting site personnel and inhabitants of the construction camp, are seasonal herder settlements and users of Roads 80 and 85. Al Jouf Airport is located approximately 5 km from the site boundary, and the nearest permanent settlements (Sakaka and surrounding communities) are approximately 11 km from the site boundary.

The IPP will prepare and establish procedures to be implemented and followed in order to minimize environmental impacts resulting from accident or emergency situations. The procedures will include methods to ensure the containment and control of the accident or emergency situation to minimize potential environmental damage, and the necessary removal, clean-up, repair and rehabilitation measures once the situation has been contained and controlled.

Potential environmental impacts may occur as a result of any of the accident or emergency situations identified through completion of the risk assessment, and each situation, and the potential damage to each receptor, will be given full consideration by The IPP when procedures to minimize environmental impacts are developed.

Although the IPP will give due consideration in the identification of the specific actions to minimize environmental impacts in response to a specific emergency situation, there will be a number of common control measures to be considered during development of response procedures to be applied during emergency situations. Such common considerations include:

- identify other critical factors (e.g. pathways to controlled waters, ease to contain/recover material, material dispersion in air or water, consequence of different materials/substances mixing etc.);
- review MSDS and apply measures accordingly;
- where possible, isolate the source of a spill and contain the spill using suitable response equipment (e.g. absorbent material, booms, mats, etc.);
- contain fire water to prevent discharge to drains and controlled waters; and
- recover fire fighting material (particularly foam or powder), especially where there is potential to discharge to controlled waters.

Waste generated as a result of response to emergency situations may have hazardous properties, which in itself poses a risk with regards to additional impacts and environmental damage occurring. The IPP will develop clear instructions for the management of hazardous waste generated from emergency response in accordance with the necessary legal requirements and relevant environmental/waste procedures applicable on site. In situations where it is evident that hazardous substances have been discharged to the environment and damage to receptors has occurred, The IPP will employ suitably qualified contractors to plan and carry out appropriate clean-up, remediation and rehabilitation works.

21.2.11 Corrective Action Plan

All accidents and emergency situations resulting in environmental impacts shall be recorded and classified in accordance with the relevant the Saudi Aramco General Instructions, including GI 6.001 Notification Requirement for Incidents (including Fires) and GI 1787.000 Report of Fire, Emergency or False Alarm.

As soon as the emergency has been contained, control and clean-up begins, The IPP will conduct an accident investigation and produce a report to determine the cause(s) of the incident; to provide a summary of the emergency response and success; and, to discuss lessons learned from the incident. The report will be prepared in line with GI 6.003 Incident Investigation, and will likely include the following information:

- circumstances of the accident (nature, timing of the event, analysis of causes, etc.);
- substances and amounts involved;

- immediate consequences and any immediate mitigation taken;
- emergency measures taken and the effectiveness of the EERP;
- proposed clean-up methods to mitigate the medium/long-term effects;
- data available to assess the effects on people and the environment; and
- actions envisaged to prevent similar accidents.

The investigation report will also be used to recommend corrective actions to be implemented to prevent escalation or repetition of the original or similar incident(s), as necessary. Possible corrective actions for implementation may include:

- controlling the source of the pollution;
- a review of operational procedures;
- replacement of equipment;
- studies of the environmental impact upon the surrounding environment;
- management of the clean-up or repair of the area affected by the incident to prevent further release of contaminants; and
- assessment of the need for additional operational training.

21.2.12 Materials Handled and Stored On-Site

The IPP will maintain and update at all times a register and inventory of all materials either stored and handled, or transported to and from the Park as described in section 21.2.7. The inventory will be prepared at the beginning of the project, and revised on a quarterly basis thereafter (as per Saudi Aramco's Construction Manual).

21.2.13 Emergency Equipment

The IPP will ensure that emergency equipment is held at key locations throughout the Park for ease of access should an emergency situation or accident occur. The location of emergency equipment and applicability for use will also be detailed in emergency response procedures, as appropriate. An inventory of all emergency equipment will be maintained and updated by The IPP at all times and regular checks and inspections of emergency equipment will take place to ensure maintenance of stock and suitability for use.

21.2.14 PPE for Emergency Personnel, First Aid and Medical Examination

The IPP will ensure that PPE and first aid boxes are held at key locations throughout the Park for ease of access should an emergency situation or accident occur. The location of PPE and applicability for use will also be detailed in emergency response procedures, as appropriate. An inventory of all PPE and first aid boxes will be maintained and updated by The IPP at all times, and regular checks and inspections of PPE and first aid boxes will take place to ensure maintenance of stock and suitability for use.

First aid and medical facilities will be provided on site during the construction period, and construction workers will have access to the new hospital in the Prince Mohammed Medical City.

21.2.15 Evacuation

The IPP will prepare appropriate evacuation procedures to be followed by construction workers and site personnel in the event of emergency situations and accidents. The type of accident or emergency will influence

the evacuation procedure, including evacuation route followed, the final evacuation point, and the assembly area. Environmental factors such as wind direction will also be considered in the preparation of evacuation procedures and in determining which procedure should be followed in the event of an emergency or accident situation occurring. The IPP will ensure that all construction workers and site personnel receive sufficient training in the evacuation procedures to be followed for the different emergency situations that may be encountered whilst working at the Park.

22. Conclusion

The Sakaka Solar Energy Park will contribute towards a more balanced energy mix in the Kingdom of Saudi Arabia; and contribute towards displacing 4,600 Thousand Barrels of Oil Equivalent (MBOE) of hydrocarbons per annum (i.e. 2,000 Thousand tons (Mt) of CO₂ per annum) from the Saudi Electricity Company power plant in Al Jouf.

This ESIA document presents the systematic assessment of potential impact. Based on the preliminary design of the facility, and the stakeholder engagement and consultation that has been undertaken to date, there are no predicted residual impacts of moderate or high significance, following the implementation of mitigation and good international industry practice (GIIP). All impacts are predicted to be low to negligible significance.

Following approval from the MEIM, stakeholder engagement commenced shortly prior to issuing this ESIA. Representatives of the Government ministries attended a workshop in Riyadh during which the project details were disclosed, and the scope of the assessment was openly discussed. At this stage of the project, the Government Ministries have expressed their support for the project and no objections have been raised.

The IPP must continue to engage and consult with the Government Ministries during the development of the project, and must additionally commence consultation with the local community and potentially vulnerable groups in accordance with the project Stakeholder Engagement Plan.

The findings of the ESIA should be reviewed following more extensive stakeholder consultation, and once the design of the new power plant has been further developed (e.g. transportation plan, constructability plan). If required, an Addendum to this ESIA will be prepared by the IPP, in consultation with project stakeholders.

23. Abbreviations and Acronyms

Acronym	Description
A.C	Alternating Current
ASTM	American Society for Testing Materials
ATC	Automated Traffic Counts
BAT	Best Available Techniques
BPM	Best Practicable Means
BS	British Standard
CEMP	Construction Environmental Management Plan
CIEEM	Chartered Institute of Ecology and Environmental Management
CN	Curve Number
CSP	Concentrated Solar Power Technologies
CWMP	Construction Site Waste Management Plan
D.C	Direct Current
dB	Decibels
DHI	Daily Heat Index
EBRD	European Bank for Reconstruction and Development
EERP	Emergency Response Plan
EHS	World Bank Group Environmental, Health, and Safety Guidelines
EMMP	Environmental Monitoring Management Plan
EPA	Environmental Protection Agency
EPC	Engineering Procurement and Construction
EPD	Saudi Aramco Environmental Protection Department
EPFI	Equator Principles Financial Institutions
Eps	Equator Principles
ESD	Emergency Shutdown
ESF	World Bank's Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMS	Environmental and Social Management System
FPD	Saudi Aramco Facilities Planning Department
GACA	General Authority of Civil Aviation
GAME	General Authority for Meteorology and Environment
GCC	Gulf Cooperating Countries
GEF	Global Environment Facility
GERRI	General Environmental Regulations Rules for Implementation
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiation
GW	Giga-Watt
GWh	Giga-Watt Hours
HAZCOM	Hazardous Materials Communication
HPSV	High Pressure Sodium Vapor
HVAC	Heating, Ventilation and Air-Conditioning
IBA	Important Bird and Biodiversity Area
IBRC	International Bird Research Centre
ICC	International Computer Company
ID	Identification Code
IFC	International Finance Corporation
IFI/MFI	International/Multilateral Financial Institutions
IPA	Important Plant Area
IPP	Independent Power Project
ISO	International Organization for Standardization
ITS	Invertor–Transformer Stations
IUCN	Union for Conservation of Nature

KACARE	King Abdullah City for Atomic and Renewable Energy
LCT	Landscape Character Types
LOS	Level of Service
LP or SP L	Sound Pressure Level
LUP	Land Use Permit
LV AUX	Low Voltage Auxiliary
LVIA	Landscape and Visual Impact Assessment
MBOE	Thousand Barrels of Oil Equivalent
MCM	Million Cubic Meters
MEIM	Ministry of Energy, Industry and Mineral Resources
MFI-WG	The MFI Working Group on the Environment
MMBOE	Million Barrels of Oil Equivalent
MODON	The Saudi Industrial Property Authority
MOT	The Ministry of Transport
MSB	Migratory Soaring Birds
Mt	Thousand Tons
MV/HV	Medium Voltage/High Voltage
NASA	The US National Aeronautics and Space Administration
NREP	National Renewable Energy Program
OUV	Outstanding Universal Value
Pa	Pascals
PEL	Public Environment Law 2011
PME	The Presidency of Meteorology & Environment
PPV	Peak Particle Velocity
PV	Photovoltaic
Qdc	Sand and Gravel Deposits
REC	Percentage Recovery
REPDO	Renewable Energy Project Development Office
RQD	Rock Quality Designation
RTU	Remote Terminal Unit
SAR	Saudi Railway Company
SCADA	Supervisory Control and Data Acquisition
SCS	Soil Conservation Service
SDSN	United Nations Sustainable Development Solutions Network
SEC	Saudi Electricity Company
SEP	Stakeholder Engagement Plan
SLM	Sound Level Meter
SLR	Single Lens Reflex
SMBC	Sumitomo Mitsui Banking Corporation
SMSE	The Surface Meteorology and Solar Energy
SPA	The Saudi Ports Authority
SRO	The Saudi Railways Organization
TMC	Turning movement Counts
TMY	Typical Meteorological Year
TRRL	Transport and Road Research Laboratory
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Program
VP	Vantage Point

Appendix A. Air Quality Assessment

In the absence of guidance on construction dust impacts specific to the Kingdom of Saudi Arabia or the United States, the assessment of dust during construction has been carried out using a qualitative risk-based appraisal with reference to the sites location in relation to sensitive locations, the planned activities and site characteristics, as described by the IAQM guidance.

Although the guidance is aimed at the UK, it is recognized within the document that this guidance may be applied elsewhere, as long as careful consideration is given as to the applicability where different climates and where working practices on construction sites are different. For this project, the use of standard construction equipment and mitigation practices as likely to be found in the UK suggests that the methodology can be used here. In addition, similar air quality standards apply in both countries, so the implied effects within the qualitative methodology will be similar. The main difference is likely to be the composition of the dust, with the dust in this instance being mainly derived from large-grained sandy material as compared to the more silt-based sedimentary material likely to occur at sites in the UK. This means that the fraction of the sandy dust here that is small enough to enter the body through the nose and/or mouth during breathing (i.e. the respirable fraction) will be less than the respirable fraction of the more silty dust in the UK. Therefore, this will tend to result in the assessment for this project being more conservative.

The methodology for the assessment of the construction impacts is based on a five-step approach as set out in Figure 23-1.

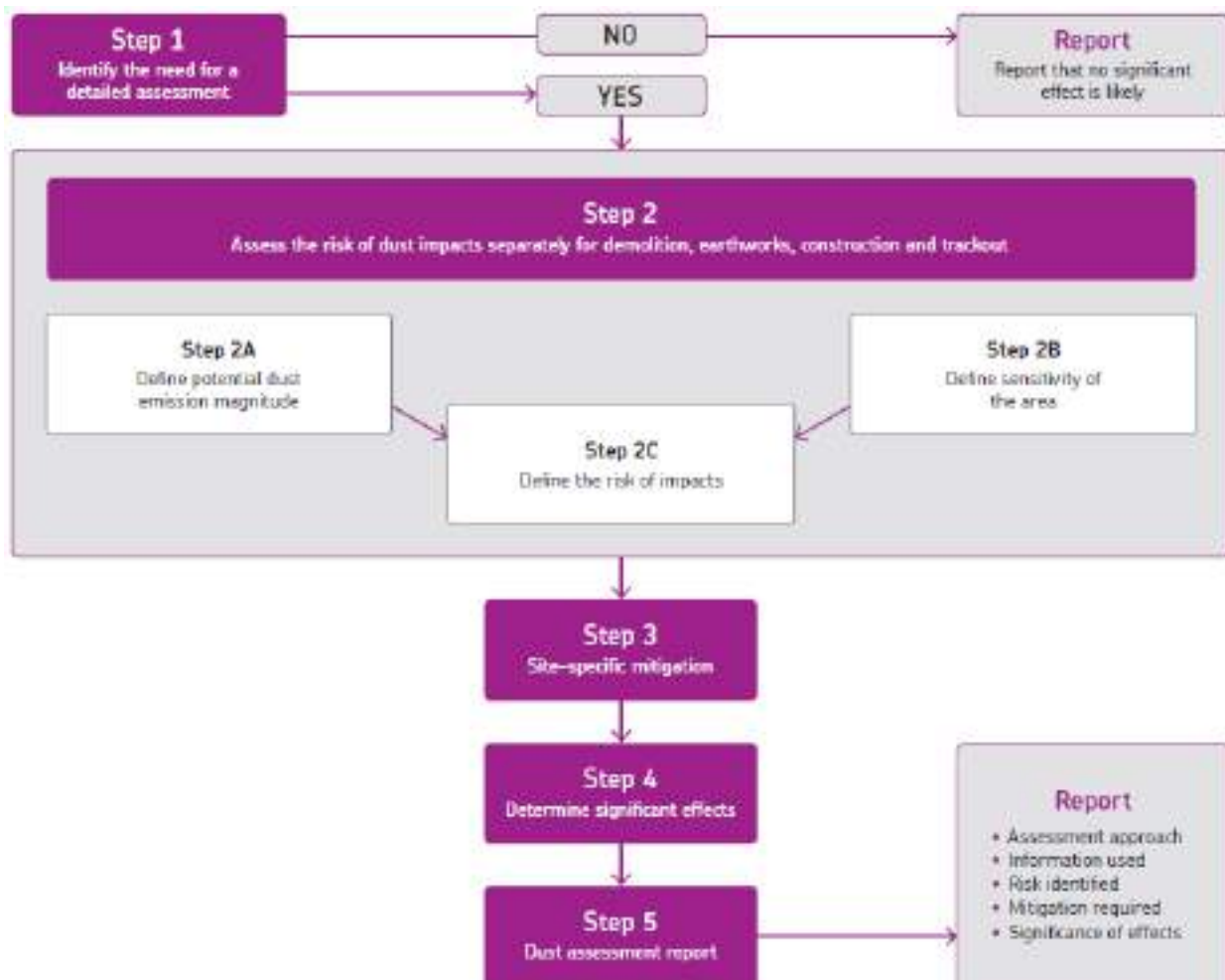


Figure 23-1 Structure of construction dust assessment

A.1 Identify the need for a detailed assessment

An assessment will be required where there is:

- a human receptor within 350m of the Sakaka site boundary and/or within 50m of the access route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s); and/or
- an ecological receptor within 50m of the Sakaka site boundary and/or within 50m of the access route(s) used by construction vehicles on the public highway, up to 500m from the site entrance(s).
 - o The requirement for a dust risk assessment can be screened out where the criteria are met, as it can be concluded that the level of risk is Negligible and any effects would be 'not significant'. If there are human or ecological receptors within the distance criteria set out in Step 1, Steps 2 to 4 should be undertaken as shown in Section A.2.

A.2 Assess the risk of dust impacts

A.2.1 Step 1: Define the potential dust emission magnitude

Demolition

The following are descriptors for the different dust emission magnitudes for demolition:

- Large:** total building volume greater than 50,000m³, potentially dusty construction material (e.g. concrete), on-site crushing and screening demolition activities greater than 20m above ground level;
- Medium:** total building volume 20,000m³ to 50,000m³, potentially dusty construction material, demolition activities 10m to 20m above ground level; and,
- Small:** total building volume less than 20,000m³, construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities less than 10m above ground, demolition during wetter months.

Earthworks

The following are descriptors for the different dust emission magnitudes for earthworks:

- Large:** total site area greater than 10,000m², potentially dusty soil type (e.g. clay, which would be prone to suspension when dry due to small particle size), greater than 10 heavy earth moving vehicles active at any one time, formation of bunds greater than 8m in height, total material moved greater than 100,000 tonnes;
- Medium:** total site area 2,500m² to 10,000m², moderately dusty soil type (e.g. silt), 5 to 10 heavy earth moving vehicles active at any one time, formation of bunds 4m to 8m in height, total material moved 20,000 tonnes to 100,000 tonnes; and
- Small:** total site area less than 2,500m², soil type with large grain size (e.g. sand), less than 5 heavy earth moving vehicles active at any one time, formation of bunds less than 4m in height, total material moved less than 10,000 tonnes, earthworks during wetter months.

Construction

The following are descriptors for the different dust emission magnitudes for construction:

- Large:** total building volume greater than 100,000m³, piling, on-site concrete batching, sandblasting;

Medium: total building volume 25,000m³ to 100,000m³, potentially dusty construction material (e.g. concrete), piling, on-site concrete batching; and,

Small: total building volume less than 25,000m³, construction material with low potential for dust release (e.g. metal cladding or timber).

Trackout

Trackout refers to the transport of dust and dirt from the site area onto the public road network, where it may be deposited and re-suspended by other vehicles using the road network. Only receptors within 50m of the route(s) used by vehicles on the public highway up to 500m from the Park entrance are considered to be at risk.

The following are descriptors for the different dust emission magnitudes for trackout:

Large: greater than 50 HGV outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length greater than 100m;

Medium: 10 to 50 HGV outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50m to 100m; and

Small: less than 10 HGV outward movements in any one day, surface material with low potential for dust release, unpaved road length less than 50m.

Define the sensitivity of the area

The sensitivity of the area takes account of a number of factors:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- the local background PM₁₀ concentrations; and,
- site-specific factors.

For this assessment of the sensitivities of people to dust soiling effects and to the health effects of PM₁₀, the receptors will be identified as 'High', 'Medium' or 'Low' sensitivity based on the criteria described in the IAQM guidance (IAQM, 2014). Table 23-1 presents indicative examples of classification groups for the varying sensitivities of people to dust soiling effects and to the health effects of PM₁₀. A judgement is made at the site-specific level where sensitivities may be higher or lower.

Table 23-1: Indicative examples of the sensitivity of different types of receptors

Sensitivity of receptor	Sensitivities of people and ecological receptors	
	Dust soiling effects ¹	Health effects of PM ₁₀ ²
High	Dwellings, museums and other culturally important collections, medium and long-term car parks and car showrooms.	Residential properties, hospitals, schools and residential care homes.
Medium	Parks, places of work.	Office and shop workers not occupationally exposed to PM ₁₀ .
Low	Playing fields, farmland, footpaths, short-term car parks and roads.	Public footpaths, playing fields, parks and shopping streets.

¹ People's expectations would vary depending on the existing dust deposition in the area.

² This follows the Department for Environment, Food and Rural Affairs (Defra, 2016) guidance as set out in Local Air Quality Management Technical Guidance (LAQM.TG (16)). Notwithstanding the fact that the air quality objectives and limit values do not apply to people in the workplace, such people can be affected to exposure of PM₁₀. However, they are considered to be less sensitive than the general public as a whole because those most sensitive to the effects of air pollution, such as young children are not normally workers. For this reason workers have been included in the medium sensitivity category.

Table 23-2 and Table 23-3 set out the selection criteria for the sensitivity of the area to dust soiling effects on people and property, and the selection criteria for the sensitivity of the area to human health impacts, respectively.

Table 23-2: Criteria for the sensitivity of the surrounding area to dust soiling effects on people and property

Receptor sensitivity	Number of receptors	Distance from the source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10 – 100	High	Medium	Low	Low
	1 – 10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Table 23-3: Criteria for the sensitivity of the surrounding area to human health

Receptor sensitivity	Annual mean PM ₁₀ concentration	Number of receptors	Distance from the source (m)				
			<20	<50	<100	<200	<350
High	> 64µg/m ³	>100	High	High	High	Medium	Low
		10 – 100	High	High	Medium	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	56 – 64µg/m ³	>100	High	High	Medium	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	High	Medium	Low	Low	Low
	48 – 56µg/m ³	>100	High	Medium	Low	Low	Low
		10 – 100	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	< 48µg/m ³	>100	Medium	Low	Low	Low	Low
		10 – 100	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Medium	> 64µg/m ³	>10	High	Medium	Low	Low	Low
		1 – 10	Medium	Low	Low	Low	Low
	56 – 64µg/m ³	>10	Medium	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	48 – 56µg/m ³	>10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	< 48µg/m ³	>10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
	< 48µg/m ³	>10	Low	Low	Low	Low	Low
		1 – 10	Low	Low	Low	Low	Low
Low	n/a	>1	Low	Low	Low	Low	Low

A.2.2 Step 2: Define the risk of impacts

The dust emission magnitude is then combined with the sensitivity of the area to determine the overall risk of impacts with no mitigation measures applied. The matrices in Table 23-4 provide a method of assigning the level of risk for each activity. These can then be used to determine the level of mitigation that is required.

Table 23-4: Determination of risk of dust impacts

Sensitivity	Dust emission magnitude		
	Large	Medium	Small
Demolition			
High	High risk	Medium risk	Medium risk
Medium	High risk	Medium risk	Low risk
Low	Medium risk	Low risk	Negligible risk
Earthworks			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible risk
Construction			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Medium risk	Low risk
Low	Low risk	Low risk	Negligible risk
Trackout			
High	High risk	Medium risk	Low risk
Medium	Medium risk	Low risk	Negligible risk
Low	Low risk	Low risk	Negligible risk

A.2.3 Step 3: Site specific mitigation

During the construction phase, it would be important to control dust levels for High, Medium and Low risk sources. In order to avoid significant impacts from dust during the construction phase, suitable mitigation measures should be adopted. Following the identification of the risk category for the demolition, earthworks, construction and trackout activities based on Table 23-3 to Table 23-4, appropriate mitigation measures can be identified. Activities identified as a High risk will require a greater level of mitigation than those identified as Low risk.

A selection of these measures have been specified for Low risk to High risk sites in the IAQM guidance (IAQM, 2014) as measures suitable to mitigate dust emissions from activities, such as those which form part of the Park.

A.2.4 Step 4 Determine significant effects

Following Step 2 (definition of the Park and the surroundings and identification of the risk of dust effects occurring for each activity) and Step 3 (identification of appropriate site-specific mitigation), the significance of the potential dust effects can be determined. The recommended mitigation measures should normally be sufficient to reduce construction dust impacts to a not significant effect.

The approach in Step 4 of IAQM dust assessment guidance has been adopted to determine the significance of effects with regard to dust emissions. The guidance states:

“For almost all construction activity, the aim should be to prevent significant effects on receptors through the use of effective mitigation. Experience shows that this is normally possible. Hence the residual effect will normally be ‘not significant.’”

IAQM guidance also states that:

“Even with a rigorous DMP [Dust Management Plan] in place, it is not possible to guarantee that the dust mitigation measures will be effective all the time, and if, for example, dust emissions occur under adverse weather conditions, or there is an interruption to the water supply used for dust suppression, the local community may experience occasional, short-term dust annoyance. The likely scale of this would not normally be considered sufficient to change the conclusion that with mitigation the effects will be ‘not significant’.”

Step 4 of IAQM guidance recognizes that the key to the above approach is that it assumes that the regulators, ensure that the proposed mitigation measures are implemented. The management plan would include the necessary systems and procedures to facilitate on-going checking by the regulators to ensure that mitigation is being delivered, and that it is effective in reducing any residual effect to ‘not significant’ in line with the guidance. It is also noted that the mitigation measures identified in the IAQM guidance includes those set out in Chapter 4 of the IFC Environmental, Health and Safety (EHS) Guidelines: Construction and Decommissioning.

A.2.5 Greenhouse Gas Emissions

The GHG emissions have been evaluated based on CO₂ equivalent and estimated based on fuel consumption. The emission sources considered comprise of:

- Scope 1 Direct emissions sources
- * Scope 3 Other indirect /value chain emissions (i.e. waste disposal and staff travel)

Due to the minimal consumption of purchased electricity, Scope 2 – Indirect Emissions has not been included in the assessment.

As described in Chapter 2, it is a requirement of the Equator Principles that projects assess their Scope 1 (direct emission sources (i.e. direct emissions from activities on site or directly associated with the operation)) and 2 (indirect emission) carbon emissions. Those projects emitting more than 100,000 metric tonnes of CO₂ annually during operations are required to undertake an alternatives analysis. The method of calculation of the project’s operational carbon is based on the GHG Protocol, assessed in accordance with the Royal Commission Environmental Regulations (RCER) 2015 Environmental Permit Program and the Saudi Aramco Engineering Procedures 13 (SAEP-13) and guidance from the UK Government’s Department of Energy and Climate Change. The process involves:

- identifying the activities/processes which release GHG,
- categorization of the activities by scope, and
- quantification of the emissions.

For the purpose of this calculation the sources of Scope 1 and 2 GHG include CO₂ emissions associated with the following elements of the project:

- transport of construction materials and the solar panels;
- fuel required for the plant and equipment required for the construction, operation and decommissioning phase; and
- materials used for the construction of the Park, such as stainless steel and concrete.

A.2.6 Transport

The information on the number of heavy duty vehicles (HDVs) required for the construction of the Park were reviewed. This includes the shipping of the solar panels from China and the transport of all other materials from Sakaka. The total distance travelled by HDVs was calculated and converted to CO₂ using a factor of 1.134 kg CO₂e/km from the UK Government GHG Conversion Factors based on a 100% laden articulated lorry (>33t)¹⁰. For shipping emissions, an emissions factor, also from the UK Government, of 0.016 kg CO₂e/tonne.km has been used to calculate the CO₂ emissions.

A.2.7 Plant and machinery

From the equipment list provided, the power rating (in kWh) of each plant was determined and the total power consumption calculated throughout the construction, operation and decommissioning. Then on the basis that the fuel used would be diesel, a conversion factor of 0.268 kg CO₂e/kWh (UK Government GHG Conversion Factors) was used to calculate the total CO₂ emissions from the plant and machinery used for the Park.

A.2.8 Materials

The final calculation was to determine the CO₂ emissions associated with the materials used to construct the Park. The four main materials used and the associated CO₂ emission factor are provided below:

- asphalt (for the perimeter road and the internal roads) – 0.086 t CO₂ / t asphalt;
- concrete (for panel foundations, building compounds, substation and gatehouse) - 0.083 t CO₂ / t concrete; and
- steel (for framework) – 6.519 t CO₂ / t stainless steel.

Appendix B. Noise Monitor Calibration Certificate

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Date of issue 22/5/15 Certificate N° 1505286



AV Calibration
2 Warren Court
Chicksands, Shefford
Bedfordshire SG17 5QB
U.K.
Tel: +44 (0)1462 638600
Fax: +44 (0)1462 638601
Email: lab@avcalib.co.uk
www.avcalibration.co.uk

Page 1 of 4 Pages

Signed

G. Parry [] B. Baker [✓]

Acoustics Noise and Vibration Ltd trading as AV Calibration

CLIENT

Jacobs Ltd
Enviros House
Shrewsbury Business Park
Sitka Drive
Shrewsbury
SY2 6LG

F.A.O. Barry Salway

ORDER No - Job No TRAC15/05127/03

DATE OF RECEIPT 12 May 2015

PROCEDURE AV Calibration Engineer's Handbook section 3

IDENTIFICATION Sound level meter Rion type NL-32 serial No 00482601 connected via extension lead type EC-04 and preamplifier type NH-21 serial No 27705 to a half-inch microphone type UC-53A serial No 321276 fitted with a foam windshield type WS-03. Associated calibrator Rion type NC-74 serial No 34257024 with a one-inch housing and adapter type NC-74-002 for half-inch microphone.

(0873)

CALIBRATED ON 22/5/15

PREVIOUS CALIBRATION Calibrated on 17 March 2014, Certificate No. TCRT14/1093 issued by a non accredited calibration laboratory ANV Measurement Systems

The measurements detailed herein are traceable to units of measurement realised at the National Physical Laboratory. This certificate may not be reproduced other than in full, except with the prior written approval of AV Calibration.

CERTIFICATE OF CALIBRATION

ISSUED BY AV CALIBRATION

Certificate N° 1505286

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The sound level meter was set to frequency weighting A and adjusted to read 93.6 dB (corresponding to 93.6 dB at standard atmospheric pressure) in response to the sound calibrator supplied. This reading was derived from the Calibration Certificate No. 1505280 supplied by this laboratory and manufacturers' information on the free-field response of the sound level meter when fitted with the windshield.

The sound level meter was then tested, and its overall sensitivity adjusted as required.

An acoustic calibration at 1kHz was performed by application of a standard sound calibrator, whilst the tests at 125Hz and 8kHz were performed by the electrostatic actuator method.

At the end of the test, the sound calibrator was reapplied to the sound level meter and the meter reading was recorded.

RESULTS

The sound level meter was found to conform to the type 1 requirements of BS EN 60651:1994* and BS EN 60804:1994* for those tests carried out.

The self-generated noise recorded was:

9.3 dB (A)

15.5 dB (C)

22.2 dB (Lin)

The sound level meter reading obtained at the end of the test in response to the sound calibrator was 93.6 dB (corresponding to 93.6 dB at standard atmospheric pressure). This reading, corrected for ambient pressure, should be used henceforth to set up the sound level meter for field use.

The expanded level uncertainty of the Laboratory's 1 kHz sound calibrator used during this verification is ± 0.22 dB; that of the calibrator supplied with the sound level meter is ± 0.23 dB.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with the *Guide to the Expression of Uncertainty in Measurement* published by the International Organisation for Standards (ISO).

All measurement data are held at AV Calibration for a period of at least six years.

The case reflection factors have been taken as zero, since an extension lead has been used for this verification.

The reference range, linearity range and primary indicator range specified by the manufacturer have been used. See note 5 below.

The Rion NL-32 sound level meter design has successfully undergone pattern evaluation at Physikalisch-Technische Bundesanstalt (PTB). It was found to meet the requirements of BS EN 60651* and BS EN 60804* and was granted pattern approval as a Type 1 sound level meter.

No component of uncertainty for manufacturer-specified corrections has been included in the uncertainty budget and, in accordance with amendments to the standards, the measured values obtained during the verification have not been extended by any measurement uncertainty when assessing conformance to each standard.

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NOTES

- *1 BS EN 60651:1994 and BS EN 60804:1994 were formerly numbered BS 5969:1981 and BS 6698:1986 respectively.
- 2 No suitable microphone frequency response information was supplied with the instrument. It was therefore measured by this laboratory using the electrostatic actuator method.
- 3 The instrument was tested with integral software as received.
- 4 The NL-32 does not have a "max hold" function available when operating with time weighting I. The results recorded for the test of time weighting I are therefore the highest instantaneous reading shown on the display. Whilst these results meet the requirements of the standard, those for response to a single tone burst in particular may give a misleading impression of the accuracy of time weighting I on this instrument.
- 5 After consultation with the manufacturer and their European agents, it has been established that the specifications given in the standard English-language handbook for the NL-32 are both incomplete and incorrect. An addendum to the handbook based on the PTB tests has been provided by Rion, and this revised specification has been used for the purposes of the present verification. For information, extracts from the addendum have been appended as page 4 of this certificate.
- 6 The instrument was labelled "Aspinwall 00673" and "SKM GB-A03515"
- 7 The combination of microphone response and WS-03 windshield corrections was causing a FAIL result at 8kHz - instrument fitted with new replacement UC-53A microphone for this verification.

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Certificate N° 1505286

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The following data supplied by Rion are included for completeness:

Addendum to the NL-32 Instruction Manual

Errata (page 133):

- Total range: 23 to 137 dB(A).
- Linearity range (on 30 - 120 dB reference range): 99 dB (28 to 127).

Additional information

- Primary indicator range (on 30 - 120 dB reference range): 32 - 111 dB, allowing a crest factor of 10 for Impulse time weighting.
- Pulse range: > 63 dB
- Measurement range for various LEVEL settings: See table below.

Measurement ranges				
Measurement range for various "LEVEL" range settings (dB) *				
Frequency weighting A-, C- and Lin.				
"LEVEL" Setting (dB)	Time weighting			Leq
	Fast/Slow	Impulse	Peak	
20 - 80	23 - 80 **	23 - 70 **	50 - 90	23 - 87 **
20 - 90	23 - 90 **	23 - 80 **	50 - 100	23 - 97 **
20 - 100	23 - 100 **	23 - 90 **	50 - 110	23 - 107 **
20 - 110	23 - 110 **	23 - 100 **	50 - 120	23 - 117 **
30 - 120	28 - 120 **	28 - 110 **	50 - 130	28 - 127 **
40 - 130	38 - 130	38 - 120	50 - 140	38 - 137

* For time weighting Fast and Slow a crest factor 3, and for time weighting Impulse a crest factor 10, is taken into account.

** The lower limit of the measurement range is 30 dB(C) for C-weighting and 35 dB(Lin) for Lin weighting.

END

Appendix C. Noise Monitoring Survey

Location 1: Noise Monitoring Site 1 (25th December 2016)		Address	Frequency-weight	Time-weight	Date-time	Sp	Sampling time	Time setting	Measurement time	L _{eq}	L ₁	L ₂	L ₅	L ₁₀	L ₅₀	L ₉₀	L ₉₅	L _{peak}	Temperature	Wind Speed (m/s)	Wind Direction	Wet	Observational Conditions During Measurements	Notes
Location 1: Noise Monitoring Site 1 (25th December 2016)	A	Fwd	30°	12:40	21.5	16/12/2016 12:39	15min	0:14:56		34.7	54.2	49.6	17.5	20.6	27.2	20.8	18.9	26.6	55.8	1.4	0	NW	Car keeping on drive away - lasted 15 sec.	
										34.1	53.6	49	17.8	26.3	27	21.9	18.3	26.9	55.8	1.4	0	NW		
	A	Fwd	30°	12:58	22.5	16/12/2016 12:40	15min	0:14:57		35.4	54.8	49.3	17.3	20	27.6	21.2	18.3	26.1	55.6	1.3	0.4	NW	Parking break drive away (within 30s of device) - lasted 20 seconds	
										34.5	54.2	48.7	17.8	23.2	28.7	20.8	18.8	26.4	55.5	1.4	0	NW		
	A	Fwd	30°	13:04	22.8	16/12/2016 13:00	15min	0:14:58		35.8	55.3	49.2	17.8	23	28.7	21.1	18.6	26.3	55.8	1.6	0.4	NW	None observed - lasted 20 seconds	
										34	53.5	49.5	17.4	25.4	29.6	20.6	18.3	26.1	55.6	1.6	0	NW		
	A	Fwd	30°	13:14	23.8	16/12/2016 13:10	15min	0:14:59		34.4	55.8	48.5	17.3	22.6	28.1	19.6	18.4	26.3	55.3	1.6	0.8	NW	None observed - lasted 20 seconds	
										32.1	46.4	40.8	16.4	25.1	28.9	20.8	17.8	26.1	55	1.5	1.1	NW		
	A	Fwd	30°	13:24	23.9	16/12/2016 13:20	15min	0:15:00		34.2	54.7	48.1	16.9	21.3	28.3	19	17.1	27	55.2	1.3	0.8	NW	None observed - lasted 20 seconds	
										32.8	47.1	46.1	16.9	40.7	28.2	20.8	17	26.9	56.2	1.3	1.3	NW		
	A	Fwd	30°	13:34	23.9	16/12/2016 13:30	15min	0:15:01		37.4	56.8	52.5	18.5	21.4	28.2	21.1	17.8	27.3	55.6	1.3	1.1	NW	Sound of dogs in the background - None seen/heard - lasted for 20 seconds	
										41.8	71.3	56.1	16.3	49.7	40.2	23.4	18.4	27.8	61.1	1.6	0	NW		
	A	Fwd	30°	13:44	24.8	16/12/2016 13:40	15min	0:15:02		35	53.5	48.5	16.1	23.3	28.2	19.8	16.9	26.4	55.6	1.6	1.3	NW	None observed - lasted for 20 seconds	
										35.1	52.7	51.8	15.8	27.4	25.4	19.3	18.8	26.8	55.9	1.3	0.9	NW		
	A	Fwd	30°	13:54	25.8	16/12/2016 13:50	15min	0:15:03		35.6	55.1	55.8	18.1	25.6	27	21.1	17.9	27.4	57.4	1.3	2.1	NW	Over overcasted for 20 seconds	
										33.3	52.8	47.8	15.8	27.9	24.6	19	16.5	26.3	58.5	1.5	1.1	NW		
	Averages											52.2	18.8	22.3	28.2	20.8	18.1	27.8	55.6					
Location 1: Noise Monitoring Site 2 (25th December 2016)		Address	Frequency-weight	Time-weight	Date-time	Sp	Sampling time	Time setting	Measurement time	L _{eq}	L ₁	L ₂	L ₅	L ₁₀	L ₅₀	L ₉₀	L ₉₅	L _{peak}	Temperature	Wind Speed (m/s)	Wind Direction	Wet	Observational Conditions During Measurements	Notes
Location 1: Noise Monitoring Site 2 (25th December 2016)	A	Fwd	30°	11:20	33.4	17/12/2016 09:54	15min	0:16:55		32.8	42.1	31.1	18.8	33.7	34.4	31.2	28.8	28.3	38.3	8	0		Drive the car backwards for 10 seconds	
										32.2	41.7	40.6	18.9	34.3	38.9	31.3	28.1	29.6	38.3	8	0			
	A	Fwd	30°	11:30	31.6	17/12/2016 09:59	15min	0:16:56		31.6	41.1	40.1	17.9	34.9	32.6	30.8	28.7	29.4	38.8	8	0		Car engine started	
										35.1	42.8	31.8	17.7	35.7	34.5	32.1	30.7	30.4	34.5	9	0			
	A	Fwd	30°	11:40	31.7	17/12/2016 10:04	15min	0:16:57		33	42.8	48	18.4	36.6	34.5	31.7	30.9	30	32.2	8	0		None observed - lasted 20 seconds	
										35.8	43.3	37	18.8	35.4	34.2	32.1	30.8	30.5	38.7	8	0			
	A	Fwd	30°	11:50	34.6	17/12/2016 10:09	15min	0:16:58		35.9	43.4	38.4	18.5	35.6	34.9	33	30.7	31.3	38.9	15	0		None observed - lasted 20 seconds	
										34.8	43.8	30.8	18.8	36.6	35.9	33.7	30.1	31.8	35.9	9	0			
	A	Fwd	30°	12:00	40.2	17/12/2016 10:14	15min	0:16:59		34.6	44.1	49.7	21.5	35.6	35.4	34.1	32.3	33	32.2	8	0		None observed - lasted 20 seconds	
										35.4	44.9	49.3	21	35.1	34.4	34.6	33.8	34.2	36.4	8	0			
	A	Fwd	30°	12:10	38	17/12/2016 10:24	15min	0:17:00		34.7	44.2	47.8	21	34.3	35.8	34.9	33.1	31.8	33.9	11	0		None observed - lasted 20 seconds	
										35.8	45.4	47.1	20.9	34.7	34.2	34.7	32.1	34.1	34.1	11	0			
	A	Fwd	30°	12:20	29.8	17/12/2016 10:34	15min	0:17:01		33.2	42.7	30.7	18.9	36.1	35.8	35.7	34.9	26.4	35.5	11	0.8	NW	None observed - lasted for 20 seconds	
										31.3	42.7	30.8	19.8	34.9	31.5	37.5	25.4	24.1	30.9	13	3.4	NW		
	A	Fwd	30°	12:30	40.2	17/12/2016 11:04	15min	0:17:02		31.4	42.8	49.8	20	36.9	34.8	28.1	28.2	24.8	35.5	13	1.4	NW	None flying over - 5 minutes	
										32.3	43.8	50	21.7	34.4	35.4	37.3	24.1	25.6	35.8	13	4	NW		
	Averages									33.1	43.4	33.8	22.2	37.2	35.9	32.2	28.8	29.1	38.7					
Location 1: Spec Sample		Address	Frequency-weight	Time-weight	Date-time	Sp	Sampling time	Time setting	Measurement time	L _{eq}	L ₁	L ₂	L ₅	L ₁₀	L ₅₀	L ₉₀	L ₉₅	L _{peak}	Temperature	Wind Speed (m/s)	Wind Direction	Wet	Observational Conditions During Measurements	Notes
Location 1: Spec Sample	A	Fwd	30°	12:55	29.3	17/12/2016 12:40	15min	0:18:46		49	70.1	72.7	19	31.7	47.5	37.3	27.3	24.2	57.7	14	3.8	NW	None seen/heard - lasted for 20 seconds	

Appendix D. Noise modelling scenarios and sound power levels

Sound power levels of construction, operational and decommissioning scenarios

Noise modelling scenario	Octave Band Centre Frequency Sound Power Level (L_{Zeq}), Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
Installation of Access Roads	124	124	118	117	117	112	108	102	121
Site Grading	124	123	119	125	119	114	110	103	125
Install Construction Compound	115	116	114	132	111	111	104	101	129
Installation of Fencing/lighting	127	131	123	125	121	119	114	110	127
Install Foundations for panels	127	130	121	120	119	119	111	106	125
Pre-Fabrication (Installing Mounting Structures)	129	124	128	128	129	127	124	128	134
Installing Solar Modules	119	116	114	137	110	107	102	94	133
Installing Cabling	129	124	116	122	112	110	111	103	121
Power Supply at Construction Site	111	108	112	106	105	101	92	83	110
Building Developers Compound	120	116	111	109	109	111	102	98	115
Operation (including site management, delivery and maintenance, emptying of sanitation and domestic waste)	123	116	118	115	116	109	102	97	119
Operation, x75 2000 kVA transformers 1)	102	105	100	100	92	85	77	65	100
Decommissioning	133	131	131	139	131	132	128	130	139

Note 1. Based on transformer noise source calculation given by National Electrical Manufacturers Association, 1980. Assuming a N_R of 73 dB, a surface area for walls of 18 m² and a C correction for the source located outdoor.

Appendix E. Noise - Heavy Vehicle Movements on Access Roads to and from Site

Table B.1: L_{zmax} pass by noise level of lorry used in the assessment of vehicle noise impacts

Noise modelling scenario	Octave Band Centre Frequency L_{zmax} Noise Level, Hz								
	63	125	250	500	1k	2k	4k	8k	dBA
Dump truck (empty)	114	107	107	107	107	112	97	88	115

Table B.2: Construction road traffic flows and speeds

Heavy vehicles movements				Assumed average speed (kmph)
Pre-construction		Construction		
TOTAL per day	Assumed hourly average	TOTAL per day	Assumed hourly average	
90	18	33	7	50

Appendix F. Important Bird and Biodiversity Areas

(All data in this Appendix has been sourced directly from www.birdlife.org)

Jabal Aja: (27°30'N 41°30'E, 200,000 ha) lies west and south-west of Ha'il city and is an extensive outcrop of granite mountains with deep valleys. The site is extended north-east to the edge of the Nafud Desert to include an area used for surveys of migrant *Grus virgo* (Jibal at-Tuwal and Dilan al-Jilf, 27°50'N 41°45'E, 200,000 ha)- an area of flattish semi-desert and sandstone hills, punctuated by medium-altitude granitic mountains with deep valleys. The climate is fairly benign (altitude 800-1,550 m), and the area is one of the greenest in northern Arabia; in wet springs the desert and sandstone hills bloom, and many ephemeral pools and lakes are formed. Valleys in granite mountains are often lined with many *Acacia* trees. Much of the crane survey area is under wheat cultivation by pivot irrigation systems.

Total area is 400,000 ha.

Table 23-5: Populations of IBA trigger species

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Sand Partridge <i>Ammoperdix heyi</i>	LC	resident	1993	abundant	B3
Demoiselle Crane <i>Anthropoides virgo</i>	LC	passage	1993	5,600 individuals	A4i, B1i, B2
Hume's Owl <i>Strix butleri</i>	LC	resident	1993	present	B3
Egyptian Vulture <i>Neophron percnopterus</i>	EN	resident	1993	10-100 breeding pairs	B2
Griffon Vulture <i>Gyps fulvus</i>	LC	resident	1992	100 breeding pairs	B2
Menetries's Warbler <i>Sylvia mystacea</i>	LC	passage	1993	common	B3
Menetries's Warbler <i>Sylvia mystacea</i>	LC	winter	1993	common	B3
White-throated Robin <i>Irania gutturalis</i>	LC	passage	1993	present	B3
Finsch's Wheatear <i>Oenanthe finschii</i>	LC	passage	1993	present	B3
Finsch's Wheatear <i>Oenanthe finschii</i>	LC	winter	1993	present	B3
Pale Sparrow <i>Carpospiza brachydactyla</i>	LC	breeding	1993	1,000 breeding pairs	B3
Cinereous Bunting <i>Emberiza cineracea</i>	NT	passage	1993	present	A1, B2
A4iv Species group - soaring birds/cranes	n/a	passage	1993	5,600 individuals	B1iv

Harat al Harrah: A huge desert area of northern Saudi Arabia, close to the border with Jordan, and 80 km north-west of Sakaka. Undulating, black, basalt boulder-fields with numerous volcanic cones and frequent low hills, interspersed with silt flats and some sabkha. Wadis are generally shallow. Rainfall is seasonal (every winter) but varies greatly in amount between years. There is rarely any surface water except for a permanent reservoir at Dumat al Jandal (see site 002) near the southern edge of the reserve. Except for a very few stunted palms the vegetation is devoid of trees, and is sparse except after good winter/spring rains, although drainage features contain a reasonable cover of small shrubs (*Artemisia*, *Haloxylon*, *Zilla*).

Total area is 1,377,500 ha.

Table 23-6 : Populations of IBA trigger species

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Sand Partridge <i>Ammoperdix heyi</i>	LC	resident	1993	common	A3, B3
Chlamydotis undulata	NR	resident	1993	50 nests	A1, B2
Chlamydotis undulata	NR	winter	1993	570 individuals	A1
Cursorius cursor	NR	breeding	1993	present	A3
Hume's Owl <i>Strix butleri</i>	LC	resident	1993	uncommon	A3, B3
Pharaoh Eagle-owl <i>Bubo ascalaphus</i>	LC	resident	1993	present	A3
Eastern Imperial Eagle <i>Aquila heliaca</i>	VU	winter	1993	uncommon	B2
Saker Falcon <i>Falco cherrug</i>	EN	passage	1993	present	B2
Eremalauda dunni	NR	resident	1993	present	A3
Greater Hoopoe-lark <i>Alaemon alaudipes</i>	LC	resident	1993	present	A3
Thick-billed Lark <i>Ramphocoris clotbey</i>	LC	resident	1993	present	A3
Bar-tailed Lark <i>Ammomanes cinctura</i>	LC	resident	1993	present	A3
Desert Lark <i>Ammomanes deserti</i>	LC	resident	1993	present	A3
Temminck's Lark <i>Eremophila bilopha</i>	LC	resident	1993	present	A3
Finsch's Wheatear <i>Oenanthe finschii</i>	LC	winter	1993	common	B3
Pale Sparrow <i>Carpospiza brachydactyla</i>	LC	breeding	1993	uncommon	B3
Pale Sparrow <i>Carpospiza brachydactyla</i>	LC	passage	1993	frequent	B3

At-Tubayq: This huge area is a raised platform of old, dark sandstone rising 300-400 m above the undulating sandy plain which surrounds it. The ramparts are extremely broken and rocky, precipitous in places, but the plateau is flat. There is no permanent water and, apart from a flush of ephemeral plant growth after rains, vegetation is limited to drought-resistant shrubs (e.g. *Haloxylon*) and grasses with a few stunted *Acacia* trees.

Total area is 1,220,000 ha.

Table 23-7 : Populations of IBA trigger species

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
Lappet-faced Vulture <i>Torgos</i>	EN	resident	1993	10 breeding pairs	A1, B2

Species	IUCN Category	Season	Period	Population estimate	IBA Criteria
tracheliotos					
Hooded Wheatear <i>Oenanthe monacha</i>	LC	breeding	1993	uncommon	B3

Dumat al Jandal: This site, on the north-east side of Dumat al Jandal town, is one of the very few remaining wetland habitats in the northern desert. Until 1983-1984 it was a medium-sized natural lake surrounded by a large marsh of reeds and sedges (900 ha overall), but this has now been drained and converted to agricultural smallholdings; the water is pumped to an elevated basin in the hills overlooking the former marsh, forming a reservoir (150 ha). From here water flows through a number of irrigation channels back to the agricultural areas, where there are some very small, scattered remains of marshland. The reservoir is used for recreation in summer, and fish *Tilapia* have been introduced.

No data is available on populations of IBA trigger species.

Appendix G. Terrestrial Ecology Survey Methodology

G.1 Overview

This section describes the scope and methodology of ecological surveys to be undertaken during the autumn and winter of 2016/17. The survey effort and design for ecological surveys accounts for the current implementation schedule for the Park. The full ESIA is scheduled to be submitted in March 2017.

Prior to the commencement of ornithological surveys, the development included a new overhead transmission line to connect the solar power plant with the nearby SEC power station. The survey design accounted for the potential impact of new overhead transmission lines on migratory birds and the risk of collision. The height of the pylons is estimated to be 30m, and the transmission lines are strung between 15m and 25m on the pylons with a maximum sag level of 6m above ground between pylons. It is understood that the requirement for a new overhead transmission line has been removed, however, a precautionary approach has been adopted.

The location of surveys discussed in this section are shown in Figure 23-2 : and Figure G.2.



Figure 23-2 : Survey Locations

G.2 Ornithological Surveys

The objectives of the bird surveys to be undertaken are as follows:

- To provide data on the activity levels and distribution of flight behavior of target species within, and in the vicinity of, the developable area during the autumn 2016 migration season.
- To provide data on the general assemblage of species present within the developable area.

As reported by Scottish Natural Heritage in 'Assessment and Mitigation of Impacts of Power Lines and Guyed Meteorological Masts on Birds Guidance (SNH, 2016) there is currently very little empirical evidence on bird interactions with power lines. There is currently no statistical model available which provides robust assessment of potential mortality.

Collisions are usually site-, season- and species-specific, and a generic collision risk model is unlikely to accurately predict levels of mortality (SNH, 2016). Therefore no collision risk modelling will be undertaken, and the emphasis will be on mitigation where surveys indicate potential conflicts.

G.2.1 KSA Bird Codes

Prior to the commencement of survey work an indicative index of bird species known to be present on the East Asia/East Africa Flyway was produced. Unique three-letter codes were attributed to each species for recording purposes during surveys. This species list is included within Appendix H.

G.2.2 Migration Vantage Point Surveys

Key Species

In accordance with international (BirdLife International, 2012) and best-practice guidance (SNH, 2014) Vantage Point (VP) surveys focus on target species which may, as a result of their flight patterns or response behavior, be subject to impact from overhead transmission lines or solar infrastructure (Barrios & Rodriguez, 2004, SNH, 2010, Smith & Dwyer, 2016). Although as previously discussed all birds utilizing the site in any capacity will be recorded.

Methods

VP surveys aim to quantify the flight activity of target species within, and in the vicinity of, the proposed overhead powerline. The methodology for such watches followed SNH guidance (SNH, 2014). VP locations have been selected with the aim of providing the least restricted observation of the overhead power line along the northern boundary of the development site. The VP locations are shown in Figure G2 and sample the activity of migratory birds in the locality of the overhead transmission line. It should be noted that there are already two 132kV transmissions lines with pylons approximately 30m in height, and a 13.8kV transmission line with towers approximately 4m in height. Based on the existing risks to migratory birds in this locality, it was determined appropriate to sample the impact of this existing utility corridor as opposed to surveying it in its entirety.

Activity patterns, and time spent flying within the area visible from each VP have been recorded. The main purpose of VP watches is to:

- collect data on target species that will enable estimates of:
 - o the time spent flying over the transmission line corridor;
 - o the relative use of different parts of the transmission line corridor; and
 - o The proportion of flying time spent within the provisional lower and upper height limits of the 132kV pylons and transmission lines.
- Gather an index of presence of all other species within the developable area.

The survey durations (three hours), recording methods, and associated controls, e.g. 30 minute breaks between watches to avoid observer fatigue, remain as per Scottish Natural Heritage guidance. Survey periods, however, have been adapted to focus on the autumn migration period. Observations were spread throughout daylight hours, with a proportion of surveys occurring at dusk and dawn.

For each target species, the following details were recorded:

- time of observation;
- duration of flying bout;
- species, age and sex (where possible);
- time spent in each height band; and

- Flight route through the survey area.

The following meteorological variables were recorded although it is anticipated some may not be applicable:

- wind direction;
- wind speed: Beaufort scale 0 (no wind), to 12 (hurricane);
- temperature (°C);
- visibility: 0 (poor <1km), 1 (1-2km), 2 (>2km);
- cloud cover: Okta scale 0 (no cloud), to 8 (total cloud cover); and
- Precipitation (type, intensity and duration).

Vantage Point Locations

In addition to health and safety considerations, the main consideration when selecting VP locations was to provide the least restricted view of the transmission lines. Due to the size of the site, four VPs were situated within the utility corridor to achieve efficient coverage. Widespread coverage of ground-level visibility is also available from each VP. This has been verified in the field and as such view shed analysis has not been undertaken.

Observations carried out at VP1 and VP2, and VP3 and VP4 were paired and surveyed concurrently with two observers together at the same location facing opposite directions. Observers focused on airspace within the developable area and adjacent areas where possible. The direction of observations will be in one approximately 180° plane, forming a 2km view arc.

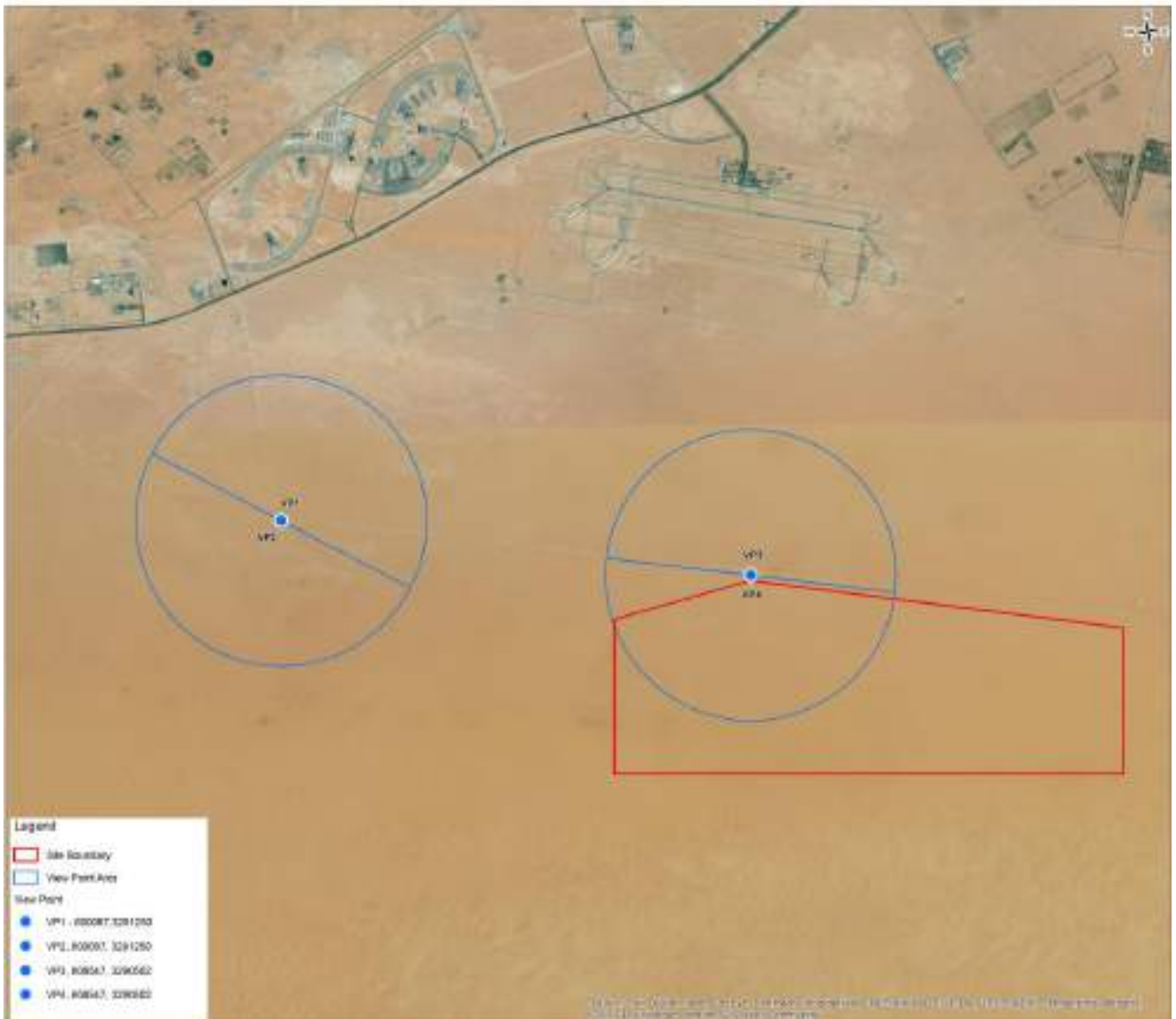


Figure G2: Viewpoint Locations

G.2.3 Survey Height Bands

All target species flights recorded during VP surveys were allocated a height band (Table 23-8). Survey height bands were determined according to the dimensions of the pylons and transmission lines under consideration at the commencement of survey works, based upon information provided by Saudi Aramco.

Table 23-8: VP Survey Height Band Summary

Height Band (meters above ground level)	
A	B
<30m	>30m

G.2.4 Autumn Migration 2016

Twelve hours of observations were undertaken from each VP in October 2016 during the autumn migration season. In total 48 hours of survey effort was undertaken. Full details of the survey dates, times, weather conditions and surveyors are provided in Appendix I.

G.2.5 Winter 2016/2017

Two site visits were undertaken in January 2017 to survey for the presence of resident and wintering species. In total 16 hours of survey effort was undertaken.

G.2.6 Incidental Observations

In addition to the structured surveys, incidental observations were recorded throughout the survey period, including during the Phase 1 habitat survey and transect surveys. These observations may include any bird species of note such as target species out with VP areas, significant movements of migrating birds and indirect evidence of target species' presence within the developable area and adjacent areas (e.g. anecdotal evidence from locals).

G.3 Phase 1 Habitat Survey

A Phase 1 habitat survey was undertaken to record the habitat features within and adjacent to the development site. The standard survey methodology developed by the Joint Nature Conservation Committee (2010) was utilized and adapted for the Kingdom of Saudi Arabia. The aim of Phase 1 habitat survey is to provide a rapid record of vegetation and wildlife habitat over large areas.

The habitat classifications are based principally on vegetation, augmented by reference to topographic and substrate features, particularly where vegetation is not the dominant component of the habitat. This latter aspect is particularly relevant for the development site which includes significant areas which support sparse or no vegetation. Descriptive target notes were taken to give a brief account of particular areas of interest, including vegetative communities. Target notes are an essential part of Phase 1 survey and provide the basis for selection of sites for more targeted species surveys (i.e. Phase 2 survey) and for the assessment of environmental impact.

During the Phase 1 habitat survey habitats across the development site were accessed and sampled to facilitate the classification of habitat type and the identification of flora communities and associations. The relative abundance of flora within the habitat classifications were reported using the DAFOR scheme which works on % cover, where D = Dominant >75%, A = Abundant 75 - 51%, F = Frequent 50 - 26%, O = Occasional 25 - 11%, R = Rare 10 - 1 %. Cover/abundance is a measure of the vertical projection on to the ground of the extent of the living parts of a species. Desert flora communities are typically sparse with areas devoid of vegetative growth. In the context of the Park, the application of the DAFOR scheme is in relation to the community.

Evidence of faunal species (e.g. tracks, borrows or dens, scats or droppings, hairs etc.) and direct sightings were recorded during the Phase 1 habitat survey, and landscape features which have the potential to support faunal species were targeted for survey.

G.4 Faunal Surveys Using Trail Cameras

Based on the findings of the Phase 1 habitat survey and identification of faunal activity, Bushnell Trophy Cam trail cameras were deployed. These cameras use a passive infrared sensor to detect movement within its monitoring range. This triggers the camera to capture still images or videos which are saved onto an internal SD card. These cameras are also equipped with infrared LEDs which allow it to take images during the night or in low light situations.

The trail cameras were deployed where there is existing evidence of faunal activity, and attempt to assist with species identification. The cameras were not be baited as experience has shown that this can influence the species recorded on the trail camera. The cameras were left in-situ for a minimum of one full night, including a sun-set and sun-rise, to ensure the activities of crepuscular and nocturnal species were captured.

Table 23-9 :lists the locations where trail cameras were deployed and the hours of recording in each location.

Table 23-9 : Deployment Locations of Trail Cameras

Trail Camera Ref	Location	Date Set	Hours Recording	Northing	Easting
A	Saudi Aramco Met Station	09-Oct-16	19	29°44'16.91"N	40° 6'11.42"E
B	Northern Part of site in proximity to an active <i>Uromastyx aegyptia</i> burrow	10-Oct-16	14	29°44'22.57"N	40° 6'10.39"E
C	Abandoned Camel Track	11-Oct-16	20	29°43'50.87"N	40° 5'7.86"E
D	Abandoned Camel Track	12-Oct-16	15.5	29°43'52.87"N	40° 7'9.21"E

G.5 Bat Activity Surveys

G.5.1 Overview

Bat activity surveys were undertaken in accordance with the Bat Conservation Trust's *Bat Surveys for Professional Ecologists Good Practice Guidelines* (2016). The surveys assess the possible impacts of the Park which include:

- loss of foraging habitat (due to solar PV construction or because bats avoid the solar PV area); and
- Fragmentation of habitat (because Solar Energy Parks form barriers to commuting or seasonal movements, and due to severance of foraging habitat).

The aim of the bat survey is to evaluate the importance of the site for bat species through a preliminary desk based assessment, followed by targeted roost and activity surveys. The following sections outline the survey approaches implemented and the survey effort deployed.

G.5.2 Assessing Need for Survey

An assessment for the need for survey was undertaken in accordance with the Bat Conservation Trust's *Bat Surveys for Professional Ecologists Good Practice Guidelines* (2016). The assessment evaluates the quality of habitat at the development sites and in the wider landscape, and the potential for these areas to support bats. The assessment took into account:

- the extent and quality of foraging and commuting habitat surrounding and on the site;
- the proximity of the proposed site to protected areas designated for bats; and
- The presence of buildings or other features or structures that may support, or are known to support bat roosts.

The level of risk that the proposed development may have on local bats, both individuals and populations was classified as low, medium or high risk. Any proposed site that has the potential to regularly support bats may have an impact on bats, although the potential impact is likely to increase in relation to the number and quality of habitat features (BCT, 2016).

G.5.3 Determining Species Specific Risk

Unlike wind turbine projects, solar PV installations have no moving parts which pose a risk to foraging or commuting bats. Notwithstanding potential impacts of habitat loss and fragmentation, there is only limited research into the effects of ground mounted solar installations on bats. A paper by Russo et al (2012) assessed the ability of bats to tell the difference between water and smooth surfaces under natural conditions in the wild. Based on this research, and other research completed under controlled conditions, there is evidence to suggest that bats may confuse smooth flat surfaces with water bodies, although this is not likely to affect the conservation status of bat populations.

Furthermore the bat species recorded within Saudi Arabia are not known to specialize in foraging for prey from the surface of water bodies, as Daubentons bats *Myotis daubentonii* are known to. Therefore the bat species in Saudi Arabia are considered at low risk to the effects of a Solar Energy Park.

The risk of collision with power lines will not change as a result of this Park as no new overhead lines are proposed. Existing infrastructure will be utilized to transfer power generated by the Solar Energy Park to the local Saudi Electricity Company (SEC) sub-station. As a result there will be no increased risk to bat species or populations.

G.5.4 Roost Surveys

There are no structures or natural features (e.g. subterranean caves, crevices or trees) within the development site, or up to 200m from the boundary of the development site which offer potential roost sites for bats. Therefore no inspections will be undertaken for the presence of bats.

G.5.5 Activity Surveys Ground Level Transects

To determine whether bats utilize the site for foraging and commuting, activity surveys at ground level were undertaken using broadband bat detectors connected to a recording device. Specifically a Bat Box Duet connected to a Tascam D5 recorder.

Activity surveys were completed along the two transects within the development site. These transects have been selected on the basis that they provide a representative sample of the development site, yet provide greater survey effort on the camel race-track which is assessed as having the greatest potential to support foraging and / or commuting bats. Each transect is approximately 8km long. The transect surveys utilize a 4x4 vehicle as it is the safest and most efficient method to cover the development site. A surveyor recorded all bat activity using the equipment specified, whilst another person drove at slow speed (<10km/h) along the designated transects within the development site. At every 1km interval, the vehicle stopped and 10 minutes of fixed point survey effort was undertaken.

Wherever possible, recorded bat calls were analyzed for identification to species or species group level using BatSound software. However unlike Europe and the United States, species sonograms are not well documented for the Middle East and it may not be possible to confirm species.

Subject to further evaluation, the development site is assessed as low risk to bat individuals and populations. The Bat Conservation Trusts good practice guidelines (2016) have been adapted for use in the Kingdom of Saudi Arabia. Based on the seasons available for survey and the low risk to bats, each transect was surveyed once during the autumn. The meteorological conditions at the time of survey were recorded. Activity surveys commenced 30 minutes before sun-set and continued for 2 hours after sun-set.

G.5.6 Automated Activity Surveys at Ground Level

Automated Anabat Express detectors were deployed in locations deemed secure and which enable the collection of representative data on bat activity. On the basis that the site is comprised of predominantly open landscapes with few habitat features and the solar panels will be located within large areas of homogenous habitat, the survey targets the disused camel race-track. The camel track supports the greatest abundance of vegetation within the development site and exhibits topographical variation, albeit restricted to the sand embankments demarcating the race-track.

Wherever possible, recorded bat calls were analyzed for identification to species or species group level using AnaLook software. However unlike Europe and the United States, species sonograms are not well documented for the Middle East and it may not be possible to confirm species.

Subject to further evaluation, the development site is initially assessed as low risk to bat individuals and populations. The Bat Conservation Trusts good practice guidelines (2016) have been adapted for use in the Kingdom of Saudi Arabia. Based on the seasons available for survey and the low risk to bats, it is proposed to complete two nights of automated survey effort. The meteorological conditions at the time of survey will be recorded.

G.6 Crepuscular and Nocturnal Faunal Surveys

To ensure the development site is surveyed at different times of day and to increase the likelihood of recording faunal activity across the site, crepuscular and nocturnal surveys were undertaken. These surveys were completed along the transect routes proposed for bat activity surveys. To confirm, each transect is 8km long and includes eight 'spot count' stops every 1km. Each transect will take approximately 2.5 hours to complete.

During the transect survey, all crepuscular and nocturnal faunal activity was recorded including species, number of individuals observed, behavior and GPS location.

Appendix H. KSA Bird Codes

RB	Arabian babbler	CRO	Common rosefinch	GRS	Greenshank
ARG	Armenian gull	COS	Common sandpiper	GRH	Grey heron
ADW	Asian desert warbler	COT	Common tern	GPL	Grey plover
AVO	Avocet	COW	Common whitethroat	GYW	Grey wagtail
BAC	Baillon's crane	COO	Coot	GRG	Greylag goose
BAF	Barbary falcon	COB	Corn bunting	GRV	Griffon vulture
BAO	Barn owl	COC	Corncrake	GUT	Gull-billed tern
BAW	Barred warbler	CRM	Crag martin	HAW	Hawfinch
BAG	Bar-tailed godwit	CRA	Crane	HEH	Hen harrier
BAL	Bar-tailed lark	CRC	Cream-coloured courser	HEG	Heuglin's gull
BEE	Bee-eater	CRL	Crested lark	HOB	Hobby
BIL	Bimaculated lark	CRB	Cretzschmar's bunting	HNB	Honey buzzard
BLF	Black francolin	CUC	Cuckoo	HOC	Hooded crow
BLK	Black kite	CUR	Curlew	HOW	Hooded wheatear
BRS	Black redstart	CUS	Curlew sandpiper	HOO	Hoopoe
BST	Black stork	DSS	Dead Sea sparrow	HOL	Hoopoe lark
BBS	Black-bellied sandgrouse	DEF	Desert finch	HUC	House crow
BLB	Blackbird	DEL	Desert lark	HOM	House martin
BBR	Black-bush robin	DTO	Desert tawny owl	HOS	House sparrow
BLC	Blackcap	DEW	Desert wheatear	IME	Imperial eagle
BNH	Black-crowned night heron	DUN	Dunlin	INS	Indian silverbill
BSL	Black-crowned sparrow lark	EBW	Eastern Bonelli's warbler	ISS	Isabelline shrike
BLW	Black-eared wheatear	OLW	Eastern olivaceous warbler	ISW	Isabelline wheatear
BHG	Black-headed gull	ORW	Eastern orphean warbler	JAC	Jackdaw
BLS	Blackstart	EGG	Egyptian goose	JAY	Jay
BTG	Black-tailed godwit	EGN	Egyptian nightjar	KEP	Kentish plover
BWK	Black-winged kite	EGV	Egyptian vulture	KES	Kestrel

BLP	Black-winged pratincole	FAR	Fan-tailed raven	KIN	Kingfisher
BWS	Black-winged stilt	FIE	Fieldfare	LAP	Lapwing
BCB	Blue-cheeked bee-eater	FIW	Finsch's wheatear	LAD	Laughing dove
BLU	Bluethroat	GAD	Gadwall	LEF	Lesser flamingo
BLE	Bonelli's eagle	GAW	Garden warbler	LGS	Lesser grey shrike
BOE	Booted eagle	GAR	Garganey	LEK	Lesser kestrel
BSA	Broad-billed sandpiper	GLI	Glossy ibis	LSL	Lesser short-toed lark
BRR	Brown-necked raven	GOO	Golden oriole	LEW	Lesser whitethroat
CAL	Calandra lark	GOP	Golden plover	LBG	Lesser-black backed gull
CAG	Caspian gull	GPR	Graceful prinia	LEE	Lesser-spotted eagle
CAT	Caspian tern	GRB	Great bittern	LES	Levant sparrowhawk
CAE	Cattle egret	GRC	Great cormorant	LIS	Lichtenstein's sandgrouse
CEW	Cetti's warbler	GRW	Great reed warbler	LIN	Linnet
CHA	Chaffinch	GWE	Great white egret	LIB	Little bittern
CHI	Chiffchaff	GWP	Great white pelican	LIC	Little crane
CHU	Chukar	GRF	Greater flamingo	LIE	Little egret
CIW	Citrine wagtail	GSA	Greater sandplover	LGR	Little grebe
CRW	Clamorous reed warbler	GSE	Greater-spotted eagle	LGB	Little green bee-eater
COD	Collared dove	GSC	Great-spotted cuckoo	LGU	Little gull
COF	Collared flycatcher	GSP	Green sandpiper	LIO	Little owl
COM	Common myna	GNF	Greenfinch	LST	Little stint
LSW	Little swift	RNP	Red-necked phalarope	STA	Starling
LIT	Little tern	RRS	Red-rumped swallow	SBZ	Steppe buzzard
LIP	Little-ringed plover	RSH	Redshank	STE	Steppe eagle
LOO	Long-eared owl	RST	Redstart	STG	Steppe gull
LOB	Long-legged buzzard	RTP	Red-throated pipit	STD	Stock dove
LOS	Long-tailed skua	RWI	Redwing	STC	Stone curlew
MAL	Mallard	REB	Reed bunting	STO	Stonechat
MAH	Marsh harrier	REW	Reed warbler	SSW	Streaked scrub warbler

MRS	Marsh sandpiper	RPL	Ringed plover	STH	Striated heron
MAW	Marsh warbler	RIP	Ring-necked parakeet	SBT	Striated bunting
MSH	Masked shrike	ROB	Robin	SUW	Subalpine warbler
MEP	Meadow pipit	ROD	Rock dove	SWA	Swallow
MOH	Montagu's harrier	ROL	Roller	SWI	Swift
MOO	Moorhen	ROS	Rose-coloured starling	SYW	Syrian woodpecker
MWE	Mourning wheatear	RUF	Ruff	TAP	Tawny pipit
MOW	Moustached warbler	RUR	Rufous-bush robin	TEL	Temminck's lark
NAD	Namaqua dove	RUW	Ruppell's warbler	TES	Temminck's stint
NIG	Nightingale	SAF	Saker falcon	THN	Thrush nightingale
NIJ	Nightjar	SAM	Sand martin	TRP	Tree pipit
NOW	Northern wheatear	SAP	Sand partridge	TRS	Tristram's starling
NUN	Nubian nightjar	SAN	Sanderling	TRF	Trumpeter finch
OTW	Olive-tree warbler	SAT	Sandwich tern	TFD	Tufted duck
OHB	Oriental honey buzzard	SDW	Sardinian warbler	TUR	Turnstone
ORS	Oriental skylark	SVW	Savi's warbler	TUD	Turtle dove
OTD	Oriental turtle dove	SCO	Scops owl	WAP	Water pipit
ORB	Ortalan bunting	SEW	Sedge warbler	WAR	Water rail
OSP	Osprey	SHD	Shelduck	WRE	Western reef egret
PCM	Pale crag martin	SEO	Short-eared owl	WHB	Whimbrel
PSU	Palestine sunbird	SHE	Short-toed eagle	WHC	Whinchat
PAG	Pallas's gull	SHL	Short-toed lark	WST	Whiskered tern
PAH	Pallid harrier	SHV	Shoveler	WHS	White stork
PSW	Pallid swift	SIS	Siberian stonechat	WWA	White wagtail
PET	Penduline tit	SKY	Skylark	WCT	White-cheeked tern
PER	Peregrine	SLG	Slender-billed gull	WCW	White-crowned wheatear
PEO	Pharaoh eagle owl	SNI	Snipe	WHG	White-eyed gull
PIK	Pied kingfisher	SOT	Song thrush	WSB	White-spectacled bulbul
PIW	Pied wheatear	SOF	Sooty falcon	WHL	White-tailed lapwing

PIN	Pintail	SGS	Southern grey shrike	WHK	White-throated kingfisher
PIS	Pin-tailed sandgrouse	SPS	Spanish sparrow	WWT	White-winged tern
POC	Pochard	SPA	Sparrowhawk	WIG	Wigeon
PUH	Purple heron	SPW	Spectacled warbler	WIW	Willow warbler
PUS	Purple swamphen	SPO	Spoonbill	WSA	Wood sandpiper
PYC	Pygmy cormorant	SPC	Spotted crane	WOW	Wood warbler
QUA	Quail	SPF	Spotted flycatcher	WSH	Woodchat shrike
RAV	Raven	SPR	Spotted redshank	WRY	Wryneck
RBS	Red-backed shrike	SSA	Spotted sandgrouse	YEW	Yellow wagtail
REF	Red-breasted flycatcher	SPL	Spur-winged lapwing	YEG	Yellow-legged gull
REG	Red-necked grebe	SQH	Squacco heron	-	-

Appendix I. Survey Timings and Conditions

I.1 Vantage Point Surveys

Survey Details					Weather										
					Hour 1			Hour 2			Hour 3		Full Survey		
Date	VP	Start Time	End Time	Observer	Wind (S/D)	Temp.	Wind (S/D)	Temp.	Wind (S/D)	Temp.	Visibility	Cloud/Rain			
10/10/2016	3+4	09:00	12:00	EB / AA	1	NW	24	1	NW	26	1	NW	27	2	0 / 0
10/10/2016	1+2	14:30	17:30	EB / AA	1	NW	33	1	NW	34	1	NW	26	2	0 / 0
11/10/2016	1+2	07:30	10:30	EB / AA	1	SW	19	2	SW	22	1	SW	24	2	0 / 0
11/10/2016	3+4	14:30	17:30	EB / AA	1	SSW	34	1	SSW	34	1	SSW	24	2	
12/10/2016	3+4	06:30	09:30	EB / AA	1	0	22	1	0	22	1	0	26	2	0 / 0
12/10/2016	1+2	15:00	18:00	EB / AA	2	SE	36	3	SE	33	4	NE	31	2	0 / 0
13/10/2016	1+2	06:20	09:20	EB / AA	1	ENE	18	1	ENE	21	2	ENE	22	2	0 / 0
13/10/2016	3+4	09:30	12:30	EB / AA	2	NE	24	4	ENE	27	4	ENE	33	2	0 / 0

I.2 Trail Camera Survey

Camera Trap Session	Location	Northing	Easting	Deployment Date	Deployment Time	Collection Date	Collection Time	Survey Effort (Hours)
1	Saudi Aramco Met Station	29°44'16.91"N	40° 6'11.42"E	09-Oct-16	15.00	10-Oct-16	10.00	19
2	northern Part of site	29°44'22.57"N	40° 6'10.39"E	10-Oct-16	17.45	11-Oct-16	8.00	14.15
3	Camel Track	29°43'50.87"N	40° 5'7.86"E	11-Oct-16	13.30	12-Oct-16	9.30	20
4	Camel Track	29°43'52.87"N	40° 7'9.21"E	12-Oct-16	14.45	13-Oct-16	6.30	15.45
Total Survey Effort								69 Hours

I.3 Automated Bat Survey

Survey Session	Location	Northing	Easting	Deployment Date	Collection Date	Start Recording	Finish Recording	Survey Effort	Recorded Activity
1	Camel Track	29°43'47.80"N	40° 5'2.27"E	11-Oct-16	12-Oct-16	17:48	06:20	c.12 hours	No Activity
2	Camel Track	29°43'45.04"N	40° 7'8.91"E	12-Oct-16	13-Oct-16	17:49	06:19	c. 12 hours	No Activity

I.4 Bat Activity Survey Transects

Bat Transect	Length of Transect	Sampling Points	Date	Start Time	Finish Time	Survey Effort	Start Temp	Finish Temp	Wind (S/D)		Rain
Transect 1	8km	8	11-Oct-16	17:18	19:48	2.5 hours	24	23	0	0	0
Transect 2	8km	8	12-Oct-16	17:19	19:49	2.5 hours	31	29	0	0	0

I.5 Crepuscular / Nocturnal Survey Transects

Crepuscular / Night-time Torch Survey	Survey Type	Length of Transect	Sampling Points	Date	Start Time	Finish Time	Start Temp	Finish Temp	Wind (S/D)		Rain
Transect 1	Dawn Crepuscular	8km	8	10-Oct-16	07:00	09:00	18	24	1	NE	0
Transect 2	Dawn Crepuscular	8km	8	11-Oct-16	07:00	09:00	18	24	1	SW	0
Transect 1	Evening Crepuscular / Night-Time	8km	8	11-Oct-16	17:18	19:48	24	23	0	0	0
Transect 2	Evening Crepuscular / Night-Time	8km	8	12-Oct-16	17:19	19:49	31	29	0	0	0

Appendix J. Bird Species List

Species	Latin/Scientific Name	KSA Code	IUCN	
			Status	Trend
Barn swallow	<i>Hirundo rustica</i>	SWA	Least Concern	Decreasing
Bar-tailed lark	<i>Ammomanes cinctura</i>	BAL	Least Concern	Decreasing
Black-headed gull	<i>Chroicocephalus ridibundus</i>	BHG	Least Concern	Unknown
Black kite	<i>Milvus migrans</i>	BLK	Least Concern	Unknown
Brown-necked raven	<i>Corvus ruficollis</i>	BRR	Least Concern	Increasing
Collared dove	<i>Streptopelia decaocto</i>	COD	Least Concern	Increasing
Cream-coloured courser	<i>Cursorius cursor</i>	CRC	Least Concern	Decreasing
Crested lark	<i>Galerida cristata</i>	CRL	Least Concern	Decreasing
Desert wheatear	<i>Oenanthe deserti</i>	DEW	Least Concern	Stable
Greater spotted eagle	<i>Clanga Clange</i>	GSE	Vulnerable	Decreasing
Hoopoe lark	<i>Alaemon alaudipes</i>	HOL	Least Concern	Decreasing
Isabelline wheatear	<i>Oenanthe isabellina</i>	ISW	Least Concern	Stable
Long-legged buzzard	<i>Buteo rufinus</i>	LOB	Least Concern	Stable
Pallid harrier	<i>Circus macrourus</i>	PAH	Near Threatened	Decreasing
Ringed plover	<i>Charadrius hiaticula</i>	RPL	Least Concern	Decreasing
Southern grey shrike	<i>Lanius meridionalis</i>	-	Least Concern	Stable
Steppe buzzard	<i>Buteo buteo vulpinus</i>	SBZ	Not Evaluated	Not Evaluated
Steppe eagle	<i>Aquila nipalensis</i>	STE	Endangered	Decreasing
White wagtail	<i>Motacilla alba</i>	WWA	Least Concern	Stable

Appendix K. Phase 1 Habitat Survey Target Notes

Target Note	Northing	Easting	Description
A	29°44'10.73"N	40° 4'54.57"E	Gravel terrace with sand and sandstone outcrops supporting limited vegetation.
B	29°43'59.91"N	40° 5'32.67"E	Abandoned camel race-track located within the development site. The track is comprised of sand, and the edges of the track are demarcated by sand embankments. These sandy habitats support more frequent stands of <i>Haloxylon salicornicum</i> .
C	29°44'16.45"N	40° 6'10.84"E	Saudi Aramco meteorology station
D	29°43'16.38"N	40° 4'42.51"E	Towards the southern boundary of the development site the sparsely vegetated gravel terrace transitions into low level dunes which mark the edge of the An Nafud Desert. This sand and dune habitat supports a greater density of <i>Haloxylon salicornicum</i> .
E	29°43'51.23"N	40° 7'8.74"E	Abandoned camel race-track located within the development site. The track is comprised of sand, and the edges of the track are demarcated by sand embankments. These sandy habitats support more frequent stands of <i>Haloxylon salicornicum</i> .
F	29°44'27.20"N	40° 5'38.85"E	The SEC access track and utility corridor. There is limited vegetation within this corridor. There are several piles of rubbish including broken wooden pallets and wooden cable drums.
G	29°43'53.33"N	40° 7'48.28"E	The eastern part of the development site is similarly comprised of gravel terrace although with a greater composition of sand. Accordingly this part of the site supports a slightly higher number of <i>Haloxylon salicornicum</i> plants than the western or central parts of the site.
H	29°43'43.42"N	40° 6'1.49"E	The central part of the development site, inside the abandoned race-track. Similar to other parts of the site, this is comprised of gravels with sand and sandstone outcrops and sparse vegetation.
I	29°43'46.05"N	40° 3'43.99"E	Occupied encampment located to the immediate west of the Project boundary.
J	29°44'9.42"N	40° 3'44.69"E	Dead livestock have been deposited in several locations within the wider locality. These are likely to attract carrion scavengers and indeed feral dogs, brown necked ravens and black kite were recorded feeding in the locality of dead livestock.
K	29°44'17.17"N	40° 6'7.46"E	Suspected <i>Uromastyx aegyptia</i> burrow. Fresh prints were recorded during the site visit in October 2016.
L	29°43'23.59"N	40° 4'14.15"E	This feature is located adjacent to the development site. It is comprised of a fenced area although the fence line has built up with sand. There is nothing within the enclosed area and no indication of its purpose. It is possible that this area was created as part of rangeland management and restoration research, to be ratified with the Camel and Range Research Centre in Al Jouf, Sakaka.

Appendix L. Phase One Habitat Survey Photography

Target Note	Image
A	

B



C



D



E



F



G



H



I



J



K



L



Appendix M. Archaeology & Cultural Heritage Glossary

Table 23-10 : Cultural Heritage Glossary

Full Title	Acronym	Description
Anno Domini	AD	The term anno domini is used to label or number years in the Julian and Gregorian calendars, making the number of years since the birth of Christ; taken to be AD 1.
Before Christ	BC	The English abbreviation of 'Before Christ'; meaning before the birth of Christ; taken to be 1 BC.
International Committee on Monuments and Sites	ICOMOS	ICOMOS is a non-governmental international organization dedicated to the conservation of the world's monuments and sites.
International Finance Corporation	IFC	IFC, a member of the World Bank Group, is the largest global development institution focused exclusively on the private sector in developing countries.
Outstanding Universal Value	OUV	Those parts of the cultural or natural heritage are of outstanding interest and therefore need to be preserved as part of the world heritage of mankind as a whole.
Photovoltaic	PV	Photovoltaics covers the conversion of light into electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon studied in physics, photochemistry, and electrochemistry.
United Nations Educational, Scientific and Cultural Organization	UNESCO	UNESCO strives to build networks among nations that enable solidarity, by: Mobilizing for education: so that every child, boy or girl, has access to quality education as a fundamental human right and as a prerequisite for human development. Building intercultural understanding: through protection of heritage and support for cultural diversity. UNESCO created the idea of World Heritage to protect sites of outstanding universal value. Pursuing scientific cooperation: such as early warning systems for tsunamis or trans-boundary water management agreements, to strengthen ties between nations and societies. Protecting freedom of expression: an essential condition for democracy, development and human dignity.
Watching Brief	-	A watching brief is a method of preserving archaeological remains by record during development. An archaeologist is employed by the developer to monitor the excavation of foundation and service trenches, landscaping and any other intrusive work.
World Heritage Site	-	A World Heritage Site is a landmark which has been officially recognized by the United Nations, specifically by the United Nations Educational, Scientific and Cultural Organization (UNESCO).