

HADEN BESS PROJECT ENVIRONMENTAL IMPACT ASSESSMENT STUDY FOR THE HADEN BESS PROJECT – TAIF – MAKKAH – KSA



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DEFINITION OF TERMS

Symbols

°C	Degrees Celsius
%	Percentage

Units of Measurement

GWh	Gigawatt-hour
km	Kilometre
km ²	Square Kilometre
km ³	Cubic Kilometre
kV	Kilovolt
m	Meter
m ³	Cubic meters
mm	Millimetres
Mm ³	mega cubic metres
MW	Megawatt
MWh	Megawatt-hour

General

AAQML	Ambient Air Quality Monitoring Location
AAQS	Ambient Air Quality Standards
AC	Alternating Current
AIS	Air Insulated Switchgear
AMSL	Above Mean Sea Level
AQMS	Air Quality Monitoring Stations
AC	Alternating Current
AMSL	Above Mean Sea Level
AQMS	Air Quality Monitoring Station
BESS	Battery Energy Storage System
BMS	Battery Management Systems
BSC	Battery System Controller
Cb	Cenozoic Basalt
CC	Control Centre Regions
CCTV	Closed-Circuit Television
CEM	Competitive Electricity Market



CIA	Cumulative Impact Assessment
CO	Carbon Monoxide
CoE	Centres Of Excellence
DAFOR	Dominant Abundant Frequent Occasional and Rare
DC	Direct Current
EAS	Environmental Auditing Study
EHS	Environmental Health and Safety
EMS	Emergency Management System
EP	Equator Principles
EPC	Environmental Permit to Construct
EPO	Environmental Permit to Operate
EPRP	Emergency Preparedness and Response Plan
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Energy Storage System
FACP	Fire Alarm Control Panel
GAMEP	General Authority of Meteorology and Environmental Protection
GDP	Gross Domestic Product
GER	General Environmental Regulation
GDP	Gross Domestic Product
GIIP	Good International Industry Practice
GIS	Gas Insulated Switchgear
GIS	Geographic Information System
GPS	Global Positioning System
HCIS	High Commission for Industrial Security
HCP	Habitat and Conservation Priority
HD	High Definition
HVAC	Heating, Ventilation, And Air Conditioning
IAS	Invasive Alien Species
IEC	International Electrotechnical Commission
IFC	International Finance Corporation
ILF	ILF Consulting Engineers for Engineering Consultancy
IUCN	International Union for Conservation of Nature
KSA	Kingdom of Saudi Arabia



LFP	Lithium Iron Phosphate
MC	Ministry of Commerce
MDD	Maximum Dry Density
MEWA	Ministry of Environment, Water and Agriculture
MHRSD	Ministry of Human Resources and Social Development
MIMR	Ministry of Industry and Mineral Resources
MISA	Ministry of Investment of Saudi Arabia
MoE	Ministry of Energy
MoH	Ministry of Health
MoI	Ministry of Interior
MoMAH	Ministry of Municipalities and Housing
MOTLS	Ministry of Transport and Logistics Service
MSW	Municipal Solid Waste
MT	Ministry of Tourism
MWAN / NCWM	National Centre for Waste Management
MV	Medium-Voltage
NCEC	National Centre for Environmental Compliance
NCM	National Centre for Meteorology
NCVC	National Centre for Vegetation Development and Combating Desertification
NCW	National Centre for Wildlife
NM	Noise Monitoring
NMC	Nickel Manganese Cobalt
NO ₂	Nitrogen Dioxide
NREP	National Renewable Energy Program
O&M	Operations and Maintenance
O ₃	Ozone
OHS	Occupational Health and Safety
PCS	Power Conversion System
PM	Particulate Matter
PPE	Personal Protective Equipment
PS	Performance Standard
PV	Photovoltaic
RC	Reinforced Concrete
RMU	Ring Main Units



SCADA	Supervisory Control and Data Acquisition
SEC	Saudi Electricity Company
SEP	Stakeholder Engagement Plan
SGS	Saudi Geological Survey
SIRC	Saudi Investment Recycling Company
SO ₂	Sulphur Dioxide
SPTs	Standard Penetration Tests
SRs	Sensitive Receptor
SS	Substations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UPS	Uninterrupted Power Supply
VP	Vantage Point
WKC	WKC Arabia for Environmental Consultancy LLC
WMP	Waste Management Plan
CESMP	Construction Environmental & Social Management Plan

Chemical Compounds

CO	Carbon Monoxide
CO ₂	Carbon Dioxide
H ₂ S	Hydrogen Sulphide
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
O ₃	Ozone
PM ₁₀	Particulate Matter with an Aerodynamic Diameter < 10 Micrometres
PM _{2.5}	Particulate Matter with an Aerodynamic Diameter < 2.5 Micrometres
SO ₂	Sulphur Dioxide



NON-TECHINICAL SUMMARY

Project Description

Background

This Environmental and Social Impact Assessment (ESIA) report has been prepared by WKC Arabia for Environmental Consultancy LLC (WKC), a National Centre for Environmental Compliance (NCEC) licensed service provider, on behalf of ILF Consulting Engineers for Engineering Consultancy (ILF), for the proposed Haden Battery Energy Storage System (BESS) Project (hereinafter referred to as the “Project”). The Project is located entirely within the boundaries of the previously permitted Haden photovoltaic (PV) Park (which is currently under construction).

Activities and Facilities

The Project will involve the installation of a utility-scale, grid-connected battery system with an installed power capacity of 518 MW and an energy capacity of 2,185 MWh. The facility will utilise modular, containerised battery units based on either Lithium Iron Phosphate (LFP) or Nickel Manganese Cobalt (NMC) technology, to be selected during procurement. Supporting infrastructure includes power conversion systems, medium voltage switchgear, step-up transformers, and a substation for grid interconnection. Additional facilities will comprise an operations and maintenance (O&M) building, staff and prayer facilities, internal road networks, a fire suppression system, and integrated security fencing with Closed-Circuit Television (CCTV). A Supervisory Control and Data Acquisition (SCADA) system will provide real-time monitoring and control of plant operations.

Site and Location

The Project will occupy an area of 0.5 km² and is approximately 205 kilometres (km) east of the Islamic Port of Jeddah, within Taif City located in the Makkah Region of the KSA. Internal roads will be constructed to connect key facilities, with access provided via Road 4410 and an additional 4.8 km asphalt link.

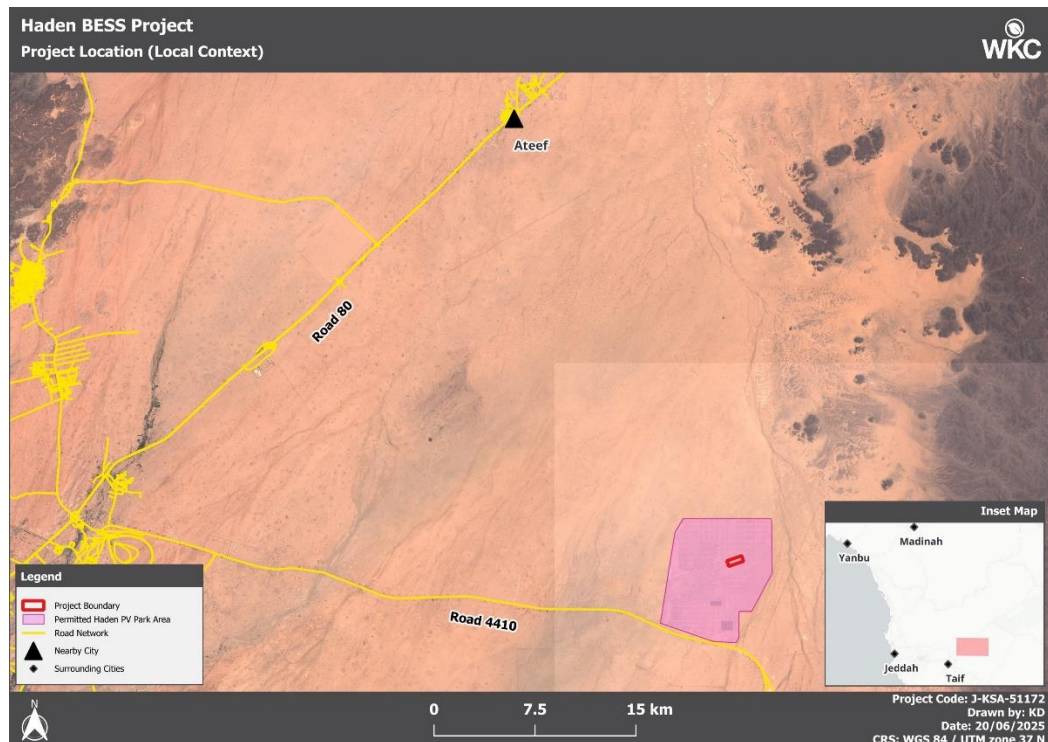


Figure 0-1: Project Location (Local Context)

Construction Activities

Construction will include site clearance, terrain levelling, installation of access and internal roads, and development of the substation and auxiliary buildings. Trenching and underground cabling will link battery modules to the grid infrastructure. Materials such as concrete (30,000 to 40,000 m³), steel (6,000 to 8,000 tonnes), and electrical cabling (600 to 900 km) will be used, and a peak workforce of up to 1,500 personnel is expected. Early works will span 6 months, followed by 36 months of construction. Fire protection and safety systems, including passive barriers and active suppression technologies, will be installed to mitigate the risk of thermal runaway.

Operation Activities

The Project will operate for 20 years, with routine maintenance covering battery diagnostics, thermal system management, SCADA validation, and fire safety system checks. The facility will be staffed during core hours and monitored 24/7 via SCADA. Waste management will address spent battery modules, electronic components, and maintenance-related materials through licensed contractors, aligned with national and international regulations. Operational water demand is estimated at 33 m³/day for domestic and cleaning purposes. Security, performance monitoring, and staff training will be sustained throughout the operational period. Technology upgrades and component augmentation may be implemented over time to improve efficiency or meet evolving grid needs.

Legislative Framework and ESIA Process

Regulations and Standards

All activities throughout construction, operation and decommissioning of the Project will be carried out in compliance with the contemporary KSA legislation and regulations and international agreements. Compliance with the Equator Principles (v4), the IFC Environmental and Social Performance Standards and World Bank EHS guidelines are committed in the Project. The most stringent of these standards will be adopted during the implementation of Project.

ESIA Methodology

This ESIA has been prepared in accordance with KSA regulations and the Project classification of 'Category II' established by NCEC (NCEC Reference No.: EPAC-2025-001577).

Alternatives

Methodology

A structured and multi-criteria approach was employed to evaluate alternatives for the Project. The analysis considered environmental performance, technical feasibility, socio-economic benefits, lifecycle cost-effectiveness, and alignment with regulatory and strategic energy objectives. Alternatives were screened based on their ability to minimise land take, emissions, and safety risks, while maintaining compatibility with grid infrastructure and supporting national energy goals under Vision 2030 and the National Renewable Energy Program (NREP).

No Project / No Amendment Alternative

The “no project” scenario would leave the designated site undeveloped within the broader PV Park, avoiding all construction-related impacts. However, this would eliminate critical energy system benefits such as fast-response reserve capacity, peak shaving, and frequency regulation, functions necessary to integrate growing volumes of variable renewable energy into the grid. It would also perpetuate reliance on fossil-fuel-based power generation, contravening Saudi Arabia's clean energy targets. The co-location efficiency, shared infrastructure, and use of an already environmentally approved site would be forfeited. As such, the no-project alternative is not considered viable or aligned with the Kingdom's long-term energy strategy.

Location Alternatives

The BESS is intentionally sited within the boundary of Haden PV Park to maximise functional efficiency, enabling direct coupling with the generation facility. Locating the Project outside this area would require new land acquisition, transmission infrastructure, and permits, which would raise environmental, social, and logistical challenges. Within the PV park, the site was selected to avoid areas of high solar irradiance and technical exclusion zones, while ensuring proximity to internal access roads and grid interconnection points. Baseline assessments confirmed the absence of sensitive biodiversity, cultural heritage, flood risk, or nearby receptors, supporting the site's environmental suitability and low-risk profile.

Technical Alternatives

Multiple battery technologies were considered during the design phase. Only two chemistries: LFP and NMC, which were retained for further evaluation.

LFP offers superior thermal stability, a longer cycle life, and reduced environmental impacts due to the absence of cobalt and nickel. It also provides higher container-level energy capacity (5 MWh per container), requiring fewer containers (437) and a smaller site footprint (97,000 m²). In contrast, NMC offers higher gravimetric energy density but requires more containers (873) and a larger footprint (162,000 m²) to deliver the same capacity, resulting in greater spatial and operational complexity. Final selection will be made during procurement, based on market conditions, vendor offerings, and lifecycle cost analyses.

Baseline Conditions

Baseline data for the Project site has been collected from a Preliminary Site Assessment (PSA) and Terrestrial Ecology Baseline Surveys (TEBS), ambient air and noise baseline surveys.

Topography, Geology and Land Use

The Haden site is located on a high plateau at an average elevation of 1175 metres (m) above mean sea level (MSL), east of the Hejaz Mountains in the Makkah Province. The terrain is predominantly flat with a very gentle northward slope (approximately 0.5%), and elevation ranges from 1,112 m to 1,267 m across the site. The site topography presents ideal conditions for a utility-scale solar PV power plant, with limited need for earthworks in most areas. Terrain irregularities such as small dunes and mounds were identified, primarily in the eastern and northern fringes. Areas with slopes above 8% have been mapped and are considered less favourable for infrastructure placement but do not pose significant constraints to project development if avoided.

Geologically, the site is underlain by sandy and gravelly soils of alluvial and aeolian origin. These surficial materials are well-suited for conventional PV infrastructure foundations, such as driven steel piles. The underlying bedrock may consist of basaltic lava flows (Harrat Hadan), sedimentary rocks of the Usfan Formation, or Precambrian basement rock, although no outcrops were observed during site visits. The area is geotechnically homogeneous and shows no signs of karst features or significant settlement risk. Land use is largely undeveloped, with minimal anthropogenic disturbance apart from sporadic camel herding and vehicle tracks. There are no agricultural fields, industrial sites, or permanent settlements within the site boundary.

Ambient Air and Noise

The ambient air quality in the area is expected to be good, as there are no major sources of air pollution in the vicinity. The only potential emissions source is traffic along Road 4410, which bisects the site east-west, but this is limited in volume. Similarly, ambient noise levels are expected to be low due to the absence of industrial activity or dense residential zones. There are no noise-sensitive receptors such as schools, hospitals, or housing units within or near the project footprint. Consequently, the baseline acoustic environment is quiet, typical of a remote desert plateau.

Soil and Groundwater

The surface soils comprise desert sands and gravels, consistent with alluvial deposits from ancient watercourses. These materials show good drainage characteristics and consolidation, with some presence of older alluvium displaying higher compaction and reduced erosion potential. No significant contamination or chemical residues were identified. While no groundwater was observed at the surface, natural depressions and remnants of waterlogging near the eastern border suggest that water can accumulate temporarily after storm events. There is no evidence of shallow groundwater aquifers that would present construction constraints, although further geotechnical and hydrogeological investigations are planned for the next phase.

Waste

No solid or hazardous waste deposits were observed during the site assessment. The land is primarily uninhabited and unused, with the exception of temporary camel grazing enclosures and occasional nomadic activity. These generate negligible organic waste, and there is no infrastructure to suggest formal waste disposal or storage. As such, the baseline waste environment is undisturbed. During construction, temporary waste management facilities will need to be established to handle construction-related waste streams.

Terrestrial Ecology

The site is located in an arid desert ecosystem with sparse vegetation and limited faunal diversity. Vegetation is predominantly composed of hardy desert shrubs such as *Acacia spp.*, *Indigofera spp.*, and *Salsola spp.*, mostly concentrated in the northern part of the site. These species are of ecological and traditional importance, particularly for grazing and medicinal use. No large terrestrial mammals or resident bird populations were recorded during the site visit. Faunal activity is largely transient and associated with nomadic camel herders who establish temporary enclosures. While no protected species were directly observed, the area falls within a medium biodiversity rarity zone and lies approximately 110 km from the Mahazat as-Sayd Wildlife Reserve, a designated Important Bird Area (IBA).

Archaeology and Cultural Heritage

No archaeological artefacts, burial sites, or cultural heritage features were identified during the preliminary desktop review or site walkovers. The area is largely flat and composed of soft sediments with no exposed rocky features that typically host neolithic relics in the region. However, archaeological sites have been noted in the broader region, especially in rocky outcrops to the north. As a precaution, it is recommended that archaeological chance-find procedures be implemented during ground disturbance. No religious, cultural, or heritage structures exist within or adjacent to the project footprint.

Project Activities and Environmental and Social Impacts

The proposed Project presents both risks and opportunities. The majority of the risks are identified during the construction phase, whereas the operation phase is characterised by its limited effects.

Natural Vegetation Cover and Biodiversity

During construction, activities such as site clearance and earthworks will lead to habitat loss and the displacement or mortality of local flora and fauna. Terrestrial vertebrates may also be disturbed by noise and increased human activity. Additionally, there is a risk of introducing invasive alien species (IAS) via vehicles, materials, and waste. Mitigation measures, including footprint control, species translocation, noise reduction protocols, and IAS prevention, will be implemented. With these measures in place, the residual significance of impacts on biodiversity is considered minor adverse.

During operation, no further vegetation clearance is anticipated, and the project footprint will remain unchanged. However, wildlife activity may be reduced due to human presence and noise from routine maintenance. These effects are expected to be localised and minimal. With continued implementation of environmental management measures, the residual significance of operational biodiversity impacts is considered minor adverse.

During decommissioning, the removal of infrastructure may cause short-term environmental disturbances, including vegetative metabolic stress due to dust generation, and potential injury or mortality of terrestrial fauna. In addition, there is a risk of accidental introduction and proliferation of IAS if proper controls are not in place. However, mitigation measures, such as effective dust suppression, wildlife rescue protocols, and strict waste management and IAS prevention strategies, will be implemented to reduce these risks. As a result, all biodiversity-related decommissioning impacts are expected to be minor adverse following mitigation.

In the event of unplanned events such as fire, chemical release, or battery malfunction, direct damage to vegetation and displacement of fauna could occur. These impacts would be highly localised and short-term, with containment measures reducing the risk of long-lasting biodiversity loss.

Ambient Air

During construction, dust generation from earthworks, heavy vehicle traffic, and material handling will temporarily degrade local air quality. However, due to the remote location and limited nearby receptors, combined with dust suppression measures such as water spraying, the residual air quality impacts are considered non-significant.

During regular operations of the Project, air emissions will be limited to minimal vehicle exhaust from infrequent site visits and minor HVAC discharges. Battery modules are fully enclosed and pose no routine emission risk, resulting in non-significant operational air quality impacts.

Dismantling activities during decommissioning will again generate dust and emissions from diesel-powered equipment. With standard suppression measures and the absence of nearby receptors, air quality impacts will be similar to construction and considered non-significant.

Unplanned events such as battery fires could result in the release of combustion gases or particulates. While these incidents would be managed quickly, short-term impacts to local air quality could occur but would be localised and temporary, resulting in a minor adverse significance following mitigation.

Noise

During construction, the use of heavy machinery and transport vehicles will elevate noise levels around the site. Given the absence of sensitive receptors nearby, and with limited working hours and use of mufflers, noise impacts are considered non-significant.

During operation activities, low-level background noise from inverters, cooling fans, and ventilation systems will persist, but these are designed to meet regulatory noise thresholds. The site's isolation ensures that operational noise does not impact any sensitive receptors, resulting in non-significant impacts.

Noise generated during dismantling during the decommissioning phase will be similar to construction and include vehicle movement and the use of power tools. These activities are short-term and will not affect the public, so the impact remains non-significant.

Noise may increase temporarily during unplanned events such as emergency responses, such as alarms, fire response, or battery venting events, but such occurrences are rare, and impacts will be short-term, highly localised and non-significant.

Water Quality (Surface Water and Groundwater)

During construction, water quality risks arise from potential accidental fuel or chemical spills during site works. However, the absence of surface water features and groundwater at shallow depths limits the potential for contamination. Spill kits and proper storage protocols will mitigate impacts to be non-significant.

Routine maintenance and potential battery leaks pose a risk of contaminating surface water during the operational phase. However, the implementation of design and management measures, such as elevating BESS components above flood levels, proper hazardous material storage, and routine inspections, will minimise this risk. The residual significance of water quality impacts during operation is considered non-significant.

During decommissioning, runoff from dismantling activities may pollute downstream areas during heavy rainfall. Mitigation measures, including strict waste handling, spill response training, and proper disposal of hazardous materials, will reduce the potential for contamination. As a result, the residual water quality impact is considered non-significant.

During unplanned events, in emergency scenarios, such as battery fires or thermal runaway, runoff from fire suppression or system drainage could impact nearby infrastructure and surface water. With appropriate spill containment infrastructure, trained emergency response teams, and environmental safeguards (e.g., sealed enclosures and sensors), the residual impact on water quality is considered non-significant.

Quality of Soil and Sediments

Construction activities such as land clearing, grading, and excavation may disturb surface soils, causing erosion and short-term sediment transport. In addition, fuel or chemical spills and improper handling of sanitation wastewater can lead to soil contamination. However, with the implementation of dust suppression, spill

containment, and sanitation management measures, the residual significance of soil and sediment impacts during construction is considered non-significant.

During operation, small-scale spills from maintenance activities and potential leakage from storage systems may alter soil chemistry or cause localised contamination. With bunded storage areas, regular inspections, proper waste disposal, and emergency protocols in place, the residual soil and sediment impacts are considered non-significant.

During decommissioning, fuel or lubricant spills during equipment removal can cause minor soil degradation, particularly along access routes. Mitigation through controlled transfers, absorbent use, and proper waste removal will minimise impacts. Therefore, the residual significance of decommissioning-phase impacts on soil and sediments is non-significant.

Emergency response actions, such as fire suppression, may lead to infiltration of contaminated firewater into permeable soils. Measures including bunded containment, runoff diversion, and safe firewater disposal will limit this risk. As a result, the residual impact of unplanned events is considered non-significant.

Health and Safety (Occupational and Public)

Construction activities pose health and safety risks to the workforce, including potential injuries, heat stress, and exposure to dust, chemicals, and machinery. With the implementation of a site-specific Health and Safety Management Plan, daily toolbox talks, proper use of Construction activities pose health and safety risks to the workforce, including potential injuries, heat stress, and exposure to dust, chemicals, and machinery. With the implementation of a site-specific Health and Safety Management Plan, daily toolbox talks, proper use of PPE, and strict machinery protocols, the residual significance of health and safety impacts is considered non-significant.

During the operational phase, occupational health and safety (OHS) risks will be managed by the appointed contractors or operators in accordance with national labour regulations and internal company procedures. As these are not subject to assessment under the EIA process, they are not evaluated further for mitigation in this report.

During decommissioning, the workforce may face risks from dismantling activities, residual chemicals, and dust exposure. These risks will be mitigated through tailored training, the use of appropriate equipment, and adherence to decommissioning safety plans. Consequently, the residual impact on health and safety is non-significant.

Unplanned events such as fires, explosions, or toxic releases pose the highest health risks but are considered unlikely. With emergency response planning, fire detection systems, and regular safety training, the residual significance of these unplanned health and safety impacts is considered non-significant.

Natural Landscapes and Visual Comfort

Construction activities may cause temporary visual disruption due to machinery, site laydown areas, and lighting. These effects will be short-term and limited in extent. Mitigation measures such as limiting night-time activities, minimising vegetation clearance, and siting laydown areas away from roads or exposed

locations will be applied. As a result, the residual significance of visual impacts during construction is considered non-significant.

The operation of the Project the presence of permanent infrastructure which may slightly alter the visual character of the area. However, the use of low-profile equipment, neutral or non-reflective finishes, and maintenance of a tidy site layout will help integrate the facility into the surrounding landscape. Therefore, the residual visual impact during the operational phase is considered non-significant.

During the decommissioning phase, visual disturbance may arise from dismantling works, increased vehicle activity, and exposed materials during decommissioning. These effects will be temporary and reversible. Mitigation measures such as screening laydown or dismantled areas, scheduling activities outside sensitive viewing times, and restoring the site promptly will be implemented. Consequently, the residual significance of visual impacts during decommissioning is considered non-significant.

Unplanned events such as fire or equipment failure may lead to temporary visual damage (e.g., smoke plumes, burned containers), but recovery and repair will follow swiftly.

Land Use

Site preparation and infrastructure installation may temporarily disrupt undeveloped land and restrict access for informal land users such as nomadic herders. However, by limiting clearance to essential areas, clearly marking boundaries, providing signage, and restoring temporary access routes post-construction, the residual land use impacts during construction are considered non-significant.

During operation, the land remains in energy infrastructure use. No additional land take or change in use is anticipated. The land use will transition to a fenced energy facility within the designated utility zone. As this change does not displace any existing formal land uses, and aligns with the permitted zoning, the impact on land use during operation is considered non-significant.

During decommissioning, infrastructure removal may cause temporary surface disruption and restricted access within the previously developed site. These impacts will be managed through activity scheduling, site stabilisation, and restoration of the land to its original or agreed condition. Therefore, the residual impact on land use during decommissioning is considered non-significant. Additionally, decommissioning presents an opportunity for land restoration. Once infrastructure is removed, the land may be returned to a more natural or alternative beneficial use, supporting long-term land use recovery in line with stakeholder expectations.

Emergency situations such as fire response may result in temporary land exclusion or localised surface damage. However, these events are expected to be short-lived and limited in scope. As a result, the residual land use impact from unplanned events is considered non-significant.

Waste Generation

Waste will be generated from construction activities and on-site worker facilities, including hazardous and non-hazardous solid and liquid waste. Risks include improper segregation, leaching, and accidental spills. Mitigation measures such as waste segregation, sanitary facilities, spill kits, and compliance with the Waste Management Plan (WMP) will be implemented. As a result, the residual waste impacts during construction are considered non-significant.

Routine maintenance will produce solid and liquid waste, including office refuse, transformer oil, and sanitary waste. Additionally, spent batteries will require replacement, handling, and disposal through licensed providers. Implementation of best practice handling, secure storage, and audit tracking systems will ensure compliance. Therefore, the residual waste impacts during operation are considered non-significant.

Dismantling activities during decommissioning will generate solid and hazardous waste such as batteries and cables, along with liquid waste from cleaning operations. These will be managed through a decommissioning waste plan, use of bunded areas, spill prevention procedures, and disposal via licensed contractors. Consequently, the residual waste impacts during decommissioning are considered non-significant.

During unplanned events, fires, chemical spills, or thermal runaway incidents may result in accidental hazardous waste generation. However, with emergency response plans, secondary containment, and trained personnel in place, the residual significance of unplanned waste impacts is considered non-significant.

Economic and Social Aspects

Construction will bring short-term employment and procurement benefits to the local workforce and service providers. However, informal land users may face temporary restrictions to land access. With transparent hiring practices, local outreach, signage, and restoration of access where safe, the residual economic and social impacts during construction are considered non-significant.

The operational phase may contribute modestly to the local economy through automated facility management and may restrict long-term access to previously open land. Communication of project benefits, subcontracting opportunities, and public awareness on land use changes will be implemented. Thus, the residual significance of economic and social impacts during operation is non-significant.

Enhancement measures such as setting local hiring targets, partnering with training centres, and promoting national energy contributions can raise the significance of benefits from minor to moderate for both construction and operational phases.

Decommissioning activities may create short-term jobs but also pose minor disruptions to local communities. Local sourcing, early stakeholder notification, and social messaging will be used to reduce concerns. Therefore, the residual economic and social impacts during decommissioning are considered non-significant.

During unplanned events, emergency incidents (e.g., fires or accidents) could raise public concern, but no major socio-economic effects are expected.

Emergency response planning and community notification protocols will be in place. As a result, the residual impact is considered non-significant.

Ruins and Cultural Heritage

During construction, no cultural heritage sites were identified during baseline studies. In the event of a discovery, a chance-find procedure will be implemented to protect potential resources. If finds are encountered, work will cease immediately, and authorities will be notified. With these mitigation measures in place, the residual significance is considered non-significant.

No activities are planned during operation of the Project that could affect buried heritage features. Impact is not expected.

During decommissioning, ground disturbance may uncover heritage material, but the chance-find procedure remains in effect. If finds are encountered, work will cease immediately, and authorities will be notified. With these mitigation measures in place, the residual significance is considered non-significant.

Emergency excavation or structural damage during unplanned events could expose unknown artefacts. Any discoveries will be protected and reported. With these mitigation measures in place, the residual significance is considered non-significant.

Human Rights

Construction-phase activities may expose workers, particularly migrants, to risks such as excessive working hours, wage delays, inadequate living conditions, lack of freedom of association, and limited access to grievance mechanisms. These concerns are mitigated through the implementation of a WMP, transparent contractor compliance with labour laws, grievance systems, and awareness training. Additionally, informal land users may experience reduced access to grazing routes or cultural sites due to workforce influx and restricted movement. Engagement and clear communication with local users, along with signage and grievance mechanisms, reduce this impact. The residual significance of both workforce and informal user-related impacts is considered non-significant.

During the operation phase, workers face limited but present risks of unfair treatment, discrimination, or lack of grievance channels. These are mitigated through transparent employment policies, access to grievance mechanisms, and periodic monitoring of worker feedback. As such, human rights impact during the operational phase are non-significant.

Worker welfare risks during decommissioning may include occupational safety issues, unfair pay, and excessive hours. Informal users may also be temporarily disturbed by traffic and workforce movements. Extending WMP provisions to this phase, providing training, monitoring site conditions, and engaging with informal users help to minimise these effects. The residual human rights impact during decommissioning is assessed as non-significant.

During unplanned events, human rights risks may arise if emergency events affect local communities or workforce wellbeing. Procedures are in place to protect vulnerable groups and provide transparent communication.

Conclusion

In conclusion, the Project presents both challenges and opportunities across its construction, operation, and decommissioning phases. While the Project is expected to have some localised environmental and social impacts, such as habitat loss, air quality degradation from dust generation, noise, and temporary disruptions to local land use, these impacts are generally considered minor and manageable with appropriate mitigation measures.

The Project will contribute positively to the local economy by providing employment opportunities, stimulating local businesses, and promoting long-term economic stability.

1 INTRODUCTION

1.1 General Information on the Study

This Category II Environmental and Social Impact Assessment (ESIA) has been prepared by WKC Arabia for Environmental Consultancy LLC (WKC), a National Centre for Environmental Compliance (NCEC) licensed service provider, on behalf of ILF Consulting Engineers for Engineering Consultancy (ILF), regarding the proposed Haden Battery Energy Storage System (BESS) Project (hereinafter referred to as the “Project”). The BESS Project is located entirely within the boundaries of the previously permitted Haden photovoltaic (PV) Park (which is currently under construction) approximately 205 kilometres (km) east of the Islamic Port of Jeddah, within Taif City located in the Makkah Region of the Kingdom of Saudi Arabia (KSA). Figure 1-1 presents the regional context of the Project, while Figure 1-2 illustrates the local setting, including urban areas and road networks.

It is important to note that Haden PV Park has already undergone the requisite environmental permitting process, including the preparation of a comprehensive ESIA and receipt of necessary approvals from the NCEC. However, the BESS component (encompassing an area 0.5 square kilometres (km²) fully situated within Haden PV Park’s permitted site) was not included in the original ESIA scope, hence under national requirements this update is now being reflected through a new application to the NCEC.

The BESS Project is designed to enhance the renewable energy integration capacity of Haden PV Park by utilising either Lithium Iron Phosphate (LFP) or Nickel Manganese Cobalt (NMC) technology, providing approximately 500 Megawatt (MW) of interconnection capacity with an energy storage capacity of 2 gigawatt-hour (GWh). This additional infrastructure aligns with Saudi Arabia’s national renewable energy objectives and supports grid stability and energy security.

Regarding land tenure, the site has been allocated for Haden PV Park and remains under the control of the Ministry of Municipalities and Housing (MoMAH), with the Project Proponent responsible for undertaking the land transfer process required for the allocation of the BESS site and associated access roads.

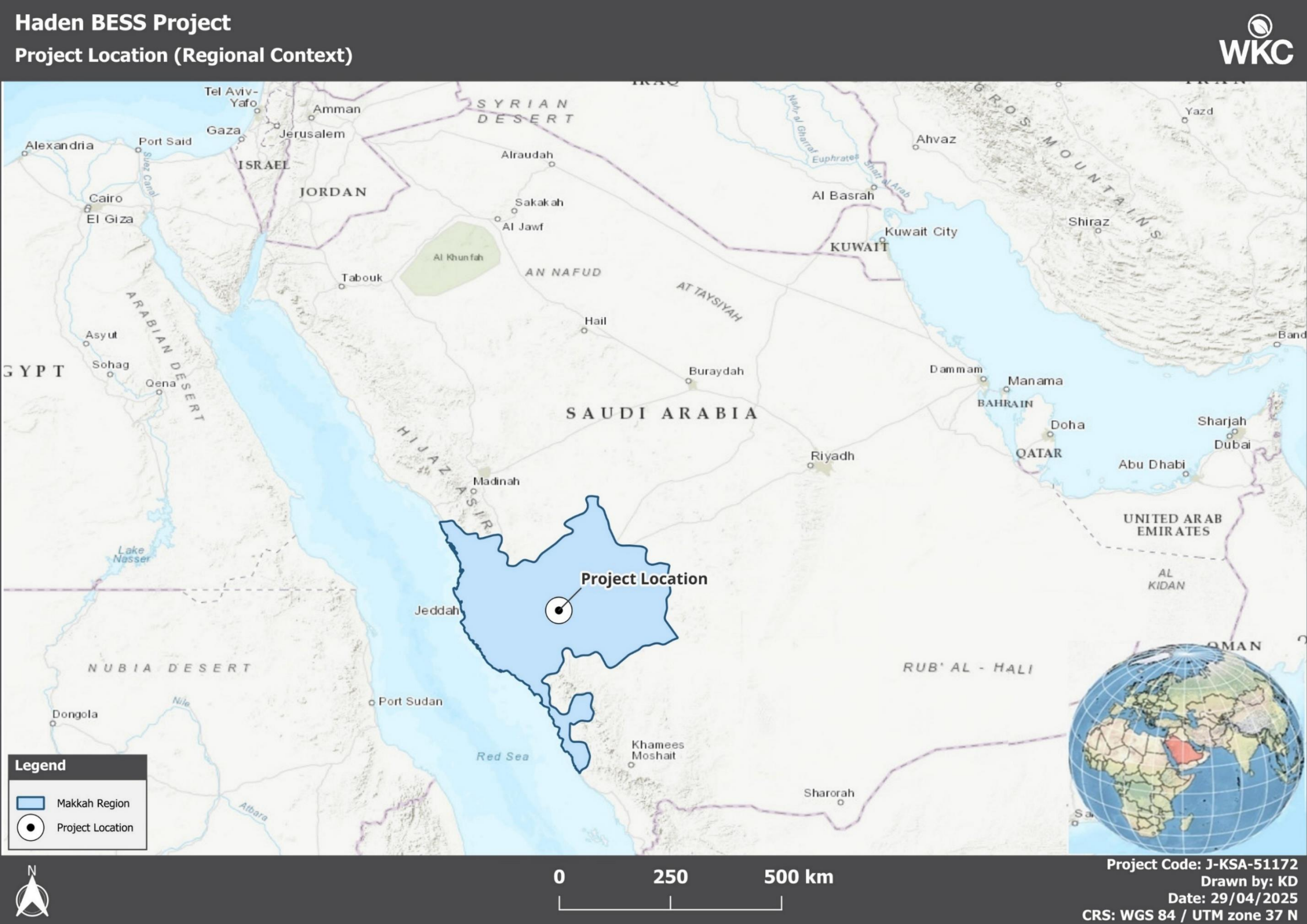


Figure 1-1: Project Location (Regional Context)

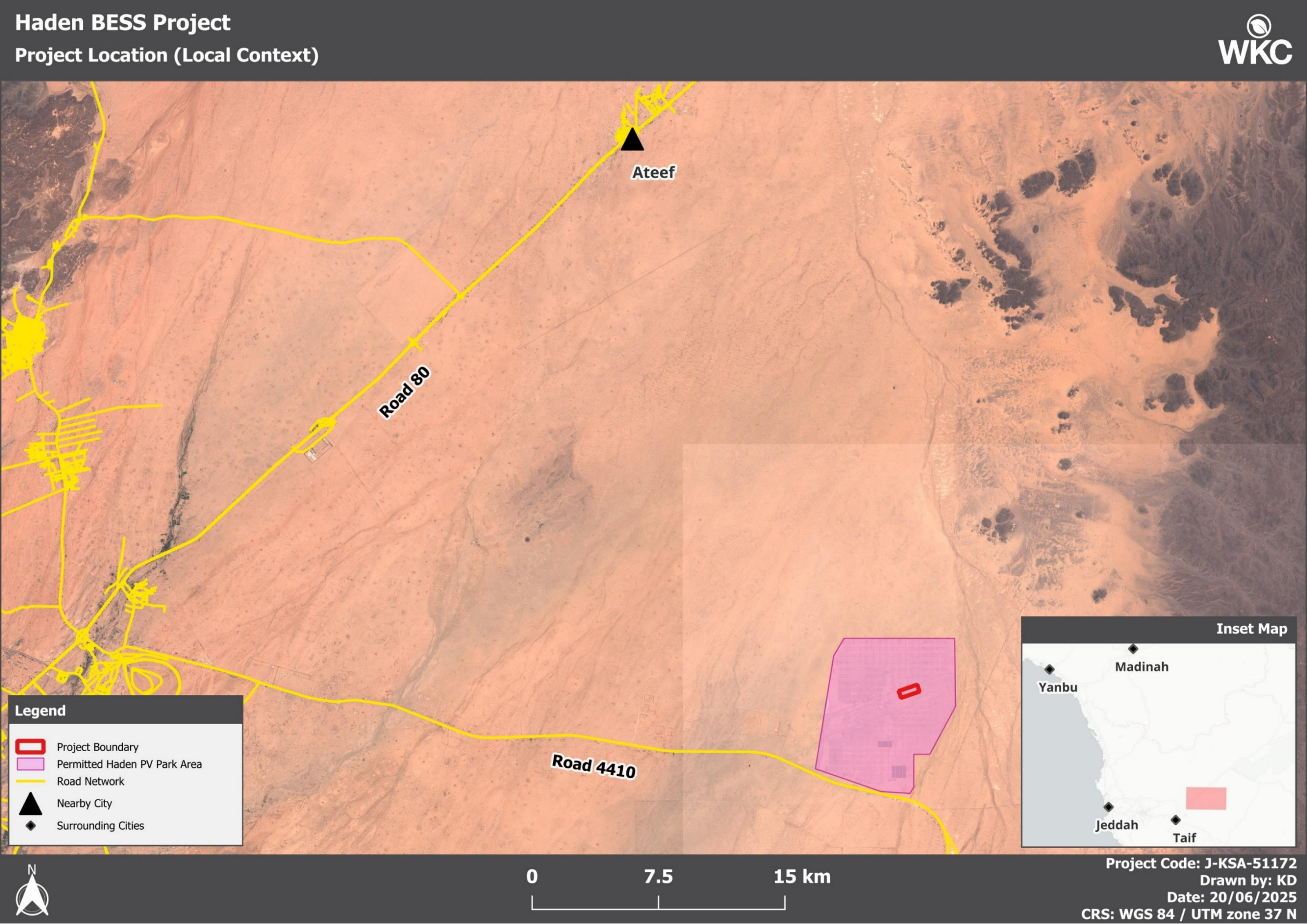


Figure 1-2: Project Location (Local Context)

1.2 Rationale, Objectives and Scope of Work of the Study

1.2.1 Rationale

ILF have been appointed by the Project Proponent to prepare this Category II ESIA report in accordance with the NCEC regulations [1], of which Article 2 stipulates that all facilities are required to obtain an Environmental Permit to Construct from the NCEC prior to commencing any construction activities.

The NCEC applies a set of project screening criteria and categorises projects into three levels / types for the purposes of ESIA's.

These are defined within the Executive Regulations [1] and are summarised as follows:

- First: Category I Activities:
 - » Activities that are expected to have minimal impacts on the environment that do not exceed the boundary of the activity site;
- Second: Category II Activities:
 - » Activities that are expected to produce moderate environmental impact throughout the different stages of the activity. This impact may be alleviated and controlled and does not largely exceed the perimeter of the activity's site; and,
- Third: Category III Activities:
 - » Activities anticipated to have a significant environmental, social and economic impact which may exceed the activity boundaries and negatively affect the sustainability of environmentally sensitive areas and receptors.

Based on the above classifications, the Project has been classified as a Category II Project / activity by the NCEC (NCEC Reference No.: EPAC-2025-001577).

1.2.2 Objectives

The purpose of an ESIA is to identify the positive and negative impacts caused by a project's activities on environmental and social aspects. This is undertaken through an analysis of the effects resulting from the interaction between environmental and social components with various project activities during site preparation, construction, operation and decommissioning phases.

The main objectives of the ESIA study are to:

- Identify sensitive environmental receptors within the existing environment potentially affected by the proposed activities;
- Review existing literature and site-specific baseline surveys to document the regional and site-specific environmental reference status, as far as practical, in order to describe the pre-Project environmental baseline;
- Identify and evaluate (at risk or opportunity level) potential environmental and / or social impacts associated with the Project during all phases of the Project lifecycle;

- Identify and recommend practical and feasible mitigation measures early in the design process to eliminate, reduce or manage any negative environmental and / or social impacts resulting from the Project and to ensure compliance with KSA;
- Recommend environmental and social management plans for the Project in order to eliminate and / or reduce the residual potential negative environmental and / or social impacts identified to As Low As Reasonably Possible (ALARP), and to ensure compliance with KSA standards; and,
- Assess the acceptability of potential residual environmental and / or social impacts associated with the Project during all phases of the Project lifecycle.

1.2.3 Scope

An ESIA involves undertaking qualitative and quantitative studies to identify and evaluate the potential impacts of the Project on environmental and social aspects. The ESIA includes mitigation measures and management actions to be implemented to prevent, minimise or control any potential negative impacts and enhance opportunities. The methodology used for the identification and assessment of impacts has been outlined in Section 5.1 of this ESIA report.

The environmental and social specialist topics assessed in the ESIA are as follows:

- Natural Vegetation Cover;
- Air Quality;
- Noise;
- Odours;
- Water Quality (Surface Water and Groundwater);
- Quality of Soil and Sediments;
- Biodiversity;
- Health and Safety (Occupational and Public);
- Natural Landscapes and Visual Comfort;
- Land Use;
- Waste Generation;
- Economic and Social Aspects;
- Archaeology and Cultural Heritage; and,
- Human Rights.

1.3 Study Outline

In order to comply with the requirements established by the NCEC for a Category II project, the ESIA report has been structured as per Table 1-1.

Chapter	Content
Chapter 1	Introduction
Chapter 2	Institutional and Regulatory Framework
Chapter 3	Activity Description
Chapter 4	Description of the Surrounding Environment
Chapter 5	Impact Identification, Analysis and Assessment
Chapter 6	Plans
Chapter 7	Conclusion
Chapter 8	Annexures

Table 1-1: ESIA Structure

1.4 Information on the Permit Applicant

The Project Proponent will serve as the permit applicant for the Project, with its role primarily focused on the pre-construction phase. The Project Proponent facilitates the permitting process by assisting the future developer in obtaining the construction permit from the NCEC and coordinating with stakeholders on behalf of the Project through the Ministry of Energy (MoE). Once construction begins, the Developer assumes full responsibility for the Project, including securing the operation permit from NCEC and managing all construction and operational activities through contracted Engineering, Procurement, and Construction and O&M (Operations and Maintenance) companies. During the construction and operation phases, the Developer also takes on direct responsibility for any stakeholder engagement, independent of the Project Proponent's involvement.

1.5 Information on the Service Provider that Conducted the Study

The Project Proponent have appointed ILF to complete the pre-development studies for the Project. ILF is an international engineering and consulting firm with over 55 years of experience in a wide array of projects.

WKC, an NCEC-approved consultant has been appointed to undertake the ESIA process, reporting and supporting studies for this Project. Refer to Annexure A in which WKC's NCEC registration certificate has been attached. Details regarding WKC are outlined in Table 1-2.



Company Name:	WKC Arabia for Environmental Consultancy LLC
Address:	Office 3, 1 st Floor Business Icon Tower Abdulrahman Aldakhel Street Al Rakah Al Janubiyah Al Khobar 34226 Kingdom of Saudi Arabia
Principal Business:	▪ ESIA; ▪ Air Quality; ▪ Ecology; ▪ Hydrodynamic Modelling; ▪ Noise and Vibration; ▪ GIS and Geospatial Modelling; ▪ AIV / FIV; ▪ Environmental Auditing; and, ▪ Carbon Management.
Point of Contact:	info@wkcgroup.com Tel: +966 5315 62745

Table 1-2: Contact Details of NCEC-Registered Consultant (WKC)



2 INSTITUTIONAL AND REGULATORY FRAMEWORK

2.1 Institutional Framework

A high-level overview of the governmental bodies and organisations responsible for the development and enforcement of environmental legislation in KSA is provided in Table 2-1. This table also includes government entities that may be consulted with regards to a Project development (usually outside of the ESIA process).

Organisation	Description
Ministry of Environment, Water and Agriculture (MEWA)	The MEWA, formerly the Ministry of Agriculture is responsible for water and environmental affairs. The ministry consists of eight agencies, namely the environment, water affairs, agriculture, land and surveys, animal resources, planning and budget, shared services, and Economic Affairs and Investment.
National Centre for Environmental Compliance (NCEC)	The NCEC is a national entity working with all parties to improve the environmental commitment through pollution monitoring, environmental assessment, and strengthening environmental control and guidance in the region as well as being committed to enhancing the sustainability of the environment.
Ministry of Industry and Mineral Resources (MIMR)	The MIMR is concerned with supervising the industrial and mining sectors in KSA encouraging investors therein, discovering and using the Kingdom's mineral resources and achieving the highest returns.
National Centre for Meteorology (NCM)	The NCM provides high quality services for weather and climate to protect lives and provide development support.
National Centre for Vegetation Development and Combating Desertification (NCVC)	The NCVC is tasked with combating desertification, development and rehabilitating forest vegetation cover, protection of local endangered plant species and developing and managing national parks.
National Centre for Waste Management (MWAN)	The MWAN aims to regulate and supervise waste management activities, stimulate investment in the Centre, and improve its quality based on the principle of circular economy in waste management to achieve sustainable development goals.
National Centre for Wildlife (NCW)	The NCW is responsible for sustaining terrestrial and marine wildlife, maintaining protected areas, and for rehabilitating rare and threatened species and their habitats.
Ministry of Commerce (MC)	The MC has the responsibility to enhance the potential of commercial sectors and protect the beneficiaries' interests, by developing and implementing effective and efficient policies and mechanisms, which will contribute to achieving sustainable economic development.
Ministry of Energy (MoE)	The MoE is one of the governmental bodies of Saudi Arabia and part of the cabinet. The ministry has the function of developing and implementing policies concerning petroleum and related products.
Ministry of Health (MoH)	The MoH is the ministry responsible for the health of the citizens of KSA. Recently, the Ministry has played an influential role in advising the Saudi government on social matters that could assist with the health of the Saudi people.

Organisation	Description
Ministry of Human Resources and Social Development (MHRSD)	The (MHRSD) was established in 2019 after merging Ministry of Labour and Social Development with Ministry of Civil Service. It is responsible for providing the community with development, support, and protection. The Ministry is also in charge of labour affairs and its related issues and policies.
Ministry of Interior (Mol)	The Mol is the responsible authority for national security, naturalization, immigration and customs in KSA.
Ministry of Investment of Saudi Arabia (MISA)	The MISA takes a leading role in improving Saudi Arabia's overall business environment, commissioning multiple market intelligence studies every year and developing local opportunities for joint ventures.
Ministry of Municipalities and Housing (MoMAH)	MoMAH was established in 1975 and is responsible for the supervision and regulation of municipalities in the Kingdom. The Ministry is the central governmental organization entrusted with the oversight and regulation of municipalities across the country's cities, towns, and villages.
Ministry of Tourism (MT)	The MT is concerned with the tourism sector in all its aspects in KSA, by organizing, developing and promoting it. The Ministry also works and always looks forward to enhancing the role of the tourism sector and overcoming obstacles to its growth, based on the vast factors and ingredients that the Kingdom enjoys. The Ministry of Tourism seeks to align the role and growth of the tourism sector with the position, values and role of the Kingdom in human civilization and its influence on the international community, as it is an important tributary of the national economy.
Ministry of Transport and Logistics Service (MOTLS)	The MOTLS provides an integrated transport sector aimed at providing safety, effectiveness and efficiency, and technical and economic development within the transport sector.
Saudi Geological Survey (SGS)	The SGS provides advisory services to the government of the Kingdom on geological matters. It has been authorised to study geological aspects of environmental issues and to determine ways to protect and mitigate any harmful effects of the proposed activities.
Saudi Investment Recycling Company (SIRC)	The SIRC is a wholly owned subsidiary of the Public Investment Fund (PIF) of KSA. The company was founded to develop, own, operate, and finance various activities across all waste types to establish recycling capacities in the Kingdom and build a circular economy for a sustainable future.

Table 2-1: Relevant Government Bodies and Organisations within KSA Concerned with Environmental Matters



2.2 Regulatory Framework

2.2.1 National Laws, Executive Regulations, Standards and Requirements

2.2.1.1 National Environmental Law 2020

The Environmental Regulation, as defined in Royal Decree No. M/165 (July 2020), entered into force on 13th January 2021, superseding the General Environmental Regulation (GER) No. 193, promulgated by Royal Decree No. M/34 dated 28/7/1422 H [1]. The Waste Management Law of Saudi Arabia has been approved by the Royal Decree No. (M/3) – on the 05/01/1443 H – 13/08/2021 AD. The Law replaced The General Waste Management Law issued with the Royal Decree No. (M/48) on the 17/09/1434 H – 25/07/2013 AD. The Waste Management Executive Regulations were issued based on the Waste Management Law and its execution is directed in the National Centre for Waste Management (MWAN).

2.2.1.2 Ministry of Environment, Water and Agriculture Implementing Regulations

The ministry consists of eight (8) agencies, namely the Environment, Water Affairs, Agriculture, Land and Surveys, Animal Resources, Planning, Shared Services and Economic Affairs and Investment.

The new Environmental Law issued under Royal Decree M/165 in July 2020 is supported by new implementing regulations which became the law on 17th January 2021. The law consolidates and supersedes much of the existing national legislation including the GER and conservation legislation into one (1) law.

The implementing regulations include:

- Executive Regulations for Environmental Permits to Construct and Operate Activities;
- Environmental Inspection and Auditing Executive Regulations;
- Air Quality Executive Regulations;
- Noise Executive Regulations;
- Prevention and Treatment of Soil Contamination Executive Regulations;
- Apprehension of Violations Executive Regulations;
- Controls and Procedures Pertaining to Financial Dues for Environmental Licenses, Permits and Services Executive Regulations;
- Hunting Terrestrial Wildlife Species;
- Logging;
- Ozone Depleting Substances and Hydrofluorocarbons Executive Regulations;
- Sustainable Management of the Marine and Coastal Environment;
- Protected Areas;
- Trade in Wildlife Species, their Products and Derivatives;
- Vegetation Cover Development and Combating Desertification;



- Protection of Aqueous Media from Pollution; and,



- Environmental Rehabilitation of Degraded Sites and Remediation of Polluted Sites.

2.2.1.3 National Centres of Excellence

The national entity responsible for establishing legislation and standards was the General Authority of Meteorology and Environmental Protection (GAMEP). GAMEP's roles and responsibilities have since been transferred to five (5) Centres of Excellence (CoE) now responsible for the environmental sector development.

The main institutional authority for environmental affairs is the NCEC. The NCEC is a national entity working with all parties on pollution monitoring, environmental assessment, environmental controls and guidance in the region as well as commitment to enhancing sustainable practices.

The NCEC environmental standards represents the minimum requirements for the Project during its construction and operational phases, including:

- Executive Regulations for Environmental Permits to Construct and Operate Activities;
- Executive Regulations for Air Quality;
- Executive Regulations for Noise;
- Executive Regulations for the Protection of Aqueous Media from Pollution;
- Executive Regulations for Prevention and Remediation of Soil Contamination; and,
- Executive Regulations for Environmental Rehabilitation.

In addition to the NCEC, the following National Centres have also been established with their own policies and standards which need to be followed where applicable:

- **National Centre for Meteorology (NCM):** Monitors weather and climate conditions, prepares forecasts, provides airports, ports and other bodies with data and weather forecasts and operates regional weather monitoring stations;
- **National Centre for Wildlife (NCW):** Responsible for sustaining terrestrial and marine wildlife, maintaining protected areas and rehabilitating rare and threatened species and their habitats;
- **The National Centre for the Development of Vegetation Cover and Combating Desertification (NCVC):** Works on developing and managing national parks, rehabilitation of vegetation cover in forests, protection of local endangered plant species, and combating desertification. The centre further undertakes studies and supporting research related to vegetation; and,
- **National Centre for Waste Management (MWAN):** Aims to regulate and supervise waste management activities, stimulate investment in the centre and improve its quality based on the principle of circular economy in waste management to achieve sustainable development goals.

Whilst the KSA regulatory framework is comprehensive, for the purposes of this ESIA, where there is an absence of a national standard, the ESIA has adopted appropriate international standards such as World Bank Environmental Health and Safety (EHS) Guidelines, General EHS Guidelines (which are referenced by IFC PSs).

2.2.1.4 The KSA Labour Law

The regulation of employment, labour relations, worker contracts and workplace conditions are defined in the Labour Law promulgated by Royal Decree No. M/51 of 2005. This supersedes the Labour and Workers Law promulgated by Royal Decree No. M/21 (6 Ramadan 1389H).

This law contains provisions intended to protect the interests of both employers and workers with the aim of establishing a stable, equitable, and sustainable work environment. As such, it establishes the legal (and hence minimum) requirements that will apply to engagement involving the Project construction and operational workforce. This law will thus govern how the Developer and its contractors employ and house their construction workforce, and it will establish the minimum conditions and facilities that the Developer and its contractors will need to apply, both in the workplace and in the worker camps, as applicable.

2.2.1.5 National ESIA Requirements and Approval

Industrial and development projects within KSA are subject to an ESIA as part of the planning and permitting process in accordance with the National Environmental Law 2021 and as described in the environmental regulations on environmental permits for the construction and operation of activities.

The ESIA regulations refer to the NCEC as the Competent Authority, responsible for ensuring environmental protection in the KSA and for implementing legislation as required. Whilst all major development projects are required to undertake an ESIA, the level of reporting and detail required is subject to classifying the project into three individual categories based upon their predicted impacts.

The Haden BESS project is a Category II Project, which falls under the categorisation of “*Activities that are expected to have moderate impacts on the environment during the different stages of the activity, where these impacts can be reduced and controlled while they do not significantly exceed activity limits.*” Such Project requires the submission of an ESIA to the NCEC as part of the environmental permitting process.

2.2.1.6 NCEC Environmental Permitting Process

The NCEC permitting process for a Category II Project consists of the following three (3) steps:

1. NCEC Project Registration
 - » Registration of the Project entity on the NCEC portal.
2. Requesting the Environmental Permit to Construct based on the classification of the Project:
 - » Initiating the request on the portal by selecting the needed service; and,

- » Filling all required information needed for this request and attaching all mandatory documents.

3. ESIA Study:

- » Preparation of the ESIA study by the ESIA consultant;
- » Preparation of the Environmental and Social Management Plans (such as the CESMP);
- » Submission of the ESIA study (including the CESMP) to the NCEC;
- » Payment of the fee for the NCEC review and decision-making process;
- » NCEC review and decision-making process; and,
- » NCEC issuance of Environmental Permit to Construct.

2.2.1.7 Environmental Permit to Construct (EPC)

An Environmental Permit to Construct follows the typical ESIA process outlined above, followed by the ESIA covering the construction, operation and closure phases.

The ESIA is submitted to the NCEC for comment and approval. Upon review of the environmental studies, as required by the regulations and requested by the NCEC, if satisfied with the scope and nature of the ESIA, an Environmental Permit to Construct is issued (subject to conditions), which allows the commencement of the construction phase of the project.

The NCEC issues the EPC to be valid for 3 years. However, according to the Executive Regulations for Environmental Permits to Construct and Operate Activities, Article 6, Second Clause 8:

“The validity of the Environmental Permit to Construct shall be three years, and the Center may extend the duration of its validity by two additional years for large projects that require long period to complete design and funding. In such cases, the extension request must be included in the Environmental Impact Study.”

Therefore, the Project Proponent respectfully requests an Environmental Permit that is valid for a minimum of five (5) years.

2.2.1.8 Environmental Permit to Operate (EPO)

In order to commence with the operation of the facility or project, the project Owner will then be required to show fulfilment of all conditions and requirements specified by the NCEC, including all the regulations and requirements for the Environmental Permit to Construct. The EPO will then be requested through the NCEC portal, through the list of services shown on the issued Environmental Permit to Construct for the project. This EPO request will include filling all needed and required information, attaching the mandatory documents, and in many cases, submitting an Environmental Auditing Study (EAS) that shall be prepared by an NCEC-registered consultant and to be prepared based on the Executive Regulation for Environmental Inspections and Audits. If the NCEC is satisfied with the submitted EAS, the EPO will be issued with specific conditions relating to the operations phase of the Project, including monitoring and reporting requirements.

2.2.2 Regional Laws, Executive Regulations, and Requirements

The KSA is a signatory to the Convention on the Conservation of Wildlife and their Natural Habitats in the Gulf Cooperation Council [2] along with six (6) other Gulf States. This Convention, which came into effect in 2003, consists of 13 articles aiming at conserving ecosystems and wildlife, particularly species threatened with extinction, and indicates the main actions to be taken by each signatory country. It contains annexes listing floral and faunal species to be protected, and animal species threatened with extinction.

In the Northern Borders Region, the regional environmental laws primarily align with national regulations established by the MEWA. These national laws set the framework for environmental protection, including ESIA's, waste management, water resource management, and air quality standards. While regional authorities may implement specific practices to address local environmental concerns, such as wildlife conservation and sustainable resource use, these initiatives are fundamentally guided by the overarching national laws. Consequently, the regional environmental standards in Northern Borders Region are consistent with national legislation, ensuring a unified approach to environmental protection across the KSA.

2.2.3 International Laws, Executive Regulations, and Requirements

2.2.3.1 Overview of the IFC Performance Standards

Based on a preliminary review against the IFC's Environmental and Social Review Procedures, the Project is considered likely to fall under IFC Category B, as it is not expected to result in significant adverse impacts that are diverse, irreversible, or unprecedented. The IFC defines a Category B Project as:

“Business activities with potential limited adverse environmental or social risks and/or impacts that are few in number, generally site-specific, largely reversible, and readily addressed through mitigation measures.”

Notwithstanding the likely IFC Category B classification, the Project is still required to systematically consider the applicability of each IFC Performance Standard, ensuring that relevant environmental and social risks are identified and managed in accordance with good international industry practice.

The IFC PSs are a key component of the IFC's Sustainability Framework and are directed towards the Project Proponent, providing guidance on how to identify risks and impacts. These standards are designed to help avoid, mitigate and manage risks and impacts throughout the life of a project. In addition, the IFC PSs aim to initiate sustainable business which includes stakeholder engagement and disclosure obligations of the client at a project level.

The IFC PSs (2012) include:

- PS1: Assessment and Management of Environmental and Social Risks and Impacts;
- PS2: Labour and Working Conditions;
- PS3: Resource Efficiency and Pollution Prevention;
- PS4: Community, Health, Safety and Security;

- PS5: Land Acquisition and Involuntary Resettlement;
- PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- PS7: Indigenous People; and,
- PS8: Cultural Heritage.

2.2.3.2 World Bank General Environmental Health and Safety Guidelines

The EHS Guidelines [3] have been set out by the World Bank Group to provide general guidelines for its members when involved in a project or when providing financial support to a project. The EHS Guidelines serve as technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP).

The following EHS Guidelines are relevant to this Project:

- General EHS Guidelines - Environmental:
 - » Air Emissions and Ambient Air Quality;
 - » Energy Conservation;
 - » Wastewater and Ambient Water Quality;
 - » Water Conservation;
 - » Hazardous Materials Management;
 - » Waste Management;
 - » Noise; and,
 - » Contaminated Land.
- General EHS Guidelines - Occupational Health & Safety:
 - » General Facility Design and Operation;
 - » Communication and Training;
 - » Physical Hazards;
 - » Chemical Hazards;
 - » Biological Hazards;
 - » Radiological Hazards;
 - » Personal Protective Equipment (PPE);
 - » Special Hazard Environment; and,
 - » Monitoring.
- Construction and Decommissioning:
 - » Environment;
 - » Occupational Health and Safety; and,
 - » Community Health and Safety.
- Industry Sector Guidelines:

» EHS Guidelines for Electric Power and Distribution.

The IFC PSs require that where an IFC environmental standard / limit is available as well as the national limits, then the most stringent of the two (2) shall be adopted by the Project.

2.2.3.3 Application of the Equator Principles in Non-Designated Countries

The Equator Principles (EPs) are a voluntary set of guidelines for assessing and managing environmental and social risks in project financing and have become the project finance industry standards for addressing environmental and social issues in global project financing.

In alignment with the IFC Performance Standards, the Project is also expected to be classified as a Category B project under the Equator Principles. This categorisation reflects the Project's moderate environmental and social risk profile, characterised by site specific, largely reversible impacts that are readily managed with standard mitigation measures. As such, while the scope of assessment and mitigation may be less intensive than for a Category A project, the Equator Principles and by extension, the relevant IFC Performance Standards and World Bank EHS Guidelines remains applicable.

The EPs currently include provisions for the following:

- Principle 1: Review and Categorisation;
- Principle 2: Environmental and Social Assessment;
- Principle 3: Applicable Environmental and Social Standards;
- Principle 4: Environmental and Social Management System and Equator Principles Action Plan;
- Principle 5: Stakeholder Engagement;
- Principle 6: Grievance Mechanism;
- Principle 7: Independent Review;
- Principle 8: Covenants;
- Principle 9: Independent Monitoring and Reporting; and,
- Principle 10: Reporting and Transparency.

In accordance with the EPs, for projects located in non-designated countries (which includes the Kingdom of Saudi Arabia (KSA), the assessment process evaluates compliance with the applicable IFC PSs and the World Bank EHS Guidelines.

2.2.4 International Conventions and Treaties to which the Kingdom is a Party

KSA has ratified or is a signatory to the international conventions outlined in Table 2-2.



Name of Convention	Date Adopted	Date Entered into Force
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Disposal, 1989	7 th March 1990	5 th May 1992
United Nations Framework Convention on Climate Change, 1992	28 th December 1994	28 th March 1995
Montreal Protocol, 1987	16 th September 1987	1 st January 1989
Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997	31 st January 2005	30 th April 2005
United Nations Convention on Biological Diversity, 1992	22 nd May 1992	29 th December 1993
United Nations Convention to Combat Desertification (in Africa), 1994	17 th June 1994	26 th December 1996
Paris Agreement under the United Nations Framework Convention on Climate Change (2015)	3 rd November 2016	4 th November 2016

Table 2-2: International Conventions to which the Kingdom is a Signatory

2.2.5 Findings of the Strategic Environmental Assessment Study If Available and Applicable to the Activity

A Strategic Environmental Assessment was not undertaken for the proposed Project. However, the Project site falls entirely within the boundaries of a designated solar energy zone that has previously been subject to detailed environmental assessment as part of Haden PV Park ESIA.

No fatal flaws were identified through the assessment process. All environmental and social risks were found to be either avoidable through design measures or manageable through standard mitigation practices.

2.2.6 Applicability of the IFC Performance Standards

2.2.6.1 Project Screening

The Project has been classified as Category II under the NCEC screening criteria, indicating that it has moderate, site-specific environmental and social risks that are largely reversible and manageable with standard mitigation measures. Based on a preliminary review against the IFC's Environmental and Social Review Procedures and the Equator Principles, the Project is also considered likely to fall under IFC and Equator Principle's Category B, as it is not expected to result in significant adverse impacts that are diverse, irreversible, or unprecedented.

Importantly, the Project is being developed within an area that has already obtained environmental approval for a broader utility-scale PV development, and construction of the large Haden PV Park facility is already underway. Accordingly, the proposed BESS will be integrated into an existing and approved development footprint. Table 2-3 assesses the applicability of each IFC Performance Standard in this context, reflecting both the project's anticipated risk profile and its

established environmental setting. The applicability of the IFC PSs to the Project has been assessed in alignment with Project characteristics and the Saudi Arabian regulatory context.



IFC PS No.	Applicability of the IFC PSs to the Project	Justification
PS1: Assessment and Management of Environmental and Social Risks and Impacts	✓ Applicable	The ESIA provides a comprehensive evaluation of environmental and social risks associated with all project phases. In addition, stakeholder engagement and disclosure have been led by the Project Proponent in line with national requirements and cultural norms, rather than under IFC's public disclosure model. This approach ensures culturally appropriate, and government aligned consultation throughout the Project permitting process, and is considered proportionate given the location within an approved Haden PV Park (under construction). Section 5.1 outlines the methodology used for impact identification, screening and assessment. Sections 5.2 and 5.2.14 present the assessment outcomes for each impact, while Sections 6.3 and 6.4 details the management and control plans to mitigate and monitor these impacts. Stakeholder engagement is addressed in Sections 1.4 and 8.5, aligned with national standards and proportional to the location within a permitted Haden PV Park.
PS2: Labour and Working Conditions	✓ Applicable	Labour and working conditions during construction and operation are addressed through the Human Resources Policy and Occupational Health and Safety (OHS) provisions. Key risks and mitigation measures are identified, with alignment to PS2 requirements, though implementation will be the responsibility of the Developer. Labour risks and working conditions during construction and operation are evaluated in Section 5.2.7. Human Rights and labour-specific risks (e.g. OHS) are further discussed in section 5.2.13, with mitigation outlined in section 5.3.12. Implementation of labour management measures is the responsibility of the developer and will be aligned with national labour law and IFC PS2 requirements.
PS3: Resource Efficiency and Pollution Prevention	✓ Applicable	The Project involves the development of a BESS using LFP and NMC battery technologies within a permitted Haden PV Park. Key environmental considerations include the management of hazardous materials, waste generation, and risks of soil or groundwater contamination due to accidental spills. Efficiency, emissions control, water consumption and waste management will also be assessed. Section 5.2.2 to 5.2.10 assess key resource and pollution-related impacts such as noise, air emissions, water use, waste generation, and soil quality. Battery-specific risks such as hazardous waste from LFP and NMC chemistries are detailed in Section

IFC PS No.	Applicability of the IFC PSs to the Project	Justification
		3.3 (Battery Specifications) and Section 3.4.3 (Decommissioning). Management and mitigation measures are covered in Section 5.3.2 to 5.3.9.
PS4: Community, Health, Safety and Security	✓ Applicable	Community health and safety risks due to construction traffic, dust, noise, emergency events and fire hazards associated with BESS are assessed. Risk mitigation measures including fencing, security protocols, and emergency response are provided in alignment with PS4. Section 5.2.7 evaluates community health and safety risks from traffic, dust, noise, and fire hazards. Emergency response planning is outlined in Section 6.1, with additional security and safety measures covered in Section 6.3. The ESIA ensures risks to local communities are identified and managed, aligned with PS4.
PS5: Land Acquisition and Involuntary Resettlement	✗ Not Applicable	The land identified for the Project is owned by government entities and is therefore subject to the legislated land acquisition process. No involuntary resettlement is anticipated as part of this Project as the Project falls within the permitted Haden PV Park boundary. Therefore, PS5 does not apply.
PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	✓ Applicable	Although no critical habitat is present, habitat sensitivity and species of conservation concern (e.g., reptiles and avifauna) have been assessed. Biodiversity risks during vegetation clearance and indirect impacts have been evaluated, and mitigation is provided in accordance with PS6. The biodiversity baseline is presented in Section 4.2. Impacts to flora and fauna, including reptile and bird species of conservation concern, are assessed in Section 5.2.1 with mitigation measures detailed in Section 5.3.1.
PS7: Indigenous People	✗ Not Applicable	There are no Indigenous Peoples present in the project area as defined by IFC. The criterion under PS7 is therefore not triggered.
PS8: Cultural Heritage	✗ Not Applicable	The Project is situated entirely within the footprint of the previously Haden PV Park that has already been the subject of an ESIA. These investigations found no evidence of archaeological features or other items of cultural heritage significance within the Project area. Given the prior disturbance associated with Haden PV Park construction activities and the absence of known or suspected heritage resources, no additional cultural heritage risks are anticipated for the BESS development. Accordingly, PS8 is

IFC PS No.	Applicability of the IFC PSs to the Project	Justification
		not considered applicable to the Project, however a Chance Finds Procedure will be implemented.

Table 2-3: IFC Performance Standards Applicability to the Project Development



2.3 Environmental Standards

The Project is required to comply with the applicable national standards (NCEC) in addition to the IFC PSs and IFC EHS Guidelines. In accordance with the IFC PSs, the Project should comply with the most stringent standards among the applicable standards, unless otherwise stated. The applicable NCEC and IFC environmental standards are attached in Annexure B.

3 ACTIVITY DESCRIPTION

3.1 Activity Objectives and Rationale

The Project Proponent aims to contribute to the development of a sustainable and diversified energy sector in the KSA to meet the country's growing energy needs while supporting the country's economic growth and environmental sustainability.

The aims and objectives are to:

- Facilitate the transition to a Competitive Electricity Market;
- Improve efficiency and transparency in the electricity sector through continuous competitive price discoveries;
- Enhance participation of all market players;
- Sustainably move from a regulated electricity market with a vertically integrated utility towards a competitive electricity market;
- Ensure compliance with regulations and standards set by the regulatory authorities;
- Promote innovation and investment in the electricity sector to drive technological advancements; and,
- Monitor market performance and make the necessary adjustments and improvements.

The inclusion of the Haden BESS Project within the existing permitted Haden PV Park is consistent with strategic objectives for the electricity sector in Saudi Arabia.

The addition of grid-scale battery storage is intended to improve system flexibility and stability, supporting the integration of variable renewable energy generation. By enabling the storage of surplus energy and its controlled release during periods of high demand or low generation, the BESS can contribute to more efficient balancing of supply and demand within the market. This function is aligned with broader efforts to promote competitive price mechanisms, improve system performance, and encourage innovation within the sector. The BESS component is also expected to support compliance with relevant technical and regulatory standards applicable to energy infrastructure in the Kingdom.

3.2 Suggested Site for the Project

The Project will occupy an area of 0.5 km² and is approximately 38 km southeast of Ateef city and 35 km southwest of Harman city within Taif City located in the Makkah Region of the KSA. The Project location in a local context is presented in Figure 1-2. In addition, the details of the geographic coordinates of each corner of the Project boundary are provided in Table 3-4 and is geographically presented in Figure 3-1.

In terms of land ownership, the land is currently controlled by MoMAH and falls entirely within the boundaries of Haden PV Park project. The Project Proponent will undertake the relevant transfer process required for re-allocation of the land for the proposed development.



Figure 3-1: Project Boundary Points

3.3 Project Elements with a Potential Environmental Impact

3.3.1 Technical Project Description

A BESS is a facility that stores electrical energy using rechargeable batteries for later use. The system includes battery modules, inverters, thermal management systems and control units, all housed within secure enclosures. A BESS can rapidly discharge stored electricity to the grid and is capable of providing a range of services including peak shaving, frequency regulation, voltage support and backup power. In the context of renewable energy projects, a BESS is particularly valuable for mitigating the variability of solar and wind generation by storing surplus energy during periods of low demand and releasing it during peak demand or when generation is low. This supports grid stability, improves the efficiency of renewable energy use and contributes to the overall resilience of the electricity system.

The Project encompasses a 518 MW plant power capacity and 2,185 megawatt-hour (MWh) plant energy capacity grid-connected BESS that is designed to enhance grid reliability. The BESS is connected to the local transmission network at the 380 kV level via step-up power transformers and switchgear infrastructure compliant with national grid codes (Figure 3-2).

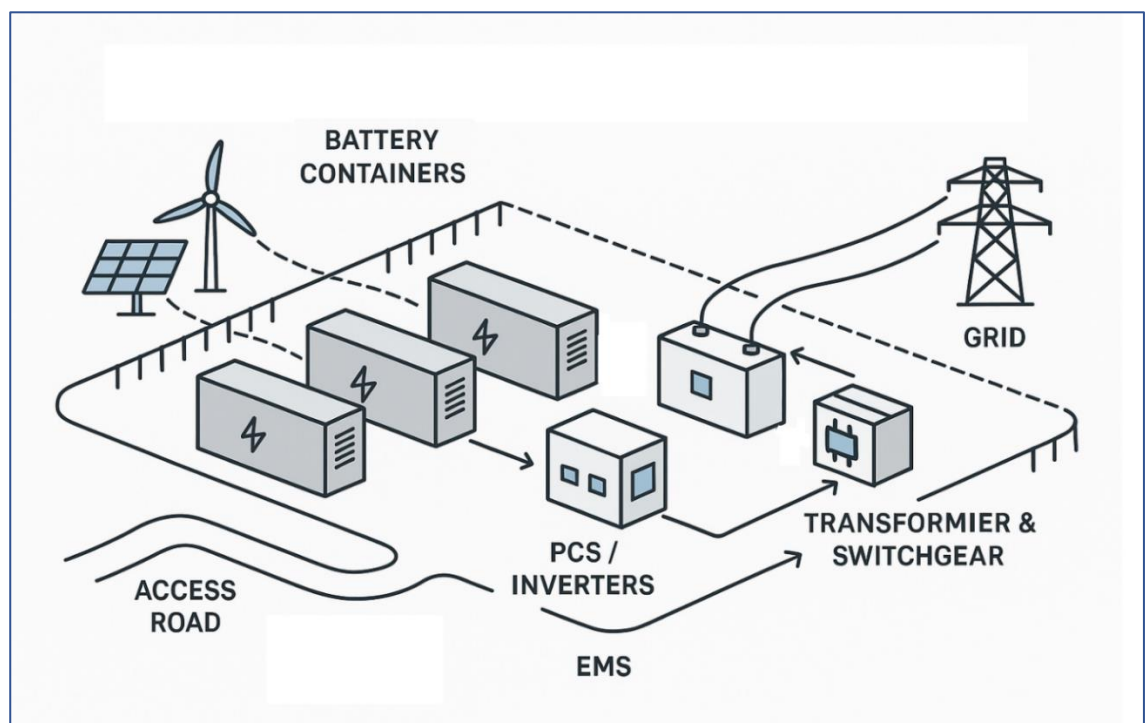


Figure 3-2: Simplified BESS Schematic

The BESS will comprise modular, containerised technology and includes the following key components (Table 3-1).

Component	Description
Energy Storage System (ESS)	Modular 20-foot containers housing battery modules (LFP or NMC), battery management systems (BMS), fire suppression systems, and liquid cooling.
Power Conversion System (PCS)	Containerised 40-foot units integrating inverters, LV and MV switchgear, and step-up transformers.
Medium Voltage Switchgear	33 kilovolt (kV) gas insulated switchgear (GIS) or air insulated switchgear (AIS) facilitating safe distribution and switching of AC power between PCS units and transformers.
Power Transformers	For voltage regulation

Table 3-1: BESS Key Components

3.3.2 Battery Specifications

Two (2) battery chemistries are under consideration for the Haden BESS Project: LFP and NMC. The technical specifications for LFP and NMC battery chemistry is shown in Table 3-2 and Table 3-3 respectively. Each offers distinct advantages in terms of technical performance, footprint, and operational longevity. The selection of technology will be finalised during the procurement phase based on technical, financial, and supply chain considerations.

Parameter	Value
POI Power Capacity	500 MW
POI Power Capacity	526 MVA (@ 0.95 pf)
POI Energy Capacity	2,000 MWh
BESS Plant Power Capacity (installed)	518 MW
BESS Plant Energy Capacity (installed)	2,185 MWh
Number of ESS Containers	437
Number of INV-TRF Containers	79
Plant Area Total	97,000 square metres (m ²)
Augmentation Area	10,000 m ²
Energy Density	225 megawatt-hours per hectare (MWh/ha)

Table 3-2: LFP Specifications

Parameter	Value
POI Power Capacity	500 MW
POI Power Capacity	526 MVA (@ 0.95 pf)
POI Energy Capacity	2,000 MWh
BESS Plant Power Capacity (installed)	518 MW
BESS Plant Energy Capacity (installed)	2,183 MWh
Number of ESS Containers	873
Number of INV-TRF Containers	79
Plant Area Total	162,000 m ²
Augmentation Area	10,000 m ²
Energy Density	134.7 MWh/ha

Table 3-3: NMC Specifications

3.3.3 Associated Facilities

A dedicated substation will be developed for the BESS facility. It will be designed to operate at a high voltage level and connected to the Saudi Electricity Company (SEC) substation via an underground transmission cable [4].

3.3.4 Operations and Maintenance Building

Additional infrastructure includes an Operations and Maintenance (O&M) and control building, staff and prayer facilities, ablutions and a maintenance workshop. The O&M building will accommodate Supervisory Control and Data Acquisition (SCADA) hardware, control systems, and facilities for operational personnel. The staff and prayer building will provide dining, ablution, and spiritual spaces, while the workshop will host spare parts, lifting equipment and maintenance tools.

3.3.5 Fencing

A perimeter fence with integrated security features will be constructed in accordance with High Commission for Industrial Security, which is a regulatory authority in Saudi Arabia responsible for developing and enforcing security, safety, and fire protection standards for industrial facilities, particularly in the energy, petrochemical, and utility sectors. The fence will consist of reinforced panels with low energy lighting, infrared CCTV coverage, motion detectors and appropriate warning signage. These measures aim to secure the site and reduce the risk of unauthorised access. Fire protection measures include both active (portable extinguishers, alarm systems) and passive (early smoke detection, fire compartmentalisation) systems.

3.3.6 Access and Internal Roads

Internal roads will be constructed to connect key facilities, with access provided via Road 4410 and an additional 4.8 km asphalt link. On-site drainage will follow natural gradients and connect with adjacent facilities for stormwater evacuation.

3.3.7 Uninterrupted Power Supply

The plant is structured such that the failure of any single rack or container will not impact the continued operation of the system. Uninterrupted Power Supply (UPS) backup ensures that control and monitoring systems remain operational during grid interruptions. The auxiliary power system is derived from the grid via a dedicated substation and includes transformers and UPS devices. Plant availability is targeted at 99.5%.

3.4 Activities throughout all Project Stages

3.4.1 Early Works and Construction

The principal construction activities and associated requirements related to civil and electrical works are listed below:

3.4.1.1 Site Clearance

The Project site will undergo site clearance and compaction to prepare the 0.5 km² area for development. This includes the removal of surface vegetation, levelling of terrain and disposal of debris if present. The surface will be compacted to a minimum of 95% of the Maximum Dry Density (MDD) for a stable base for foundations and infrastructure.

3.4.1.2 Road Construction (Access Roads and Internal Primary Roads)

The Project site is accessible via a branch road connected to Road 4410, which serves as the main regional access route to the area. From this point a new access road approximately 4.8 km in length will be constructed to reach the designated BESS site (Figure 3-3). This new section will be asphalt-paved and designed to support heavy construction and transport vehicles, including 40-foot container trucks and equipment trailers. The condition of the existing branch road and the new access alignment are suitable for year-round use, pending minor upgrades based on geotechnical survey results [5].

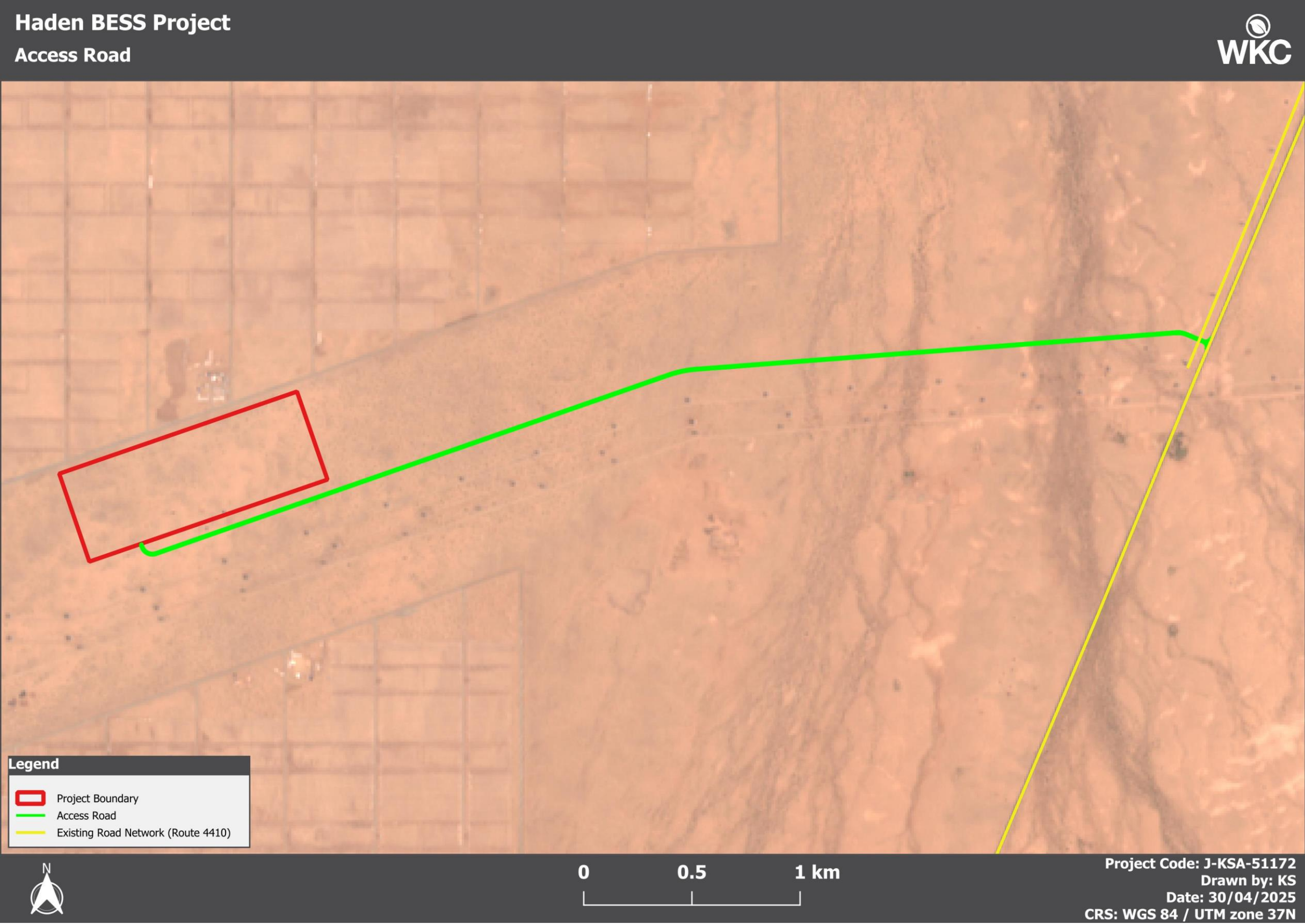


Figure 3-3: Proposed Site Access Road



The Project network will also include a network of internal roads for operational and maintenance purposes. The primary internal roads will connect the site entrance with infrastructure such as the O&M control buildings, PCS stations, and transformer yards. These roads will be constructed with a minimum width of 6 m and compliant with turning radius requirements for large vehicles including semi-trailers [5].

3.4.1.3 Substation Building Construction

The substation will be responsible for transforming and exporting the energy stored within the BESS to the national grid. It will include key infrastructure such as medium-voltage (MV) and high-voltage (HV) equipment, switchgear, protection and control systems [5].

The substation will house the following:

- MV switchgear;
- Power transformers;
- Ring Main Units (RMU) and auxiliary transformers; and,
- Relay and control panels.

3.4.1.4 Construction of Site Buildings

The Project includes construction of several essential buildings namely:

- O&M Building: The building will serve as the main operational hub for the Project. It is designed as a single-level reinforced concrete (RC) structure, constructed on compacted soil with RC footings and a monolithic RC slab;
- Staff and Prayer Building: The building is designed to support daily workforce needs and provide adequate space for rest, dining, and religious observance. It will also be built using reinforced concrete foundations and framing following the same construction approach as the O&M building; and,
- Workshop and Warehouse Building: This building will be used for the storage of spare parts and the maintenance of tools and equipment required for BESS system upkeep. It is a reinforced concrete structure with multiple-span framing.

3.4.1.5 Trenching and Cable Layering

The Project involves the installation of extensive underground cabling infrastructure to connect the various electrical components of the BESS. This includes the DC cabling from the battery containers to the PCS, AC MV cabling between PCS and MV switchgear, and control and communication cables integrated with SCADA and emergency management system (EMS). The cables used for this site will comply with the relevant international electrotechnical commission (IEC) and Saudi Electricity Company (SEC) standards [5].

Trenching will be carried out across the site to accommodate separate pathways for DC and AC MV cables. The trenching design is based on load, voltage class, and separation requirements between different cable systems as described below:

- DC cable trenches: These will have a typical width of 1 m, designed to house the positive and negative conductors from each ESS container to its corresponding PCS station; and,
- MV AC cable trenches: These will be 2 m wide, accommodating the 33 kV cables that run between MV switchgear, transformers, and interconnection points.

3.4.2 Operations and Maintenance

The BESS site is designed for an operational life of 20 years, depending on the selected battery technology. A comprehensive O&M strategy will be implemented to ensure the system operates reliably, safely, and in compliance with applicable technical, environmental, and grid standards.

Routine and preventive maintenance will be conducted in accordance with manufacturer specifications, OEM manuals, and best industry practices. Activities will be scheduled on a weekly, monthly, and annual basis and will include:

- Battery inspections and diagnostics, covering voltage and temperature balancing, state-of-health assessments, and recalibration of the Battery Management System;
- Thermal management system checks, particularly for liquid cooling loops and HVAC units, to maintain optimal internal conditions and minimise the risk of thermal runaway;
- Electrical system inspections, including cleaning, torque checks, insulation resistance testing, and thermal imaging of cable connections, switchgear and inverters;
- SCADA and EMS validation, to ensure real-time data accuracy, alarm responsiveness, communication integrity, and compatibility with evolving grid requirements;
- Servicing of active and passive fire protection systems, in line with HCIS and NFPA 855, including extinguishers, gas suppression units, smoke detectors and fire compartmentalisation;
- Auxiliary equipment maintenance, such as lighting, ventilation, drainage, and UPS systems critical for safe access and system resilience; and,
- Security infrastructure, including CCTV, access controls, and motion detectors, to be routinely tested and maintained under HCIS-compliant protocols.

The facility will be manned during core operating hours and remotely monitored on a 24/7 basis through a centralised SCADA system. A dedicated on-site control room will support real-time diagnostics and local intervention. A mobile maintenance crew will also be available for emergency callouts and corrective maintenance outside of planned schedules.

Personnel training will be provided regularly to ensure all staff are competent in BESS safety procedures, emergency response protocols, and the operation of high-voltage systems. Safety drills, system simulations, and refresher courses will be integrated into the operational calendar.

Waste management procedures will be developed for the responsible handling and disposal of maintenance-related waste, including battery modules, packaging materials, used oils, filters, and other consumables. Any hazardous waste will be collected and transported by licensed contractors in accordance with national environmental regulations.

Component upgrades or augmentations may be implemented over the plant's life to enhance capacity, address technology obsolescence, or align with evolving grid needs. Such interventions will follow engineering change protocols and be subject to environmental review where applicable.

Proper O&M activities will be required to ensure consistent performance in accordance with the grid requirements. The key O&M activities will include battery system inspection and calibration, cooling system maintenance, electrical system maintenance, fire detection and suppression system servicing and the maintenance of auxiliary systems (lighting, heating, ventilation, and air conditioning (HVAC) and site drainage systems) [5].

3.4.3 Decommissioning

Although the facility is designed for a minimum operational lifespan of 20 years, decommissioning planning will be undertaken in accordance with regulatory requirements and prevailing international best practices at the time of closure. While specific dismantling techniques and final land use options cannot be fully determined at this stage, the following principles will guide decommissioning:

- All electrical and battery equipment, including inverters, transformers, switchgear, and battery enclosures, will be de-energised, safely dismantled and removed from the site using appropriate handling techniques;
- Battery modules will be removed by trained personnel and either recycled, refurbished, or disposed of through licensed hazardous waste contractors in line with national regulations and manufacturer guidelines. Where feasible, materials such as aluminium, copper and lithium will be recovered for reprocessing;
- Foundations and ancillary infrastructure (e.g. fencing, O&M buildings, drainage systems) may be demolished or repurposed depending on post-closure land use agreements with relevant stakeholders; and,
- Site restoration will be implemented to return the land to a safe and stable condition. This may include backfilling, grading and, where appropriate, ecological rehabilitation or reversion to prior agricultural or undeveloped status.

A Decommissioning and Rehabilitation Plan will be developed and submitted to the appropriate KSA authorities prior to closure. This plan will outline environmental safeguards, stakeholder consultation mechanisms, workforce demobilisation procedures and a schedule for staged dismantling.

3.5 Project's Geographical Scope

The Project is located in Taif City located within the Makkah Region of KSA, approximately 205 km east of the Islamic Port of Jeddah. The nearest international airport is Taif International Airport which is located approximately 80

km northwest of the Project site. A desktop review undertaken for the Project area, indicated no active Bedouin camps within the Project area (this was confirmed through the site visit). The details of the geographic coordinates of each corner of the Project boundary are provided in Table 3-4.

Boundary Point ID	Geographic Coordinates (Decimal Degrees (°))	
	Latitude	Longitude
P1	21.553323	41.151038
P2	21.557006	41.149731
P3	21.560299	41.160389
P4	21.556607	41.161695

Table 3-4: Project Boundary Coordinates

3.6 Required Surface Area for the Project

To account for the different technological and geographical needs of the LFP and NMC configurations, two (2) layout options have been developed for the Project (Figure 3-4 and Figure 3-5). For the chosen battery type, each architecture takes into consideration the corresponding container quantities, energy density, and related infrastructure. The final layout will be confirmed following the technology selection during the procurement phase.



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Figure 3-5: NMC Layout



3.7 Types and Sources of Project Resources

3.7.1 Construction Stage

All construction activities will occur within the designated boundary of the BESS Project site. Machinery anticipated for use during construction includes:

- Graders;
- Compactors;
- Excavators;
- Wheel loaders;
- Cranes;
- Concrete mixers;
- Diesel generators;
- Trucks and trailers (including water and waste transporters); and,
- Forklifts.

Early works will involve site clearance, fencing, levelling, access road construction, and preparation of foundations for BESS enclosures and auxiliary buildings. Installation will include battery containers, PCS units, transformers, switchgear, and supporting civil infrastructure. Mechanical and electrical installation will be followed by system integration and pre-commissioning tests.

Site Access: The site will be accessed via Road 4410 with logistical support from Jeddah Islamic Port (~205 km) and Taif International Airport (~80 km).

Workforce: Peak construction workforce is estimated at up to 1,500 personnel, including civil workers, electrical and mechanical technicians, HSE officers, and supervisory staff.

3.7.1.1 Water Requirements

Concrete mixing, dust suppression, machinery cleaning: ~100–150 m³/day. Water will be sourced via authorised water tankers and stored on site.

3.7.1.2 Construction Materials and Inputs:

The assumed construction materials and quantities are listed below:

- Concrete: ~30,000–40,000 m³;
- Reinforcement Steel and Structural Steel: ~6,000–8,000 tonnes;
- Cabling (LV/MV/Control): ~600–900 km;
- Electrical Components: Switchgear, breakers, grounding systems;
- Diesel Fuel: ~15,000 tonnes over construction phase (for machinery and generators); and,
- Chemicals: Cement, admixtures, paints, lubricants, hydraulic fluids.



3.7.2 Operation and Maintenance Stage

The O&M phase will involve scheduled and corrective maintenance, monitoring of plant performance, safety inspections, and component replacement. These activities will be managed by on-site and remotely located technical staff.

3.7.2.1 Routine O&M Resources

- Spare parts: Inverters, BMS units, control systems, sensors;
- Coolants and HVAC fluids: ~10,000–15,000 litres/year;
- Fire suppression agents: ~500–800 kg/year;
- UPS batteries and backup system components;
- Lubricants and cleaning agents;
- Security and surveillance equipment;
- Power Supply: Power for auxiliary services and O&M activities will be drawn from the grid, with standby generators on-site;
- Water Requirements: Primarily for domestic use, HVAC support, and occasional equipment cleaning: ~33 m³/day; and,
- Wastewater Management: Domestic wastewater will be managed via the on-site STP or holding tanks, with removal by licensed contractors.

3.7.3 Decommissioning Stage

At end-of-life, the BESS will be decommissioned in accordance with a detailed plan to be submitted to the relevant Saudi authorities. The process will include:

- Dismantling of all battery units, PCS equipment, transformers, and structures;
- Removal and recycling of steel structures and cabling;
- Transportation of battery modules for reuse, recycling, or disposal by licensed firms; and,
- Site clearance and rehabilitation to a stable, safe condition.

3.7.3.1 Resources Required

- Lifting and cutting equipment;
- Water for dust suppression;
- Spill response kits; and,
- Vehicles and packaging for component removal.

3.8 Gas and Liquid Emissions, and their Reduction Methods

There is no gas emissions associated with the Project. During the construction, operations and decommissioning phases of the Project, liquid waste is expected to be generated from sanitary waste streams.

The treatment method has not been confirmed at this stage of the design.

Wherever possible, wastewater shall be recycled and used for dust suppression at the site. If wastewater is deemed contaminated or unable to be recycled and



reused at the site, then wastewater will be disposed by the approved Contractor to a licensed WWTP facility.

3.9 Solid Waste (Types and Methods of Disposal)

Waste generated over the life of the Haden BESS Project will be segregated by phase and type, with clear differentiation between hazardous and non-hazardous streams. All handling, storage, transport and disposal activities will comply with the regulations of the National Centre for Waste Management (MWAN) and relevant international obligations, including the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.

Waste will be transferred off-site only via licensed waste management contractors operating under valid authorisation from the relevant Saudi authorities. All final disposal or treatment locations, including sanitary landfills, recycling centres, and hazardous waste facilities, must be officially permitted and subject to regulatory inspection. The selection of contractors and disposal sites will be documented through the Project's Waste Management Plan (WMP).

Hazardous waste streams (such as spent battery modules, waste electrical and electronic equipment, fire suppression chemicals, and used oils) will be stored temporarily in dedicated areas with bunding, impermeable floors, ventilation, and fire protection. Collection and transportation of these materials will only be undertaken by approved hazardous waste carriers, with full manifesting and tracking to ensure traceability to final disposal or recovery.

Where export of hazardous waste (e.g. battery modules) is required for recycling at specialist international facilities, all shipments will be subject to the prior informed consent procedures of the Basel Convention. Export will only proceed:

- With prior notification to and consent from the receiving country;
- Via authorised routes and compliant packaging / labelling;
- Through licensed intermediaries with demonstrated capacity to recover or dispose of the waste safely;
- Limitations may apply in relation to;
- Restrictions on the export of waste containing certain heavy metals (e.g. cobalt, nickel);
- Temporary bans or controls imposed by receiving countries; and,
- Availability of authorised transboundary logistics partners.

A dedicated WMP will be developed and implemented throughout the project lifecycle. This will address:

- Waste minimisation and recycling measures;
- On-site storage and segregation protocols;
- Emergency spill response procedures; and,
- Contractor management, auditing, and legal compliance tracking.

The Project will maintain full records of all waste movements, including volumes, waste codes, transporter details, and final disposal certificates. These records will

be made available for review by regulators and form part of the ESMP. The expected waste quantities by phase and category are summarised in Table 3-5.



Project Phase	Waste Type	Estimated Quantity Range	Remarks	Assumptions
Construction	Concrete and steel offcuts	1,000–2,000 tonnes	Foundation waste, rebar and civil works trimmings	Based on ~30,000–40,000 m ³ concrete and steel volume of 6,000–8,000 tonnes
Construction	Packaging and domestic waste	200–400 tonnes	Wood pallets, plastics, food and hygiene waste	0.2–0.4 tonnes/worker/year × 1,500 workers
Construction	Hazardous fluids and materials	50–100 tonnes	Oils, hydraulic fluids, paint residues, used PPE	1% of 15,000 tonnes diesel and related chemical inputs
Operation	Spent battery modules	40–50 tonnes (lifetime)	Small proportion of modules replaced during operation	1% replacement of total 2,185 MWh (avg. 500 kg/MWh) over 20 years
Operation	Electronic waste (WEEE)	20–40 tonnes/year	SCADA systems, UPS, sensors, BMS units	Annual turnover of components typical for utility-scale O&M
Operation	Office and maintenance waste	30–60 tonnes/year	Packaging, HVAC filters, maintenance residues	Based on comparable facility outputs and expected maintenance volume
Decommissioning	Battery modules and electronics	1,000–1,100 tonnes	Full removal and replacement of battery systems	2,185 MWh × 500 kg/MWh = ~1,092.5 tonnes
Decommissioning	Structural scrap metals	6,000–8,000 tonnes	Racking, steel supports, container shells	Based on total installed structural materials
Decommissioning	Mixed demolition waste	500–1,000 tonnes	Inert debris, concrete footings, auxiliary building remnants	Based on site infrastructure scale and clearance requirements

Table 3-5: Anticipated Waste Quantities by Project Phase



3.10 Work Schedule

The following development milestones are anticipated based on the preliminary schedule:

- Early Works: 6 months;
- Construction: 36 months;
- Commissioning: 6 months;
- Operations: 20 years; and,
- Decommissioning: 6 months at end of the operation period.

3.11 Project Scale

The Project covers an area of 0.5 km² within the permitted boundaries of Haden PV Park. The Project is designed to support grid stability and enhance renewable energy integration, providing approximately 2,000 MWh of interconnection energy capacity with an energy storage capacity of 2.185 GWh.

3.12 Alternatives to the Activity

3.12.1 Methodology

A structured approach was applied to evaluate the alternatives for the Haden BESS Project. This involved identifying, screening, and assessing the viability of alternatives in terms of environmental performance, technical feasibility, socio-economic benefit, cost-effectiveness, and compliance with regulatory frameworks.

The alternatives analysis was guided by:

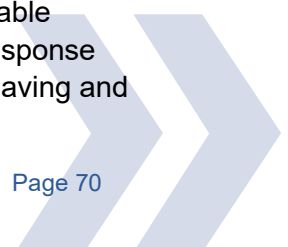
- Environmental impact: minimisation of land take, emissions, waste, and fire risk;
- Technical viability: proven utility-scale battery chemistries, plant availability, and grid compatibility;
- Stakeholder considerations: alignment with national renewable energy targets under NREP and regional land-use constraints; and,
- Economic performance: lifecycle cost optimisation and modular deployment flexibility.

3.12.2 Alternative to “No Activity (Project) / “No Amendment”

Under the “no project” scenario, the site would remain as an undeveloped parcel of land within the larger Haden PV Park, and the proposed BESS would not be implemented. While this would eliminate all construction-phase impacts, it would result in the loss of the energy system, environmental, and socio-economic benefits that the project is designed to deliver.

Key implications of this scenario include:

- Reduced national energy resilience: Without the BESS, the national grid’s ability to absorb and manage increasing volumes of variable renewable energy would remain as is. The BESS is intended to provide fast-response reserve capacity, support frequency regulation, and deliver peak shaving and



load shifting—services essential to maintaining grid stability as solar generation expands;

- Continued reliance on fossil-based generation: In the absence of battery storage, grid operators would need to continue relying on fossil-fuel peaker plants to meet short-term balancing requirements. These conventional plants typically have higher greenhouse gas emissions and lower operational efficiency, contrary to the objectives of Saudi Arabia’s clean energy transition;
- Undermining of Vision 2030 and NREP targets: The project forms part of the NREP and supports Vision 2030 goals by facilitating large-scale renewable energy integration. Cancelling or deferring the BESS would delay progress on these strategic commitments and reduce the system’s readiness for higher renewable energy penetration;
- Loss of co-location and infrastructure efficiencies: The BESS is designed as a co-located asset within the boundary of Haden PV Park facility. Its development would capitalise on shared infrastructure including access roads, substations, and interconnection points. If not implemented alongside Haden PV Park facility, future standalone storage would require duplicative infrastructure and potentially higher environmental and financial costs; and,
- Environmental opportunity cost: The BESS would enable greater utilisation of zero-carbon solar electricity by storing surplus generation and dispatching it during periods of peak demand or low irradiance. Without this capability, fossil-fuel generation would fill the gap, increasing cumulative emissions. Moreover, the proposed BESS location lies within the approved Haden PV Park site boundary and has already been assessed through the prior ESIA. No sensitive ecological, hydrological, or heritage features were identified in the baseline studies, confirming the site’s suitability for low-impact development. Failing to utilise this pre-screened, environmentally compliant site would represent a missed opportunity to maximise the benefit of approved renewable land use.

Given these considerations, the “no project” alternative is not regarded as a sustainable or strategic option. It would constrain the flexibility and resilience of the national power system, delay emissions reductions, and reduce the socio-economic returns from the energy transition.

3.12.3 Location Alternatives

The BESS is strategically located within the boundary of the approved Haden PV Park facility. This integrated siting approach ensures direct coupling with the generation asset, enabling effective load shifting, frequency regulation, and renewable firming functions. As the BESS is designed to serve Haden PV Park, its location within the same development footprint is functionally required and operationally optimal.

Alternative locations outside Haden PV Park boundary were not considered viable due to the need for dedicated land acquisition, additional permitting, and new transmission infrastructure, all of which would introduce complexity, increase costs, and elevate environmental and social risks.



Within Haden PV Park site, the BESS footprint was selected based on the following spatial planning considerations:

- Access: Positioned adjacent to the internal road network to facilitate delivery logistics, maintenance access, and emergency response.
- Land-use efficiency: Sited outside areas allocated for PV arrays, avoiding high-insolation zones and preserving the generation potential of the site.
- Site suitability: Established on terrain with limited grading requirements, avoiding drainage paths and technical exclusion zones, thereby reducing site preparation needs.
- Critically, no environmental constraints were identified at the BESS location during the baseline surveys conducted for Haden PV Park facility ESIA. Aspects screened in line with IFC Performance Standards included:
 - » Biodiversity and critical habitat: No priority species, sensitive habitats, or ecologically significant features were recorded;
 - » Land use and tenure: The site comprises government-controlled, undeveloped desert terrain with no agricultural, residential, or industrial uses;
 - » Cultural heritage: No archaeological or heritage resources were identified within or near the BESS footprint;
 - » Community health and safety: The site lies more than 30 km from the nearest settlements, eliminating concerns related to noise, air emissions, or visual intrusion; and,
 - » Natural hazards and hydrology: The area is not flood-prone and exhibits no geomorphological instability.

The use of land already subject to environmental assessment and permitting, combined with its low environmental sensitivity, supports a low-risk profile for the BESS component and enables streamlined implementation under the existing regulatory framework.

3.12.4 Technical Alternatives

The Project will proceed with either LFP or NMC battery technology, both of which are well-established in utility-scale applications.

3.12.4.1 Preferred Technologies: LFP and NMC

Both LFP and NMC technologies were retained through the conceptual design stage of the Haden BESS Project. Each was technically configured for a total installed energy capacity of approximately 2,185 MWh, designed to integrate with the co-located Haden PV Park facility and the SEC grid. These configurations ensure full compatibility with site infrastructure, operational requirements, and applicable regulatory standards.

LFP technology is widely favoured for utility-scale storage due to its safety profile, high thermal stability, and extended cycle life. It offers notable environmental benefits by avoiding the use of cobalt and nickel, which reduces both ecological impacts and supply chain risks. For the Haden BESS Project, each LFP container delivers 5 MWh of capacity, requiring 437 containers to achieve the full plant

capacity. This results in a total footprint of 97,000 m², making LFP the more space-efficient option when assessed at the site level. Although LFP has a slightly lower gravimetric energy density than NMC, its higher container-level capacity results in a reduced physical footprint.

NMC remains a technically viable alternative and is recognised for its higher gravimetric energy density, which can be beneficial in applications where mass or volume constraints dominate. However, in this project context, each NMC container provides only 2.5 MWh of capacity. Consequently, 873 containers would be required, expanding the overall site footprint to 162,000 m² to match the same installed energy capacity. This increased spatial demand results in greater complexity for layout planning, civil works, and long-term operation and maintenance. Additionally, the inclusion of cobalt in NMC chemistry may present sourcing challenges, and it is prone to thermal runaway under fault conditions.

Both LFP and NMC technologies have been assessed as compliant with relevant regulatory and performance requirements. The final selection will be made during the procurement phase, based on current market availability, pricing, vendor specifications, and detailed lifecycle assessments. Selection will be guided by the need to optimise environmental performance, operational safety, and cost-efficiency across the project lifecycle.

The detailed technical specifications for the LFP and NMC options are presented below.

Parameter	LFP Specification	NMC Specification
POI Power Capacity	500 MW	500 MW
POI Power Capacity	526 MVA (@ 0.95 pf)	526 MVA (@ 0.95 pf)
POI Energy Capacity	2,000 MWh	2,000 MWh
BESS Plant Power Capacity (installed)	518 MW	518 MW
BESS Plant Energy Capacity (installed)	2,185 MWh	2,185 MWh
Number of ESS Containers	437	873
Number of INV-TRF Containers	79	79
Plant Area Total	97,000 m ²	162,000 m ²
Augmentation Area	10,000 m ²	10,000 m ²
Energy Density	225 megawatt-hours per hectare (MWh/ha)	134.7 MWh/ha

Table 3-6: LFP and NMC Specifications



3.12.5 Comparison of Alternatives

The assessment of alternatives for the Haden BESS Project has considered a range of scenarios, including the no-project case, alternative locations, and a suite of battery technologies.

No Project: This alternative would avoid construction-phase impacts but would forego key energy system services such as load shifting, frequency regulation, and renewable firming. It would also forfeit co-location efficiencies, delay emissions reductions, and undermine strategic goals under Vision 2030 and the NREP.

Alternative Locations: Dismissed due to the need for additional permitting, land acquisition, and infrastructure duplication. As the BESS must directly serve Haden PV Park facility, its location within the same boundary is functionally required. The selected site has been assessed through Haden PV Park ESIA and confirmed to be environmentally low-risk, with no constraints related to biodiversity, heritage, land use, or hydrology.

Crucially, the Haden BESS site was selected not only due to its topographic suitability, logistical accessibility (via Road 4410 and proximity to Jeddah Islamic Port and Taif International Airport), and government pre-allocation through MoMAH, but also because it is situated in Taif City located in a part of the Makkah Region identified as underserved in terms of reliable power provision. The area lies approximately 38 km southeast of Ateef city and 35 km southwest of Harman city, both of which are poised for growth and require enhanced grid resilience and capacity. The site's strategic location supports national energy security objectives and enhances system resilience in a priority region.

Preferred Technologies: LFP and NMC were retained and technically configured for the project. Table 4-1 provides a comparative summary of both options based on project-specific engineering data.

The comparative assessment confirms that the “no project” and offsite location scenarios are neither strategic nor sustainable. LFP is technically preferred due to its superior safety, environmental profile, and spatial efficiency, although both LFP and NMC remain viable. The final technology decision will be confirmed at the procurement stage, but both options are compatible with the project's technical, environmental, and regulatory framework. The site itself represents an optimal convergence of policy, infrastructure, and regional energy planning considerations.



4 DESCRIPTION OF THE SURROUNDING ENVIRONMENT

The following Chapter provides a description of the existing environmental conditions at or near to the Project site, as the Project activities intended may affect the surrounding environment.

A description of the existing environmental baseline conditions presented in this chapter is drawn largely from the following:

- An ESIA report was prepared in 2022 for Haden PV Park development area,
- A PSA was conducted on 15th April 2025. The PSA report is included in Annexure E;
- Air (12th and 13th May 2025) and noise (14th and 15th May 2025) baseline surveys were undertaken by a third-party NCEC-registered subcontractor. The third party's NCEC registration certificate, ambient air quality baseline survey report and noise baseline survey report are presented in Annexures C, F and G, respectively;
- Geotechnical investigations for Haden PV Park project were conducted during 19th - 24th September 2021;
- A hydrological and flood assessment was conducted in 2021 for Haden PV Park; and,
- A desktop review of freely available, published information on the Project site.

4.1 Physical Environment

4.1.1 Air Quality

Air quality refers to the composition of gases and particles in the atmosphere, and it has direct implications for human health and the environment. Poor air quality can lead to respiratory and cardiovascular diseases and affect ecosystems. It is typically measured by the concentration of pollutants such as particulate matter (PM), ozone (O₃), nitrogen dioxide (NO₂), sulphur dioxide (SO₂), and carbon monoxide (CO), among others. NO₂, SO₂, CO and fine PM (PM_{2.5}) are primarily generated from combustion processes. According to the United Kingdom Institute of Air Quality Management (UK IAQM), dust is defined as solid particles suspended in the air or settled on a surface after being airborne.

4.1.1.1 Existing Data

An ambient air quality survey for Haden PV Park was undertaken to assess air quality at the project site. The methodology for locating air measurements within the site involved selecting representative sites for sampling, considering wind direction, to understand the impact of on-site activities and emissions from surrounding facilities [6].

Three (3) US-EPA approved air quality monitoring stations (AQMS) were set up on 7th February 2022, approximately 2 km apart within Haden PV Park. These stations measured O₃, NO₂, SO₂, CO, and particulate matter (Particles < 2.5 micron (PM_{2.5}) and Particles < 10 micron (PM₁₀)). Data from the monitoring

stations were measured over a 24-hour period as hourly averages and compared against the NCEC air standards [6]. The coordinates of the AQMS are provided in Table 4-1.

AQMS ID	Geographic Coordinates (Decimal Degrees (°))	
	Latitude	Longitude
P1	21.54851683	41.16769772
P2	21.52884385	41.14237078
P3	21.51658093	41.11042168°

Table 4-1: Coordinates of the Ambient Air Quality Monitoring Stations – Existing Data

Based on the air quality measurement results from the monitoring stations, no deviations or exceedances were observed for any of the parameters when compared to the standards [6].

4.1.1.2 Site Visit Results

As observed during the site visit undertaken on 5th April 2025, the Project area is largely underdeveloped wherein the existing high tension (HT) overhead transmission line, existing asphalt road that provides access to the Project site for about 8 km, and the dirt road providing access to the site for a further 4 km are the prominent land use features. Sources of anthropogenic air emissions would be from vehicles utilising the asphalt road and dirt road [4].

4.1.1.3 Ambient Air Quality Baseline Survey

A short-term ambient air quality survey was undertaken by a third-party NCEC-registered subcontractor as part of the air quality baseline studies required for the Project on 12th and 13th May 2025. The subcontractor's contact details and NCEC registration certificate is included in Table 4-2 and Annexure C of this ESIA report, respectively.

Company Name:	Element Saudi Arabia Company Limited (Element)
Company Commercial Registration Number:	2050116606
Address:	P.O. Box 31775 Al Khobar 31952 Dammam KSA
Principal Business:	Environmental Monitoring and Analysis Services
Point of Contact:	info.saudiarabia@element.com Tel: +966 (0) 13 812 7750 Fax: +966 (0) 13 812 1837

Table 4-2: Contact Details of NCEC-Registered Subcontractor

4.1.1.3.1 Methodology

Given the small size of the Project site, one (1) ambient air quality monitoring location (AAQML) was monitored for a duration of 24 hours to establish and

assess baseline air quality conditions and meteorological data as well as assess compliance against the NCEC AQ Regulations using a USEPA reference air quality monitoring station (AQMS) [7]. Air quality was also assessed as part of Haden PV Park ESIA conducted in February 2022 (refer to Section 4.1.1.1). A summary of the methodology is presented in Table 4-3.

Pollutants and Equipment to be Used	▪ Particulate Matter < 10 µm (PM₁₀) ▪ Particulate Matter < 2.5 µm (PM_{2.5}) ▪ Sulphur Dioxide ▪ Nitrogen Dioxide ▪ Carbon Monoxide ▪ Ozone
Meteorological Parameters	▪ Wind Speed ▪ Wind Direction ▪ Relative Humidity ▪ Temperature
Equipment	Vair 9009, Mezus Analyser, VM 8000
No. Instruments	1
No. Locations	1
Duration (per location)	24 hours

Table 4-3: Ambient Air Quality Monitoring Specifications

The Project site is an undeveloped, remote, arid desert area with no significant land use types influencing air quality. Additionally, the Project area has very low human presence. The closest urban settlements are Ateef, located about 38 km to the northwest, and Harman, approximately 33 km to the northeast. The surrounding landscape is characterised by open terrain with minimal anthropogenic activities in the immediate vicinity.

Data was recorded continuously for 24 hours at the monitoring location and was used to derive short-term averages for comparison with the relevant NCEC ambient air quality standards (AAQS). The coordinates of the AAQML are provided in Table 4-4 and its location is presented in Figure 4-1.

AAQML ID	Geographic Coordinates (Decimal Degrees (°))	
	Latitude	Longitude
AAQML 1	21.556890	41.155756

Table 4-4: Coordinates of Ambient Air Quality Monitoring Location





Figure 4-1: Ambient Air Quality Monitoring Location

4.1.1.3.2 Results

The meteorological conditions recorded at the monitoring location is detailed in Table 4-5 and the ambient air quality survey results are detailed in Table 4-6 to Table 4-8. The ambient air quality results do not represent an annual dataset, thus have not been used for a direct comparison to the annual average concentrations. However, the results are indicative of the relevant averaging periods used for the standards and therefore can be compared to the 1-hour, 8-hour and 24-hour averaging periods.

Results are well below the applicable NCEC AAQS, demonstrating that the air quality is representative of a rural desert site [7]. The ambient air quality baseline survey methodology and results are further detailed in Annexure B.

The Project site is located in a predominantly undeveloped and remote desert area, with minimal local pollution sources [7]. The nearest potential contributor, Highway 4440, lies approximately 7 km from the Project site. However, its influence appears to be negligible based on low pollutant levels recorded [7]. During the monitoring period, the Project area was classified as clean and largely unaffected by anthropogenic emissions [7].

The following parameters were measured: NO₂, SO₂, O₃, PM₁₀, PM_{2.5}, and CO. Results were compared against the NCEC air quality standards where applicable.

- NO₂ (1-hour average):
 - » AAQML 1: 42 µg/m³; and,
 - » All values are significantly below the NCEC limit of 200 µg/m³.
- SO₂ (1-hour average):
 - » AAQML 1: 19 µg/m³;
 - » All values are significantly below the NCEC limit of 441 µg/m³.
- SO₂ (24-hour average):
 - » AAQML 1: 13 µg/m³; and,
 - » All values meet the NCEC standard (217 µg/m³).
- O₃ (8-hour average):
 - » AAQML 1: 37 µg/m³; and,
 - » All values comply with the NCEC limit of (157 µg/m³).
- PM₁₀ (24-hour average):
 - » AAQML 1: 90 µg/m³; and,
 - » All values are well within the NCEC limit (340 µg/m³).
- PM_{2.5} (24-hour average):
 - » AAQML 1: 20 µg/m³; and,
 - » All values are below the NCEC limit (35 µg/m³).
- CO (8-hour average):
 - » AAQML 1: 145 µg/m³; and,

- » All values are well below the NCEC standard of 10,000 $\mu\text{g}/\text{m}^3$.



Parameter	Temperature	Relative Humidity	Wind Direction	Wind Speed
Unit	°C	%	Deg.	m/s
AAQML 1	28	20	147.9 SSE	1.7

Table 4-5: Meteorological Conditions Recorded at AAQML1 and AAQML 2 [7]

Parameter	CO	NO ₂	SO ₂	PM ₁₀	PM _{2.5}	O ₃
Unit	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³	µg/m ³
AAQML 1	119	21	13	90	20	29
NCEC Standard	-	-	217	340	35	-

Table 4-6: Average Ambient Air Quality Results for the 24-hour Average Period [7]

Parameter	CO	O ₃
Unit	µg/m ³	µg/m ³
AAQML 1		
15:00 - 23:00	145	37
23:00 - 07:00	117	29
07:00 - 15:00	97	23
NCEC Standard	10 000	157

Table 4-7: Average Ambient Air Quality Results for the 8-hour Average Period [7]

Parameter	NO ₂	SO ₂
Unit	µg/m ³	µg/m ³
AAQML 1		
5/12/2025 16:00	20	17
5/12/2025 17:00	23	15
5/12/2025 18:00	26	16
5/12/2025 19:00	30	13
5/12/2025 20:00	37	13
5/12/2025 21:00	42	11
5/12/2025 22:00	39	3

Parameter	NO ₂	SO ₂
5/12/2025 23:00	33	3
5/13/2025 00:00	28	16
5/13/2025 01:00	25	18
5/13/2025 02:00	22	19
5/13/2025 03:00	21	19
5/13/2025 04:00	19	17
5/13/2025 05:00	18	17
5/13/2025 06:00	17	14
5/13/2025 07:00	15	14
5/13/2025 08:00	14	12
5/13/2025 09:00	13	9
5/13/2025 10:00	12	6
5/13/2025 11:00	10	4
5/13/2025 12:00	9	1
5/13/2025 13:00	10	17
5/13/2025 14:00	12	18
5/13/2025 15:00	15	17
NCEC Standard	200	441

Table 4-8: Average Ambient Air Quality Results for the 1-hour Average Period [7]



4.1.2 Meteorology and Climate

4.1.2.1 Methodology

A desktop study using existing information was used to supplement the meteorology and climate section, covering the Haden area.

4.1.2.2 Results

The climate across the majority of Saudi Arabia is typically hot and dry with virtually no rainfall and is classified as BWh (hot, arid desert) under the Köppen Classification of global climatic zones (Figure 4-2). The Haden Project is located in the western of Saudi Arabia.. The Haden area has a mean annual temperature of 25.4 °C, and an annual average rainfall of 51.7 mm [8]. The data provided for the Haden area is based on 30 years with a spatial resolution of approximately 30 km.

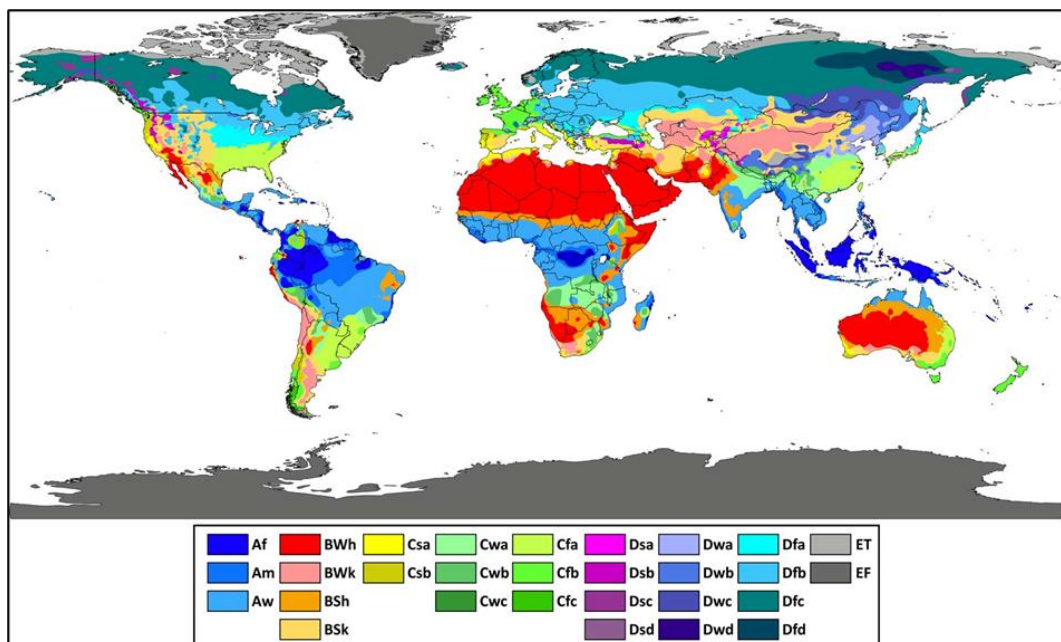


Figure 4-2: World Distribution of Climate Types based on Köppen Classification [9]

4.1.2.2.1 Temperature

The climate in the Haden area is an arid desert climate with significant seasonal temperature variations. The mean daily maximum temperature ranges from 24°C in January to 37°C in June, while the mean daily minimum temperature varies between 10°C in January and 25°C in July. Extreme conditions are reflected in the average hottest days reaching up to 40°C during summer and the coldest nights dropping to 5°C in winter [8].

Figure 4-3 illustrates the temperature trends for the Haden area, showing both the average and extreme conditions based on data from the last 30 years [8]. The solid red line represents the mean daily maximum temperature, indicating the typical high temperature for each month. Similarly, the solid blue line depicts the

mean daily minimum temperature, reflecting the typical low temperature for each month [8].

For a broader perspective on temperature extremes, the dashed red line shows the average hottest day of each month, while the dashed blue line displays the average coldest night of each month. This is based on data from the last 30 years [8].

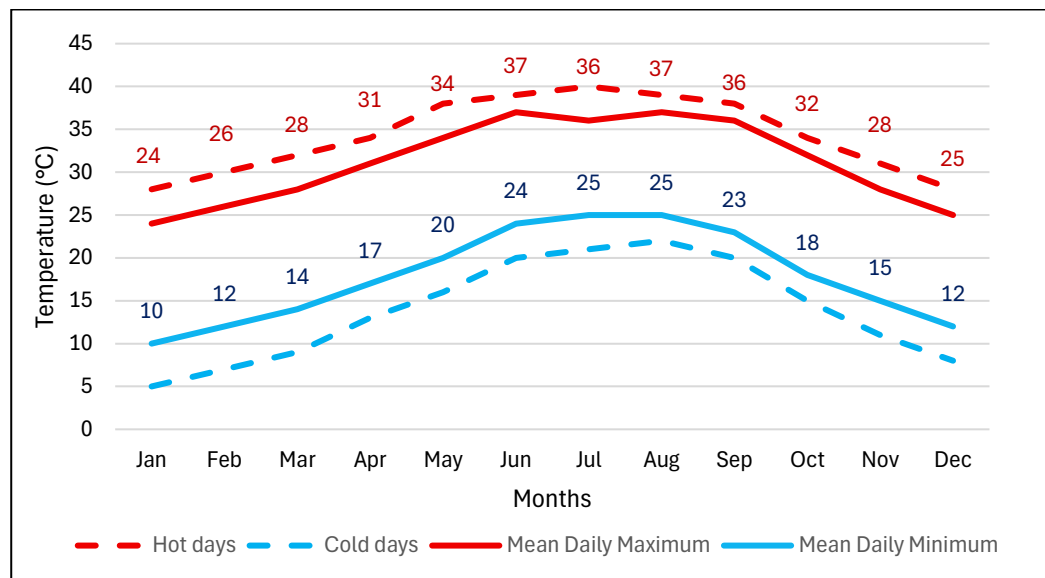


Figure 4-3: Average Temperature [8]

4.1.2.2.2 Rainfall

From Figure 4-4 below, the Haden area experiences low rainfall, which is a characteristic of an arid desert climate. Monthly precipitation peaks in April at approximately 26 mm, followed by March, and January, which receive a precipitation of 12 mm, and 11 mm, respectively. Rainfall is minimal to negligible from June through October, with nearly no precipitation during the summer months. It is important to note that much of the annual rainfall often occurs over relatively short periods of time during intense storm events [8].

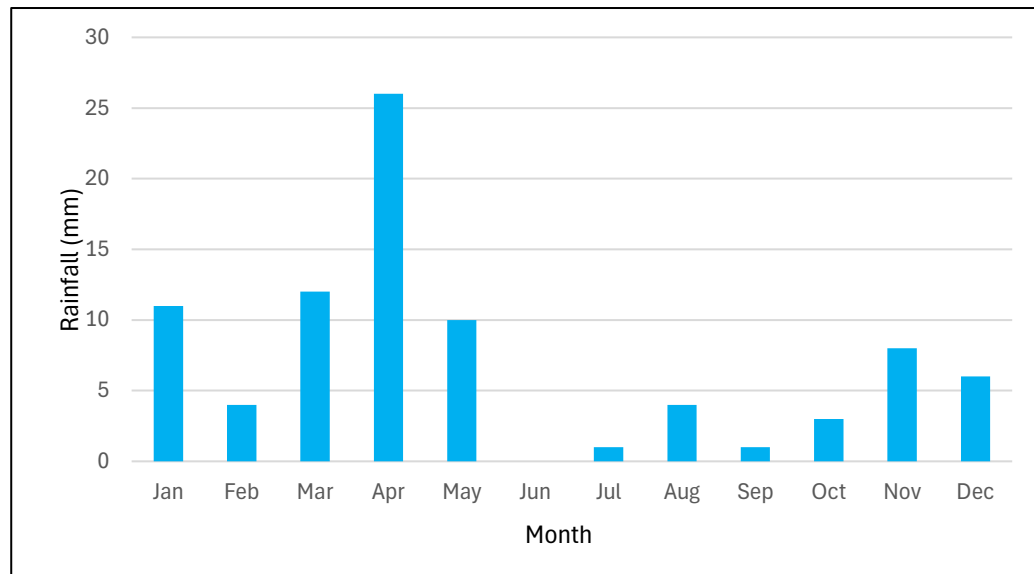


Figure 4-4: Average Precipitation [8]

4.1.2.2.3 Wind Speed and Direction

Generally, wind flows across KSA tend to blow from the north, northeast and northwest directions. Strong winds frequently occur during both winter and summer, causing sandstorm conditions known locally as 'Shammals'. Winter Shammals typically present with higher wind speeds, but summer Shammals tend to persist for a longer period.

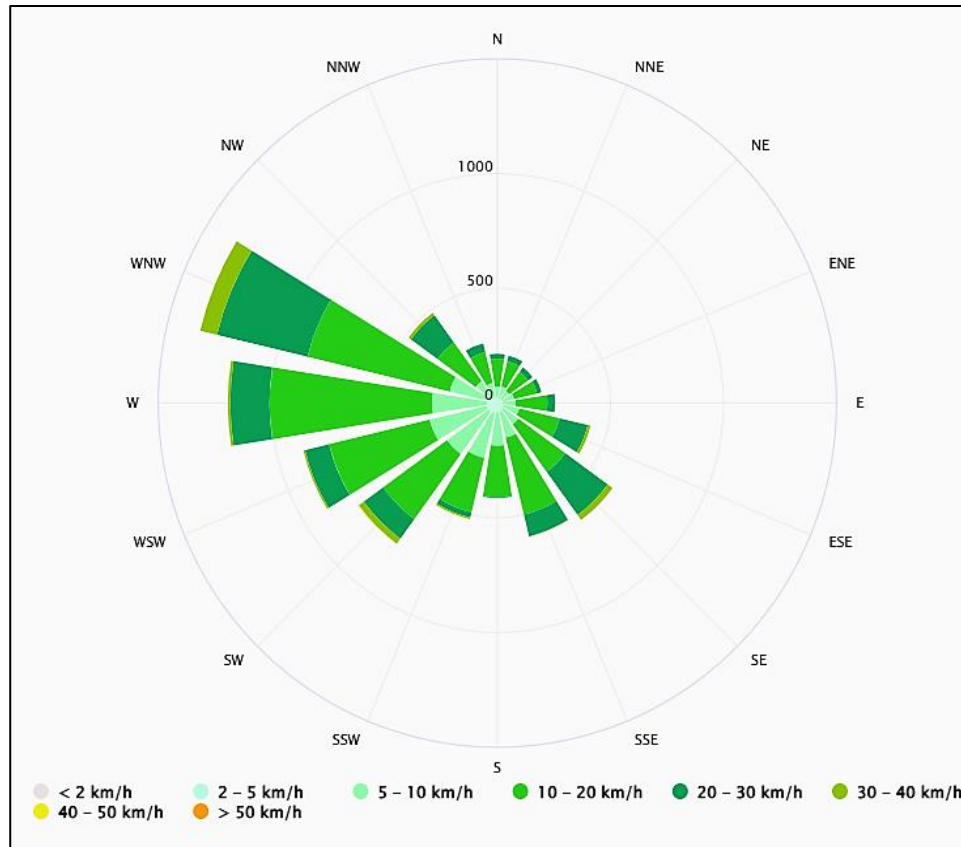


Figure 4-5: Wind Rose for the Haden area [8]

Wind roses as shown in Figure 4-5 comprise of 16 spokes, which represent the directions from which winds blow during a specific period. The colours on the wind rose indicate the different classes of wind speeds. The wind rose for the Haden area represented in Figure 4-5, illustrates the distribution of wind direction and speed over a year (2024). It represents the number of hours per year the wind blows from the indicated direction. The prevailing winds predominantly originate from the northwest, west, southwest, and southeast directions, with the most frequent wind speeds falling within the 10 - 20 km/h range, followed by 20 - 30 km/h. Winds from the north, northeast, east, and south directions occur less frequently and at lower speeds.

Higher wind speeds within the range 30 - 40 km/h are less frequent than lower speed winds; however, they remain significant due to their potential influence on dust dispersion, vegetation stress, and structural considerations. The wind rose illustrates a prevailing wind direction, indicating a consistent wind regime that aligns with the broader climatic characteristics of the Haden area, where stable wind patterns are largely influenced by the region's geographical setting and prevailing climate conditions [8].

4.1.3 Water: Groundwater, Seawater, Stormwater, Clean Water for Domestic Purposes and Drinking Water

Groundwater in Saudi Arabia is primarily within thick, permeable aquifers of large sedimentary basins across the northern and eastern parts of the country. The fractured Precambrian crystalline rocks of the Arabian Shield in the west play a

crucial role in generating surface runoff and localised, shallow wadi underflow. The Arabian Shelf, a vast area covering about two-thirds of Saudi Arabia (1,485,00 km²). These aquifers, formed predominantly of limestone and sandstone, vary in thickness from a few hundred to over 5,000 m and generally dip eastward from their outcrops in the west. Groundwater is stored in more than 20 principal and secondary layered aquifers of varying geological ages [6].

Aquifers in the north are characterized by multiple, permeable Lower Palaeozoic arenaceous formations interdigitated with impermeable argillaceous strata. Most of the aquifers in the east consist of both karstified Tertiary carbonates and Mesozoic to basal Palaeozoic arenaceous formations. A single, thick basal Lower Palaeozoic sandstone formation in the south of the Arabian Shelf constitutes a high-yield aquifer [6].

A significant portion of the groundwater stored in deep sedimentary aquifers, with the exception of the Basalts and Wadi Sediments, is considered non-renewable fossil water. Estimated groundwater reserves to a depth of 300 m below ground surface are approximately 2,185 cubic kilometres (km³), with a total annual recharge of 2,762 mega cubic metres (Mm³). Renewable groundwater resources are primarily found in shallow alluvial aquifers and within Basalt formations, predominantly located in the southwestern parts of the country. These shallow aquifers, with varying thickness and width, store about 84,000 Mm³ and have an estimated average annual recharge of 1,196 Mm³. The total national groundwater reserves in both shallow and deep aquifers to a depth of 300 m are estimated at approximately 2,259 km³ [6].

These combined renewable and non-renewable resources represent a crucial and dependable water source for various purposes, including irrigation in the Kingdom, provided they are managed effectively [6].

The Project (located within the permitted Haden PV Park) is situated in Taif City located in the Makkah region to the east of the Hijaz Mountain Range, northeast of Taif City in an interior watershed. The area is flat with higher elevations present in the southwest causing water to flow from east to northwest. Additionally, the site is situated near two (2) hydrologic depressions [6].

4.1.3.1 Existing Data

A geotechnical site assessment for Haden PV Park was conducted from January to February 2022 [10]. This assessment included drilling 16 boreholes to a depth of 10 m and 160 linear m to investigate the lithological section and geotechnical parameters of different soil layers. It was found that no groundwater table was encountered up to the maximum investigated 10 m depth [10].

A geotechnical and geophysical site investigation conducted for Haden PV Park Substations (SS) and Control Centre regions (CC) between 22nd July 2024 and 3rd August 2024 involved drilling 46 boreholes with a total depth of 690 m [11]. Additionally, standard penetration tests (SPTs) were also performed. As concluded for the geotechnical site assessment, no groundwater level was encountered in any of the drilled boreholes.

Given the nature of the proposed Haden BESS Project as a containerised battery energy storage facility, there is no significant expectation of interaction between

the Project and the underlying groundwater resources. The Project does not involve activities such as deep excavations, significant water abstraction, or subsurface discharges that would typically warrant further groundwater investigations.

Based on the existing geotechnical data and the limited potential for groundwater interaction associated with the Project design, no additional groundwater baseline surveys are considered necessary. The existing data is deemed sufficient to support the groundwater baseline characterisation for the purposes of the ESIA.

4.1.3.2 Site Visit Results

4.1.3.2.1 Hydrology and Surface Water

The Project is situated within a sub-catchment of the 600 km long Wadi al-Rummah. The catchment area draining to the Project site is estimated at approximately 285 km².

Geographically, the area is characterized by flat, arid terrain with low relief and sparse vegetation cover. The regional climate is classified as hyper-arid, receiving annual rainfall significantly below 100 millimetres (mm). Precipitation primarily occurs in short, localised storm events between November and April. Evaporation rates greatly exceed precipitation with no permanent surface water bodies existing within the region [4].

The Project site lies within a broad, endorheic drainage basin. Surface runoff is limited and conveyed via a network of ephemeral drainage channels (wadis) that activate only during rare rainfall events visible at the Project site [4].

Based on the site visit conducted, no permanent rivers, lakes or wetlands were observed within 10 km of the Project site. However, review of satellite imagery and topographic maps indicated the presence of wadi channels intersecting the Project area. These wadis are ephemeral and are typically dry during most of the year. Additionally, they may carry floodwater during rare rainfall events for a few hours up to several days. Ponding or sheet flows can also occur during intense rainfall events. Given the flat topography of the area, main catchment areas are diffuse with poorly defined drainage patterns apparent [4].



Figure 4-6: Absence of Surface Water and Drainage Channels at the Project Site

4.1.3.2.2 Groundwater

Probable salinity and depth indicate that no groundwater is expected to be a primary water source for either Haden PV Park or the Haden BESS Project. No groundwater table was encountered up to a maximum depth of 10 m [4].

4.1.3.2.3 Water Infrastructure and Use

The Project Site lacks connection to any municipal or industrial water supply networks. Consequently, water required during Project construction and operation phases will necessitate external sourcing. Potential supply methods include water transported via trucks, through modular desalination or treated water supply, if deemed feasible [4].

Similarly, there is no existing wastewater infrastructure, such as pipelines, treatment plants or discharge infrastructure in the vicinity of the site. Therefore, all wastewater and drainage generated onsite will require management through self-contained treatment and disposal systems. Particular attention will be needed for managing water used for any BESS auxiliary systems such as cooling or fire suppression systems [4].

Water required for the Project construction and operation phases will be transported by water tankers from Taif City [4].



4.1.3.2.4 Flood Risk and Drainage

As mentioned in 4.1.3.2.1, the Project area is flat. As a result, partial flooding (ponding) may occur in areas during extreme rainfall events. Consequently, the proposed BESS area may be subject to a light flood hazard associated with such ponding. It is recommended that the BESS system be raised onto pads so that they will be elevated 300 mm above the 1-in-100-year (Q100) flood waters and / or 500 mm in worst case scenarios.

Flood hazard was evaluated for the 100-year return period as part of hydrological studies for Haden PV Park, revealing a low flood risk (H1) for the area in which the current Project is situated, as shown in Figure 4-7 [4].

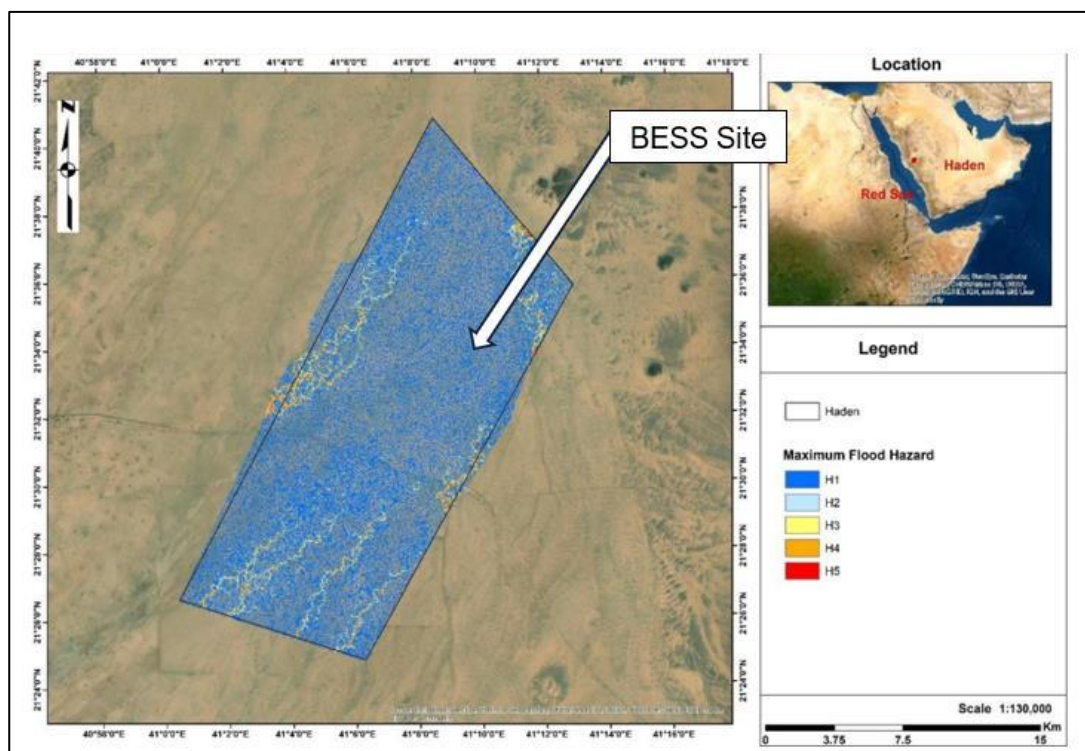


Figure 4-7: Low Flood Risk Evaluated for the Project Site [6]

4.1.4 Waste

4.1.4.1 National Waste

With a population of 33 million, Saudi Arabia generates at least 15 million tonnes of solid waste on a yearly basis, most of which ends up untreated and landfilled. Dammam, Jeddah and Riyadh Municipalities exceed a million tonnes per annum (Ministry of Municipal and Rural Affairs, 2019).

Although local municipalities and some private companies manage solid waste collection, waste management involves the majority of municipal solid waste (MSW) going to landfills and combustion facilities (Ministry of Municipal and Rural Affairs, 2019) (Anjum, et al., 2016). Once the landfill sites are full, the land typically cannot be used for other purposes. It is acknowledged that, historically, waste management infrastructure and facilities in the Kingdom have been limited.

On average, within the Kingdom, MSW consists mainly of organic wastes (40%), out of which food waste is the prominent waste stream (50.6%). Plastic is the second-largest stream found in the MSW (between 5-17%). Further components found in the waste stream include textile (6.4%), glass (4.6%) and minerals (8.1%) (Anjum, et al., 2016).

Some of the bigger waste management facilities present in KSA are listed below:

- Landfill site located in Makkah;
- Landfill site located in Jeddah;
- Saudi Investment Recycling Company located in Riyadh;
- National Environmental Recycling Company (Tadweer) located in Riyadh;
- Waste Collection and Recycling Company located in Jeddah; and,
- Yanbu United Company located in Yanbu Al-Sinaiyah.

4.1.4.2 Waste Management

In 2021, the Waste Management Law was issued in KSA by Royal Decree and the Council of Ministers, replacing the MSW Management Law, consisting of thirty-eight (38) articles of legal rules and procedures governing waste management in Saudi Arabia [12]. As outlined in Articles Two and Three, the Waste Management Law seeks to regulate all waste-related activities, including transportation, sorting, storage, import, export, treatment, safe disposal, and post-care of disposal sites. The law's provisions exclude radioactive, nuclear, and military waste [12].

The National Centre for Waste Management (MWAN / NCWM) is responsible for issuing the requirements and regulations service providers and waste producers are to adhere to. It also classifies waste according to its environmental and public health risks, establishing the necessary rules and conditions for effective management [12].

Article Eleven of the Waste Management Law mandates that waste producers follow measures such as conserving materials and natural resources, reusing products, minimising waste, storing waste in designated areas, and sorting

reusable or recyclable waste to ensure proper disposal. The types of waste subject to these measures are specified in the regulations [12].

4.1.4.2.1 Responsibility of the Service Provider in the Waste Management Law

The Waste Management Law requires service providers to dispose of waste according to methods specified by MWAN / NCWM. Service providers must verify the accuracy of waste information, maintain transport document records, and, if contracted by government entities, submit regular reports to MWAN / NCWM. Service providers involved in transport, treatment, storage, and safe disposal must comply with transport document requirements. Additionally, recycling, treatment, and safe disposal service providers are obligated to accept any waste that falls within their licensed areas of responsibility.

4.1.4.3 Regulations for Transporting Hazardous Waste by the Service Provider

Article Seventeen of the Waste Management Law stipulates the following regulations that are to be implemented by a service provider [12]:

- Service providers must transport hazardous waste using vehicles that meet the specifications of MWAN / NCWM;
- Warning labels must be placed on hazardous waste transport vehicles;
- Required documentation for hazardous waste must be available during transport;
- Relevant authorities must be notified of the routes for hazardous waste transport vehicles and informed of any changes;
- Hazardous waste vehicles must avoid residential areas and city centres during specified times set by the relevant authority;
- Authorities must be informed of the parking locations for hazardous waste transport vehicles; and,
- Vehicles must be washed and disinfected after each use, following guidelines coordinated with the relevant authority.

4.1.4.4 Site Visit Results

The nearest designated waste disposal facility is the Makkah landfill, situated on Road 298, approximately 143 km southwest of the Project site. Consequently, the Project will require the use of wastewater collection tanks and the regular transportation of wastewater off-site [4].

4.1.5 Soil, Landform and Land Use

4.1.5.1 Soil Quality

Soil formation in the KSA occurs due to various factors, which result in two (2) major soil types with unique characteristics influencing the type of agricultural crops, water utilisation, and the investment of funds in agricultural operations. The two (2) soil formation types are the Arabian Shield and the Arabian Shelf.

Western Arabia is situated in the low-latitude desert of North Africa and the Middle East. Its core consists of the Arabian segment of the African Shield, which is primarily made up of complex basement rocks. These rocks form the Arabian

Shield, accounting for about a third of the Arabian Peninsula's total area. The Project is located within this Arabian Shield, found in the western sector of the peninsula [10].

The Arabian Shield accounts for one-third of the total area in the region. Whilst the Arabian Shelf constitutes the remaining two-thirds of the total area and is located within the eastern part of the Arabian Shield and the Arabian Gulf [13]. Most of the soils found in the KSA are young soils characterised as shallow to deep clay soils over rocks [14]. The nature and properties of the soils in KSA's agricultural regions have been examined and the textures of soil in such regions are sand, loamy sand and sandy loam [15].

The surface geological conditions at the Project site consist of gravels and sands, primarily composed of basaltic rock fragments [10]. These appear to be piedmont type deposits. These surficial deposits are developed over the lithological substrate or bedrock. This bedrock could be from lava flows from nearby harrats, the Precambrian substrate beneath the Sahl Rakhah alluvial deposit, or potentially sedimentary materials of the Usfan Formation [10].

4.1.5.1.1 Existing Data

The Project site is characterised by aeolian sands with an unknown thickness. Fine sands are predominant in the area with gravels apparent on the surface due to wind drags [10]. In addition, there are signs of runoff processes that have washed the sands and deflection processes as a result of winds blown, depicted in Figure 4-8.



Figure 4-8: Sand Subjected to Runoff Processes and Deflection Processes

Soils are classified as very poorly developed semidesert soils (sands and gravels) within the area with vegetation largely occurring on expanses of broken rock as presented in Figure 4-9 [6].



Figure 4-9: Poorly Developed Semidesert Soils and Vegetation within the Project Area

The physical and chemical parameters of the soil layers at Haden PV Park were determined from soil samples obtained from boreholes and trial pits as part of geotechnical and geophysical site investigations [11]. Sieve analyses results revealed that soil layers were comprised of coarse-grained and fine-grained materials. Additionally, the general soil profile was observed to be uniform.

To characterise soil conditions at Haden PV Park site, a total of ten soil samples were collected from various locations across the site to ensure representative coverage of the area [6]. Laboratory analysis of these samples indicated that soil quality parameters were within the permissible limits set by the NCEC [6].

Additionally, a comprehensive chemical analysis was conducted on 50 selected subsurface soil samples to evaluate their chemical properties and determine appropriate exposure classes related to soil aggressiveness. Based on the analysis, the sulphate content of the soil is classified as S0 for exposure class and indicates no specific restriction on the type of cement required according to Tables 19.3.1.1 and 19.3.2.1 of the American Concrete Institute (ACI) 318 [16].

4.1.5.1.2 Site Visit Results

Surface observations at the Project site indicate the presence of very loose sand with scattered gravel. Soil across the Project area is predominately comprised of granular material – very loose to loose sand with varying amounts of gravel as

presented in Figure 4-10. These materials are characteristic of Cenozoic (Quaternary (Qu)) surficial deposits, which are classified within the Siliciclastic and Carbonate Surficial Deposits family division. Their composition typically includes sand, silt, gravel, and minor conglomerate. Traces of evaporites and coral limestone may also be present within these deposits, although they were not prominently exposed. Additionally, no cohesive soils or rock outcrops were encountered during the site visit [4].



Figure 4-10: Surface Granular Soil with Loose Silty Sand and Gravel

No bedrock exposures were visible at the surface. However, regional geological mapping indicates the potential presence of Cenozoic basalt (Cb) underlying the site at varying depths. This formation is classified as part of the volcanic (fine-grained igneous) rock family and is characteristic of the regional geology. Figure 4-11 presents the surface conditions at the Project site.



Figure 4-11: Surface / Ground Conditions at the Project Site

The Project area surface exhibits no significant erosion, waterlogging, or rock outcrops and is generally consistent. These conditions are conducive to easy site preparation activities such as shallow foundations, trenching, and cable routing required for the Project.

4.1.5.1.3 Soil Sampling Survey

Shallow soil sampling from two (2) from different soil bore locations within the Project site were taken.

The samples were collected at the surface from 0 to 30 cm and sent to the laboratory for analysis. The soil samples were collected following strict procedures to avoid cross-contamination. The samples were collected into glass jars with properly sealed caps and packed on ice to maintain a temperature of approximately 4 - 5°C to ensure sample integrity.

In terms of soil analysis, the soil samples were tested for certain chemical parameters listed in "Appendix 1 – Standards for Protecting Soil from Pollution" as required by Executive Regulation for the Prevention and Remediation of Soil Pollution [17] [17] as well as the chemical parameters required by the Dutch Ministry of Infrastructure and Water Management.

Soil Sampling Locations

The soil sampling locations are detailed in Table 4-9 and depicted in Figure 4-12.

Soil Sampling Location ID	Coordinates ((Decimal Degrees (°))	
	Latitude	Longitude
S01	21.557828	41.159469
S02	21.555584	41.152385

Table 4-9: Coordinates of Soil Sampling Locations

Soil Sampling Results

Table 4-10 details the soil sampling results of the Project site. Annexure I contains the soil sampling analysis report.

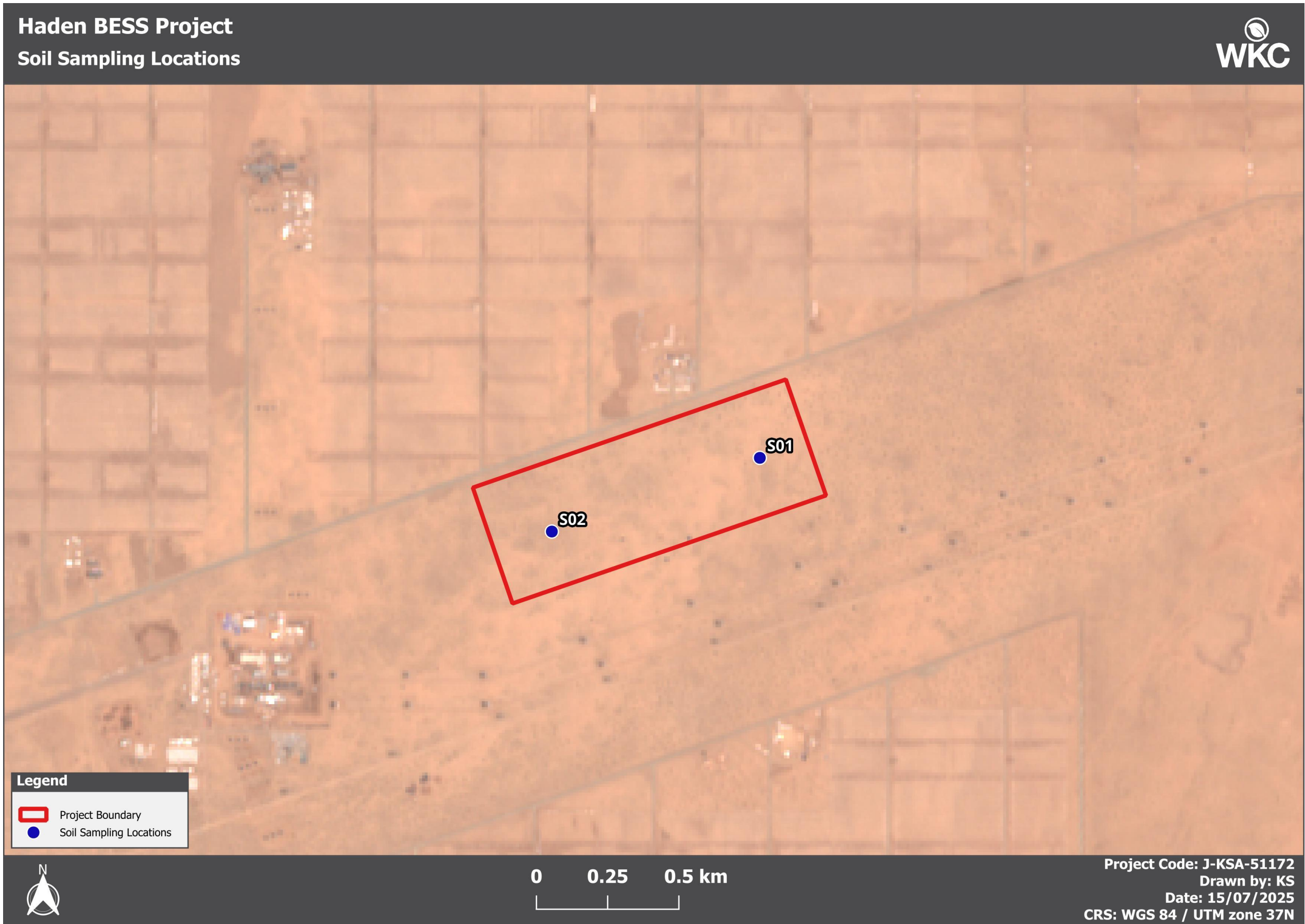


Figure 4-12: Soil Sampling Locations for the Project Site



Parameter	Unit	Results		Limits NCEC Standard
		S01	S02	
Inorganic Parameters				
pH	pH units	9.3	9.3	8.5
Cyanide (Total)	mg/kg	<0.1	<0.1	0.9
Anions				
Fluoride (Water Soluble)	mg/kg	<0.1	0.1	200
Metals				
Zinc	mg/kg	<0.25	<0.25	200
Antimony	mg/kg	<0.10	<0.10	20
Arsenic	mg/kg	<0.10	<0.10	17
Boron	mg/kg	<0.10	<0.10	3.3
Cadmium	mg/kg	<0.10	<0.10	3.8
Chromium	mg/kg	<0.10	<0.10	64
Cobalt	mg/kg	<0.10	<0.10	20
Copper	mg/kg	<0.10	<0.10	63
Lead	mg/kg	<0.10	<0.10	70
Mercury	mg/kg	<0.10	<0.10	6.6
Nickel	mg/kg	<0.10	<0.10	45
Selenium	mg/kg	<0.10	<0.10	1
Sulphur (S)	%	<0.01	<0.01	500
BTEX				
Benzene	mg/kg	<0.05	<0.05	0.046
Toluene	mg/kg	<0.05	<0.05	0.52
Ethyl benzene	mg/kg	<0.05	<0.05	0.073
m&p-Xylene	mg/kg	<0.1	<0.1	0.99
o-Xylene	mg/kg	<0.05	<0.05	0.99
Hydrocarbons				
VPH C6-C9	mg/kg	<0.025	<0.025	210
EPH C10-C16	mg/kg	<5	<5	150
EPH C17-C35	mg/kg	<5	<5	1,300
EPH C36-C40	mg/kg	<5	<5	5,600
PAHs				
Acenaphthene	mg/kg	<0.01	<0.01	0.32
Acenaphthylene	mg/kg	<0.01	<0.01	-
Anthracene	mg/kg	<0.01	<0.01	0.0046
Benzo(a)anthracene	mg/kg	<0.01	<0.01	0.07
Benzo(a)pyrene	mg/kg	<0.01	<0.01	0.6



Parameter	Unit	Results		Limits NCEC Standard
		S01	S02	
Benzo(b)fluoranthene	mg/kg	<0.01	<0.01	6.2
Benzo(g,h,i)perylene	mg/kg	<0.01	<0.01	-
Benzo(k)fluoranthene	mg/kg	<0.01	<0.01	6.2
Chrysene	mg/kg	<0.01	<0.01	6.2
Dibenzo(a,h)anthracene	mg/kg	<0.01	<0.01	-
Fluoranthene	mg/kg	<0.01	<0.01	0.032
Fluorene	mg/kg	<0.01	<0.01	0.29
Indeno(1,2,3-c,d)pyrene	mg/kg	<0.01	<0.01	-
Naphthalene	mg/kg	<0.01	<0.01	0.014
Phenanthrene	mg/kg	<0.01	<0.01	0.051
Pyrene	mg/kg	<0.01	<0.01	0.034
PCBs				
2,2',3,3',4,4' - Hexachlorobiphenyl (PCB 128)	mg/kg	<0.002	<0.002	1.3
2,2',3,3',4,4',5 - Heptachlorobiphenyl (PCB 170)	mg/kg	<0.002	<0.002	1.3
2,2',3,3',4,4',5,5',6,6' - Decachlorobiphenyl	mg/kg	<0.002	<0.002	1.3
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (PCB 206)	mg/kg	<0.002	<0.002	1.3
2,2',3,3',4,4',5,6 - Octachlorobiphenyl (PCB 195)	mg/kg	<0.002	<0.002	1.3
2,2',3,4',5,5',6 - Heptachlorobiphenyl (PCB 187)	mg/kg	<0.002	<0.002	1.3
2,2',3,4,4',5' - Hexachlorobiphenyl (PCB 138)	mg/kg	<0.002	<0.002	1.3
2,2',3,4,4',5,5' - Heptachlorobiphenyl (PCB 180)	mg/kg	<0.002	<0.002	1.3
2,2',3,5' - Tetrachlorobiphenyl (PCB 44)	mg/kg	<0.002	<0.002	1.3
2,2',4,4',5,5' - Hexachlorobiphenyl (PCB 153)	mg/kg	<0.002	<0.002	1.3
2,2',4,5,5' - Pentachlorobiphenyl (PCB 101)	mg/kg	<0.002	<0.002	1.3
2,2',5,5' - Tetrachlorobiphenyl (PCB 52)	mg/kg	<0.002	<0.002	1.3
2,2',5 - Trichlorobiphenyl (PCB 18)	mg/kg	<0.002	<0.002	1.3
3,3',4,4' - Tetrachlorobiphenyl (PCB 77)	mg/kg	<0.002	<0.002	1.3
3,3',4,4',5 - Pentachlorobiphenyl (PCB 126)	mg/kg	<0.002	<0.002	1.3
2,3',4,4' - Tetrachlorobiphenyl (PCB 66)	mg/kg	<0.002	<0.002	1.3
2,3',4,4',5 - Pentachlorobiphenyl (PCB 118)	mg/kg	<0.002	<0.002	1.3
2,3,3',4,4' - Pentachlorobiphenyl (PCB 105)	mg/kg	<0.002	<0.002	1.3
2,4' - Dichlorobiphenyl (PCB 8)	mg/kg	<0.002	<0.002	1.3
2,4,4' - Trichlorobiphenyl (PCB 28)	mg/kg	<0.002	<0.002	1.3
Di-benzo-p-dioxins (PCDD)				
2,3,7,8-TCDD	mg/kg	<2.90 x10 ⁻¹²	<2.90 x10 ⁻¹²	0.00025
1,2,3,7,8-PeCDD	mg/kg	<2.81 x10 ⁻¹²	<2.81 x10 ⁻¹²	0.00025
1,2,3,4,7,8-HxCDD	mg/kg	<2.25 x10 ⁻¹¹	<2.25 x10 ⁻¹¹	0.00025



Parameter	Unit	Results		Limits NCEC Standard
		S01	S02	
1,2,3,6,7,8-HxCDD	mg/kg	<2.43 x10 ⁻¹²	<2.43 x10 ⁻¹²	0.00025
1,2,3,7,8,9-HxCDD	mg/kg	<2.53 x10 ⁻¹²	<2.53 x10 ⁻¹²	0.00025
1,2,3,4,6,7,8-HpCDD	mg/kg	<1.12 x10 ⁻¹²	<1.12 x10 ⁻¹²	0.00025
OCDD	mg/kg	<1.59 x10 ⁻¹²	<1.59 x10 ⁻¹²	0.00025
Dibenzofurans (PCDF)^{(1)}				
2,3,7,8-TCDF	mg/kg	<1.97 x10 ⁻¹²	<1.97 x10 ⁻¹²	0.00025
1,2,3,7,8-PeCDF	mg/kg	<1.97 x10 ⁻¹²	<1.97 x10 ⁻¹²	0.00025
2,3,4,7,8-PeCDF	mg/kg	<1.97 x10 ⁻¹²	<1.97 x10 ⁻¹²	0.00025
1,2,3,4,7,8-HxCDF	mg/kg	<2.15 x10 ⁻¹²	<2.15 x10 ⁻¹²	0.00025
1,2,3,6,7,8-HxCDF	mg/kg	<2.15 x10 ⁻¹²	<2.15 x10 ⁻¹²	0.00025
2,3,4,6,7,8-HxCDF	mg/kg	<2.15 x10 ⁻¹²	<2.15 x10 ⁻¹²	0.00025
1,2,3,7,8,9-HxCDF	mg/kg	<2.62 x10 ⁻¹²	<2.62 x10 ⁻¹²	0.00025
1,2,3,4,6,7,8-HpCDF	mg/kg	<8.4 x10 ⁻¹³	<8.4 x10 ⁻¹³	0.00025
1,2,3,4,7,8,9-HpCDF	mg/kg	<9.4 x10 ⁻¹³	<9.4 x10 ⁻¹³	0.00025
OCDF	mg/kg	<1.50 x10 ⁻¹²	<1.50 x10 ⁻¹²	0.00025
Pesticides - Organochlorine				
o,p'-DDT	mg/kg	<0.01	<0.01	0.7
p,p'-DDT	mg/kg	<0.01	<0.01	0.7
SVOC				
Phenol	mg/kg	<0.02	<0.02	0.0028
VOC (Organo Halogen Compounds included)				
Methyl Tert-Butyl Ether (MTBE)	mg/kg	<0.009	<0.009	0.044
Radioactive Elements				
Radium-22	Bq/g	0.00856	0.011	0.3

Table 4-10: Chemical Test Results for Soil Sampling Locations



A soil sampling campaign was conducted at two locations (S01 and S02), assessing various physical, chemical, and biological parameters in compliance with NCEC standards. The following key observations were made:

- pH: Soil pH were recorded at 9.3 for both TP01 and TP02. These results exceed the NCEC standard of 8.5. However, elevated soil pH is not uncommon in arid regions, due to naturally occurring alkaline soils, limited organic matter, and low rainfall. These conditions naturally increase soil pH. As this site is undisturbed, the elevated pH is likely biogenic rather than a result of anthropogenic contamination;
- Anions: Fluoride (Water Soluble) concentrations were <0.1 mg/kg (S01) and 0.1 mg/kg (S02) which are well within the NCEC standards of 200 mg/kg;
- Hazardous Compounds: Cyanide (Total) concentrations were below detection limits (<0.1 mg/kg) at both S01 and S02 which is well within the NCEC regulatory limits of 0.9 mg/kg. However, phenol exceeded the NCEC standard limit of 0.0028 mg/kg. Given the undeveloped nature of the site and absence of industrial activity, the exceedance of phenol may be attributed to natural organic matter degradation in alkaline soils or from background biogenic sources;
- Metals: All tested metals including zinc, antimony, arsenic, boron, cadmium, chromium, cobalt, copper, lead, mercury, nickel and selenium were below detection limits (<0.25 mg/kg to <0.10 mg/kg) at both S01 and S02. These results are well within their respective NCEC standards. Sulphur was also below detection limits and within the NCEC standard;
- BTEX Compounds: Benzene, toluene, ethylbenzene, m&p-Xylene, and o-Xylene were not detected (<0.05 mg/kg to <0.1 mg/kg) at either S01 or S02 confirming minimal contamination. The detection limit for benzene (0.05 mg/kg) is slightly higher than the NCEC standard of 0.046 mg/kg indicating a potential exceedance. While benzene was not detected above the detection limit (0.05 mg/kg), the detection limit itself exceeds the NCEC standard (0.046 mg/kg). This is a limitation of the laboratory analytical method rather than a confirmed exceedance. It should be noted that no actual benzene concentration above the detection limit was recorded, and as such, this does not confirm the presence of contamination. Other BTEX compounds were compliant.
- Polycyclic Aromatic Hydrocarbons (PAHs): Most tested PAHs were below detection limits (<0.01 mg/kg). However, the detection limit for anthracene (0.01 mg/kg) exceeds the NCEC standard of 0.0046 mg/kg indicating a potential exceedance. The exceedance is only theoretical based on detection capability. This does not constitute confirmed contamination, and the risk of exceedance remains minimal based on the greenfield status of the site. Other PAHs with specified limits were compliant. Acenaphthylene, Benzo(g,h,i)perylene, Dibenzo(a,h)anthracene, and Indeno(1,2,3-c,d)pyrene do not have specified NCEC limits;
- PCBs: All tested polychlorinated biphenyls (PCBs) were below detection limits (<0.002 mg/kg) at both S01 and S02. These results are well within the NCEC standards of 1.3 mg/kg for these compounds;

- Dioxins and Furans (PCDD / PCDF): All tested dioxins (PCDD) and Furans (PCDF) were below their respective detection limits (8.4×10^{-13} mg/kg to 2.25×10^{-11}) at both S01 and S02. These detection limits are significantly lower than the NCEC standard of 0.00025 mg/kg for all listed PCDDs and PCDFs indicating compliance;
- Pesticides – Organochlorine: o,p'-DDT and p,p'-DDT were both below detection limits (<0.01 mg/kg) at S01 and S02. These detection limits are well within the NCEC standard of 0.7 mg/kg for both compounds; and,
- VOC (including Organo Halogen Compounds): Methyl Tert-Butyl Ether (MTBE) was below detection limits (<0.009 mg/kg) at both S01 and S02 and is well within the NCEC standard of 0.044 mg/kg.

The soil quality at the sampling locations generally complies with NCEC standards. However, several parameters show exceedances or detection limits higher than the NCEC standards, specifically pH at both S01 and S02, benzene, anthracene, and phenol.

4.1.5.2 Landform

4.1.5.2.1 Existing Data

Saudi Arabia has a vast topography that is predominately characterised by various natural features, including mountains, plateaus, plains, valleys and sand dunes. The topography greatly influences the diversity of the physical environment in terms of agricultural activities, vegetation growth and other environmental aspects KSA makes up the majority of the Arabian Peninsula in terms of land mass and covers an area of approximately 2,250,000 km². The topography of Saudi Arabia is varied and characteristic of a desert region. The vast landscape is composed of a variety of habitats such as mountains, valleys (wadis), sandy and rocky deserts, salt pans (sabkhas) and lava areas.

The geomorphological framework of the Project area is made up of three units: the great alluvial depression of Sahl Rakhah, the pediments of the area between the northern border of Harrat Hadan (lava field) and the southern end of Harrat Al Kishb. These units are briefly described below [10]:

- Sahl Rakhah
 - » An alluvial depression and one of the largest open plains in the southern Hijaz. It is an interior basin with no apparent drainage outlet, formed by streams being dammed by volcanic barriers.
- Harrat Hadan
 - » Occupies an elongate area, a deeply eroded remnant of a prominent lava plateau above the Sahl Rakhah. It has a west-facing erosional escarpment with about 300 m of relief. Its eastern flank is described as subdued due to tilting. It also forms the eastern barrier of the great Sahl Rakhah.
- Harrat Al Kishb



- » A volcanic field comprised of basaltic scoria cones, tuff rings, and maars, phonolitic lava domes and flows. It forms the northern boundary of Sahl Rakkah and acted as a barrier to northward drainage.

4.1.5.2.2 Site Visit Results

The Project area has a predominantly flat terrain with sparse vegetation consisting occasional grass patches and shrubs (Figure 4-13). The maximum slope from east to west of the Project site is 2.67 % over a 450 m horizontal distance. The elevation of the Project area ranges from 1,153 – 1,161 m above mean sea level (AMSL) as shown in Figure 4-14. The surrounding topography does not exhibit significant elevation changes. The general topography of the Project area is presented in Figure 4-15.



Figure 4-13: Predominately Flat Terrain of the Project Area with Sparse Vegetation

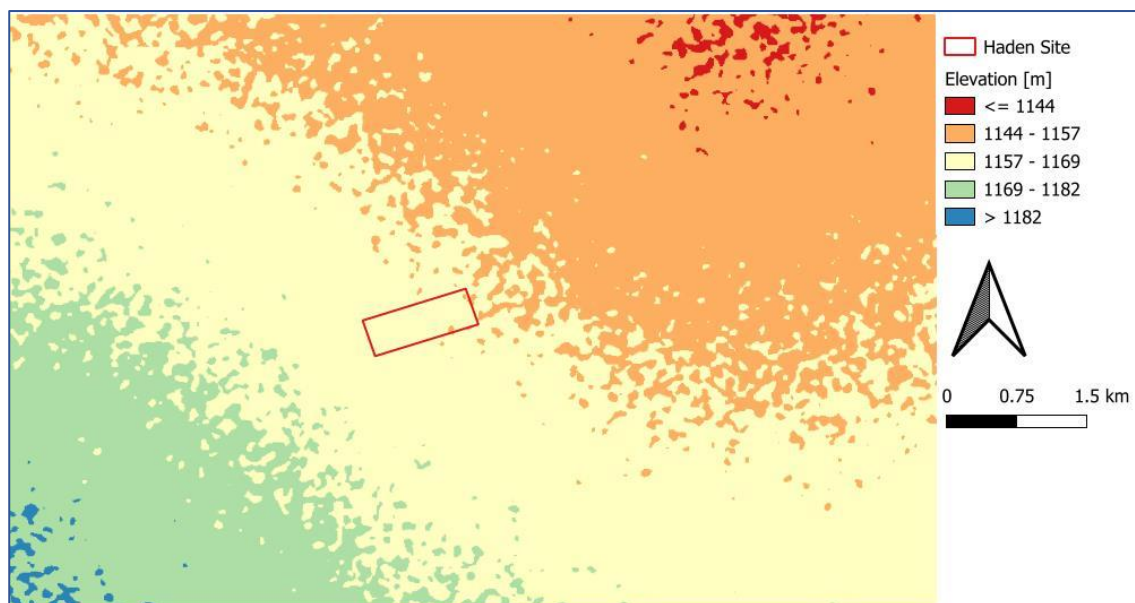


Figure 4-14: Topographical Attributes of the Site [6]

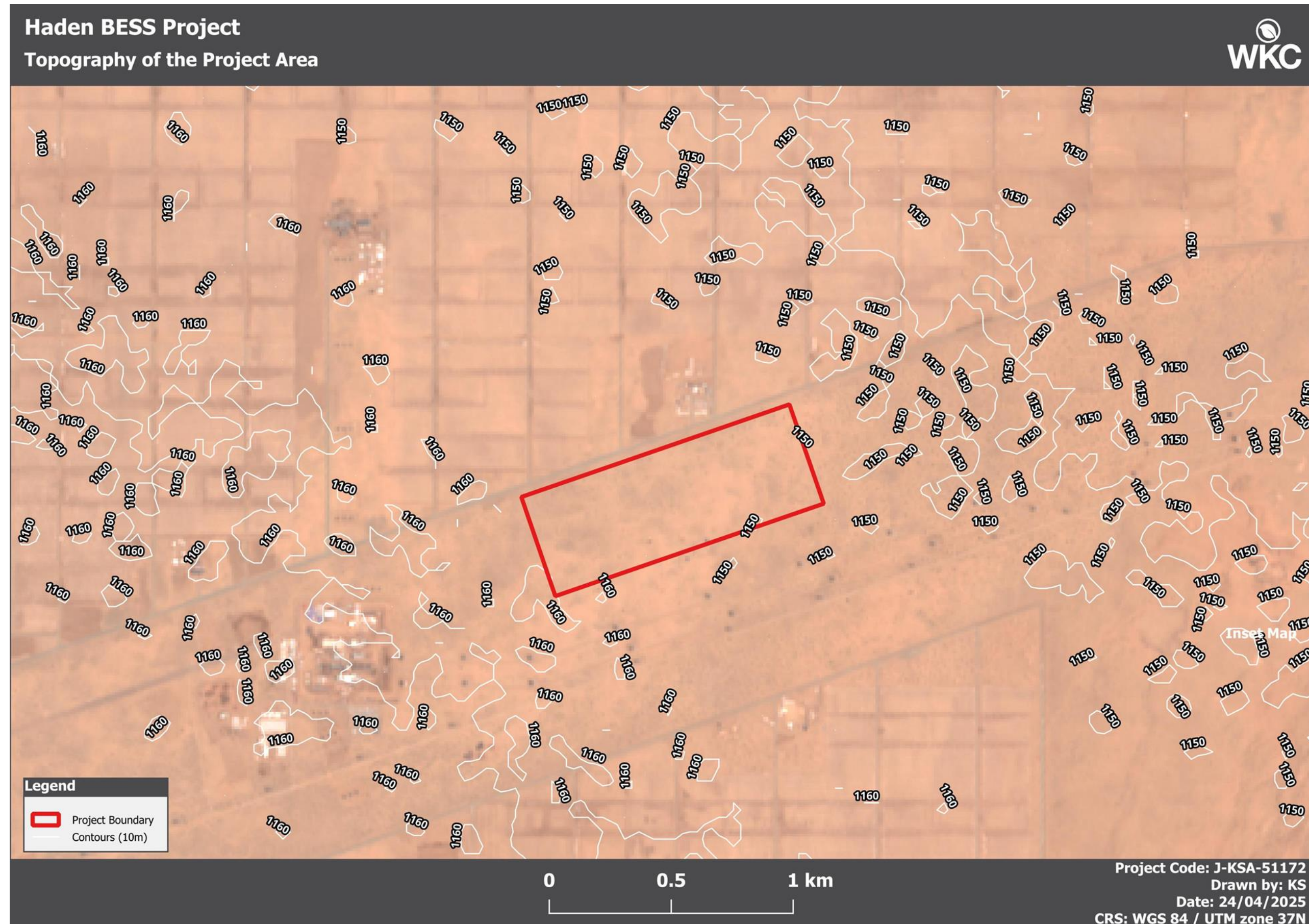


Figure 4-15: Topography of the Project Area



4.1.5.2.3 Tectonic Setting and Seismicity

KSAs capability to monitor and assess seismic hazards was enhanced with the establishment of the Saudi National Seismic Network in 1984. Data from this network has informed the development of seismic zoning maps, including estimates of Effective Peak Acceleration (EPA), a key parameter for engineering and construction applications. EPA is expressed as a fraction of gravity (g), and the Kingdom has been divided into four seismic zones accordingly. Based on these classifications, the Project falls within **Seismic Zone 0** (Figure 4-16), which corresponds to a **No expected ground motion level** [18].

Seismic Zone Number	0	1	2A	2B
Z	0.05	0.075	0.15	0.20

Table 4-11: Basis of Seismic Zone Number Assignment [19]

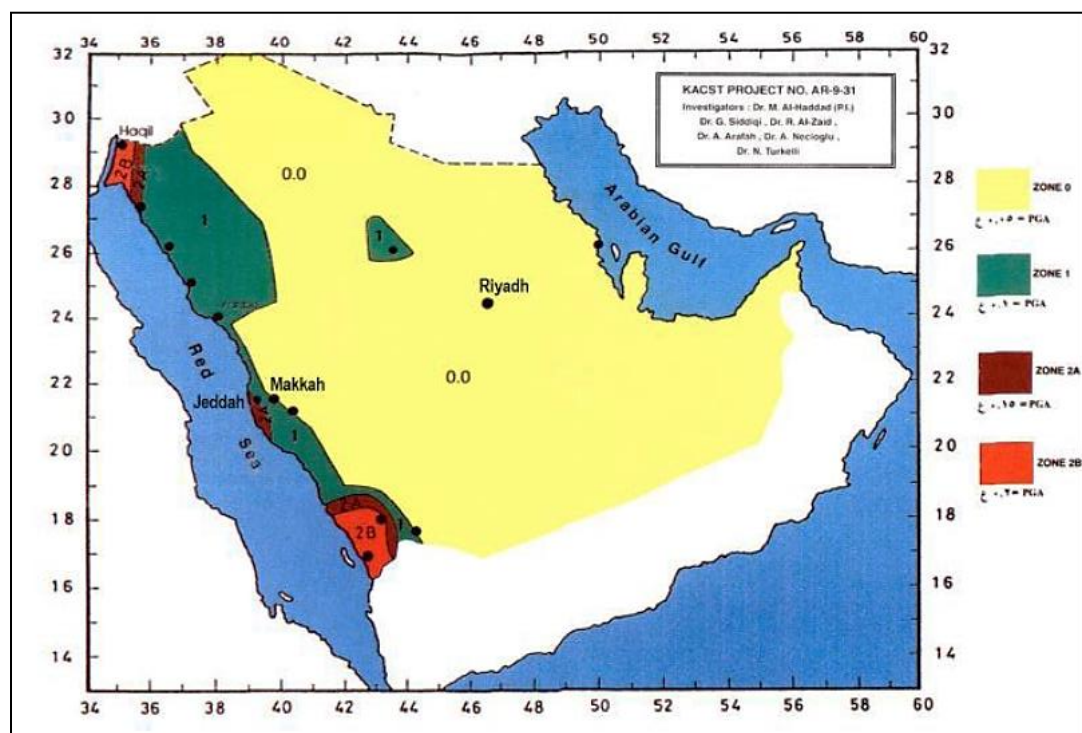


Figure 4-16: Seismic Zoning Map for KSA [19]

The seismic hazard for Saudi Arabia ranges from low to medium. A graphic representation of the seismic hazard distribution for Saudi Arabia is presented in Figure 4-17. This study also estimated the level of seismic hazard to be low within the Project study area. The greatest potential for the Project sites to be affected by an earthquake originates from seismic activity along the Zagros subduction zone. Danger of serious damage to this region is reduced [19].

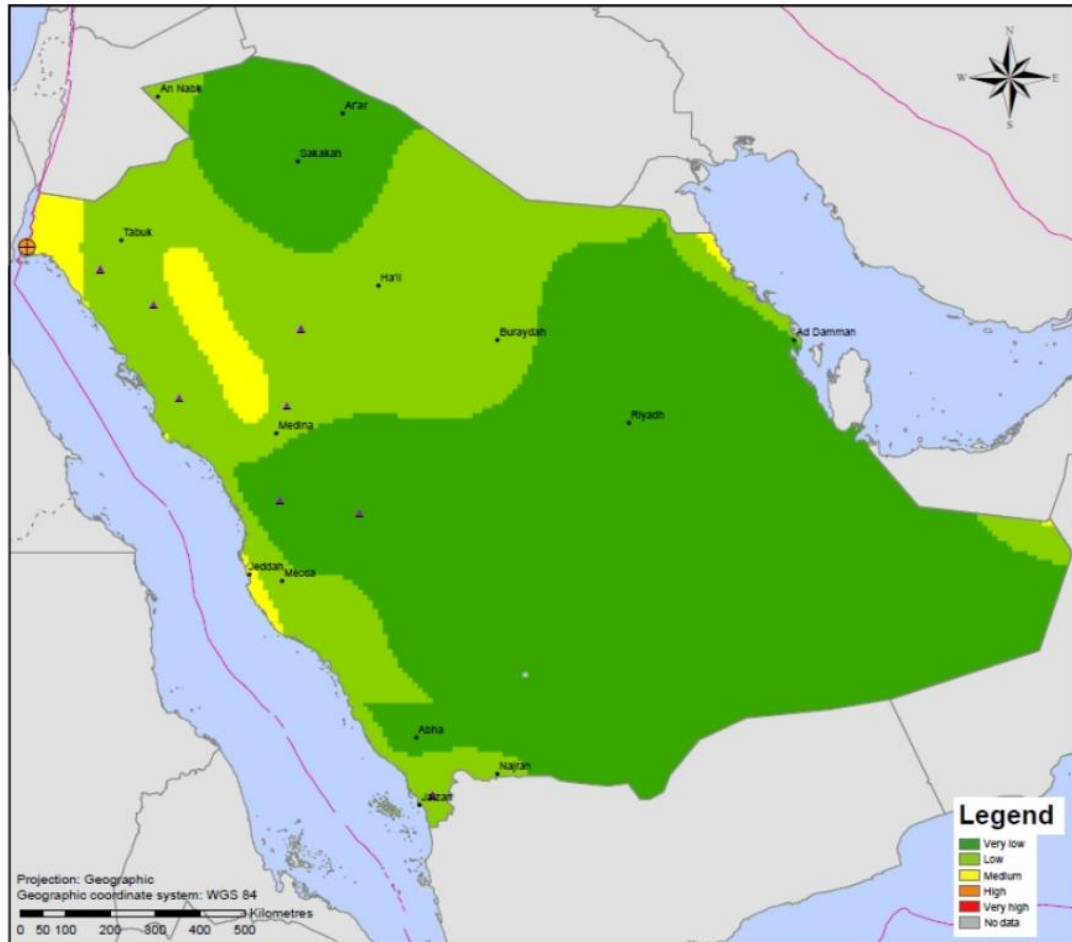


Figure 4-17: Seismic Hazard Distribution Map [19]

No significant historical earthquakes have been recorded near the Haden area or the greater Makkah Region in modern times. Seismic hazard is defined as the expected intensity of ground shaking over a specified period, and it forms the foundation of seismic risk when combined with the vulnerability of structures, population exposure, and other local factors [20].

4.1.5.3 Land Use

4.1.5.3.1 Site Visit Results

The Project area is characterised by sparse vegetation and lacks cohesive soils or distinct rock outcrops. During the site visit, no signs of active or abandoned Bedouin camps, active grazing, or nomadic livestock herding were observed within the Project site. Furthermore, no mining activities or military training grounds were identified. It was also noted that there are no protected areas in the vicinity of the Project site [4].

In terms of permanent land use and infrastructure, an overhead transmission line (OHTL) is located south of the Project area illustrated in Figure 4-18 [4].

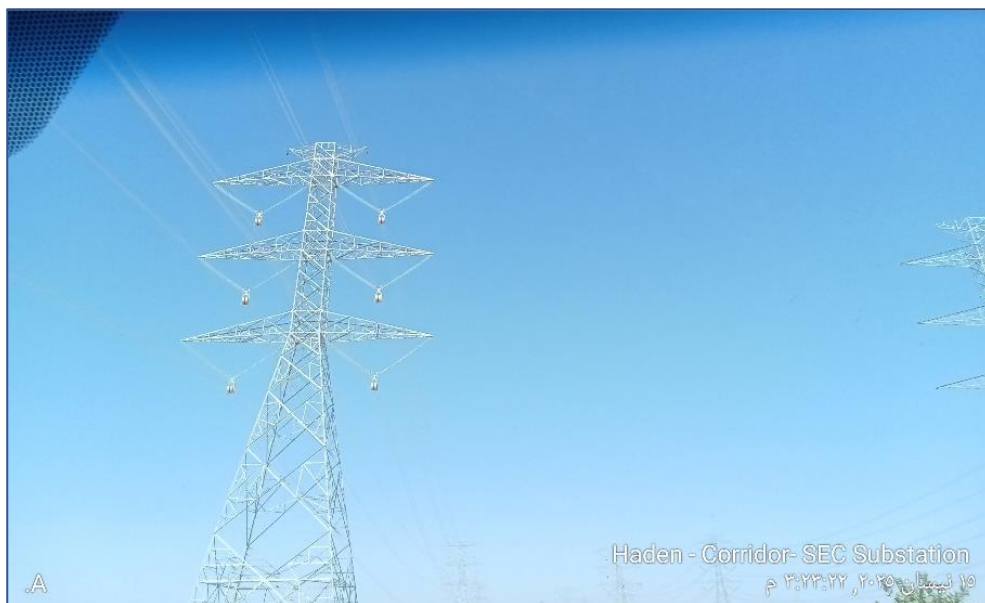


Figure 4-18: Exiting OHTL South of the Project Area

In terms of Land Use, the Project is not expected to result in any significant changes or additional requirements as it is situated within a previously permitted Haden PV Park.

4.1.5.3.2 Stakeholder Engagement

Stakeholder engagement formed a critical component of the proposed Haden PV Park. Engagement efforts were initiated early in the ESIA process and continued through multiple project phases i.e., design, pre-construction, construction, and planned operational phase in accordance with the IFC Performance Standards and Equator Principles.

A range of affected and interest-based stakeholders were identified, including local sheepherders and camel herders who utilise the Project area for grazing, and various governmental entities such as the Turbah Municipality, MoMAH, the

Ministry of Interior, Ministry of Defence, Ministry of National Guard, the NCVC, the NCW and the General Authority of Civil Aviation. Several of these stakeholders are directly linked to land use, planning, environmental regulation, and local development controls [21].

Engagement methods included bilateral meetings, official correspondence, public notices, and awareness campaigns. Key activities focused on the disclosure of Project information, clarification of land use implications, alignment with existing land development frameworks, and the implementation of grievance redress mechanisms to ensure that land users could voice concerns and receive timely responses [21].

Special consideration was given to nomadic land users who may be displaced or whose access may be restricted. Their inclusion in early consultations allowed the Project team to integrate feedback into site selection and layout design, thus minimising potential land use conflicts [21].

4.1.6 Noise

4.1.6.1 Existing Data

Baseline environmental noise monitoring was undertaken at three (3) locations on 7th February 2022 within Haden PV Park project area. The data was collected for 30 minutes to 1 hour for daytime and nighttime measurements at each location.

The coordinates of the noise monitoring locations are provided in Table 4-12.

Location ID	Geographic Coordinates (Decimal Degrees (°))	
	Latitude	Longitude
P1	21.54733869	41.16813836
P2	21.52726846	41.13831618
P3	21.51543115	41.11104989

Table 4-12: Coordinates of the Noise Monitoring Locations – Existing Data

The monitoring was conducted using NCEC-approved noise monitoring equipment, with measurements recorded for the following key noise indicators:

- LA_{eq} (equivalent continuous sound level);
- LA_{Fmax} (maximum sound level, fast time-weighted);
- LA₁₀ (sound level exceeded for 10% of the measurement period); and
- LA₉₀ (sound level exceeded for 90% of the measurement period).

Given the site's distance from residential areas and the primary potential for noise impacts being associated with nearby roads, the applicable noise level limits were those defined by the NCEC standards for areas adjacent to roadways. The monitoring results confirmed that recorded noise levels were within the permissible thresholds set by the NCEC executive regulations.



4.1.6.2 Site Visit Results

Minor sources of noise pollution may include vehicles using the existing asphalt road and dirt road that provides access to the Project site, though their intermittent use is unlikely to significantly contribute to noise emissions [4].

4.1.6.3 Ambient Noise Baseline Survey

A short-term baseline noise monitoring (NM) survey was undertaken to characterise the existing noise conditions at the Project site (prior to the Project development). The survey was carried out by a third-party, NCEC-registered subcontractor (see Table 4-2) as part of the noise baseline studies required for the Project from 12th to 15th May 2025.

4.1.6.3.1 Methodology

The survey equipment and noise monitoring methodology are presented in the sections below.

Survey Equipment

Sound level measurements were performed using an analyser that met the requirements of IEC 61672-1:2013 and / or ANSI S1.4 for a Class 1, Precision Sound Level Meter. A one-half-inch microphone was used, and the sound level meter was set to fast response.

The equipment included:

- Cirrus Acoustic Calibrator;
- Cirrus Noise Meter (SLM) Class 1; and,
- Monitoring tripod.

The analyser and calibrator had undergone annual calibration by the equipment supplier. On-site calibrations were performed before and after each measurement series.

Monitoring Methodology

Sound level measurements were conducted for a 15-minute period with the sound level meter mounted on a tripod approximately 1.5 m above ground level, with the microphone positioned at a 70-degree angle to optimize direct sound emission capture. The observer did not stand between the microphone and the source but stood behind and to one side of the microphone.

The main parameters and methodology utilised by the noise monitoring team are summarised below.

Parameters	▪ LA_{eq} ▪ LAF₁₀ ▪ LAF₉₀ ▪ LAF_{max} ▪ LAF_{min}
Equipment	▪ Cirrus Acoustic Calibrator; ▪ Cirrus Noise Meter (SLM) Class 1; and, ▪ Monitoring tripod.

No. Instruments	IEC 61672-1:2013 and / or ANSI S1.4 for a Class 1, Precision Sound Level Meter
No. Locations	4 locations
Duration (per location)	15 minutes (day and night)

Table 4-13: Noise Survey Methodology

The proposed ambient noise quality monitoring locations are provided in Table 4-14. A map of the ambient noise quality monitoring locations is shown in Figure 4-19.

ANML ID	Geographic Coordinates (Decimal Degrees (°))	
	Latitude	Longitude
ANML 1	21.553323	41.151038
ANML 2	21.557006	41.149731
ANML 3	21.560299	41.160389
ANML 4	21.556607	41.161695

Table 4-14: Noise Monitoring Locations





Figure 4-19: Ambient Noise Monitoring Locations



4.1.6.3.2 Results

Table 4-15 and Table 4-16 details the results for a 15-minute integration period for daytime and nighttime noise levels for the Project site. The results were compared with NCEC noise limits and regulations. The ambient noise quality baseline survey methodology and results are further detailed in Annexure G.

ANML ID	LA _{eq} (dB(A))	LAF _{max} (dB(A))	LAF _{min} (dB(A))	LAF ₁₀ (dB(A))	LAF ₉₀ (dB(A))
ANML 1	32	43	27	38	29
ANML 2	32	40	27	37	28
ANML 3	32	41	27	37	29
ANML 4	33	42	30	38	31
NCEC Day (Cat. A)	50	-	-	-	-

Table 4-15: Daytime Noise Monitoring Results [22]

ANML ID	LA _{eq} (dB(A))	LAF _{max} (dB(A))	LAF _{min} (dB(A))	LAF ₁₀ (dB(A))	LAF ₉₀ (dB(A))
ANML 1	36	40	34	38	34
ANML 2	35	39	33	38	33
ANML 3	35	45	32	41	33
ANML 4	36	45	33	42	35
NCEC Night (Cat. A)	40	-	-	-	-

Table 4-16: Nighttime Noise Monitoring Results [22]

Daytime L_{eq} levels (32-33 dB(A)) and nighttime L_{eq} levels (35-36 dBA) across all monitoring locations remained well within the NCEC limits of 50 dBA (day) and 40 dBA (night) for Category A areas [22]. Although some values reached up to 45 dBA at night, overall ambient noise levels were low and compliant, indicating no significant noise impact during the monitoring period [22].

Nighttime noise levels were observed to be slightly higher than daytime levels, indicating a relatively consistent ambient noise environment across the 24-hour period [22]. This suggests the presence of continuous background sources such as distant traffic, natural ambient sounds, or ongoing low-intensity activities [22].

4.2 Biodiversity

4.2.1 Terrestrial Ecology Baseline Survey

4.2.1.1 Methodology

The single-season (summer) terrestrial ecology baseline survey was conducted from 21st to 22nd May 2025. The survey employed a combination of vantage point counts, quadrat sampling, trapping, deployment of camera traps, bat recorders, and general observations to assess the flora and fauna in the habitats present in the Project area. Prior to this, available satellite imagery of the study area was

reviewed to provide an initial understanding of the features of the site. The specific approach undertaken during the surveys is further detailed in the following sections.

4.2.1.1.1 Desktop Review

Prior to the ecological field survey, a detailed desktop review has been conducted using publicly available information, including the following:

- Relevant Legislation and Laws pertaining to the protection of the environment on a Local, National and International Level (Convention on Biological Diversity (CBD) Report, BirdLife International, United Nations Educational Scientific and Cultural Organisation (UNESCO) etc);
- Satellite Imagery;
- Academic reports; and,
- Freely available and public information.

The species account has been updated with information gathered from the International Union for Conservation of Nature (IUCN) Red List website's advanced species search facility. This was done by conducting an advanced search within the map feature, by providing the geographical outline of the Project area straight onto the map as a criteria option. Note, that the list was then re-assessed by the WKC Ecology Team to ensure that only species with the highest probability of occurring in the Project area has been included in the final listing provided and described herein. Those species that have been deemed as highly unlikely to be found in the Project area have not been included.

4.2.1.1.2 Field Survey Methodology

The preliminary mapping exercise, which was developed through unsupervised analysis of freely available satellite imagery using WKC's in-house Geographic Information System (GIS) facility, produced a rough habitat classification map. This map then formed the basis of the planning for the field surveys that is focused on the terrestrial habitats within the Project site boundary.

The terrestrial ecology survey was then conducted in these areas in accordance with international best practice. The survey has been conducted by two (2) qualified ecologists of complimentary skill sets.

In order to obtain maximum data in the timeframe available, suitable and acceptable approaches as provided within the following handbook or scientific journals have been adopted:

- Hill, D. et al. 2005. Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring. Cambridge University Press [23]; and,
- Bibby, C.J. et al. 200. Bird Census Techniques, Second Edition [24].

The methodology adopted from Hill et al. (2005) allows for ease of replication in future monitoring surveys. Each selected area was assessed using a combination of quadrat (mainly for plants) and transect (for faunal inventories) sampling and supplemented by active and passive recordings where practicable as further described in the following sections.

Habitats and Flora

The habitats and flora of the study were broadly surveyed through a combination of driven and walked transects. During the survey, vegetation was assessed using quadrats of 10 x 10 m in size where practicable. As the habitats and communities within the Project area are uniform, at least one (1) quadrat has been sampled to characterise the habitat and flora of each site. In areas where more variably-covered habitats are present, additional quadrats have been sampled.

The vegetation of the Project area has been recorded by identifying the main habitat types and their plant communities in accordance with established protocols and standards in the country. In addition, as the aim of the completed survey was to determine changes in species diversity and community composition throughout the entire study area, species density have been recorded rather than cover (but such information have been duly noted as far as practicable to inform on species density and other population indexes). As such, in each quadrat the numerical frequency of all plant species encountered have been recorded. Assessment of the floristic communities have been mainly based on the Dominant Abundant Frequent Occasional and Rare (DAFOR) scale. Flora were recorded to species level where possible and species of conservation value have been identified.

The DAFOR scale is a semi-quantitative method used in ecological surveys to estimate the relative abundance of plant species within a defined area, such as a quadrat or plot. It provides a standardised approach to categorising vegetation cover using five categories: Dominant, Abundant, Frequent, Occasional, and Rare. This method is especially useful in habitats where precise quantitative measurements are impractical due to limited time or resources. Table 4-17 shows the DAFOR scale categories.

Category	Description	Typical Cover Estimate
D – Dominant	Species is the most prevalent and clearly dominates the quadrat	>50% frequency
A – Abundant	Species is very common and abundant, but not dominant	31-50% frequency
F – Frequency	Species occurs often throughout the quadrat	11-30% frequency
O – Occasional	Species appears intermittently or scattered	5-10% frequency
R – Rare	Species is present but with very low cover or as single individuals	<5% frequency

Table 4-17: DAFOR Scale Categories

Fauna

The fauna within the Project area have been assessed using a combination of active and passive survey efforts described below

Birds (Avifauna)

The avifaunal surveys at the Project area were undertaken using point counts (Vantage Points (VP) counts), one of the two (2) most widely used standardised survey methods in accordance with standard bird census protocols as per Bibby, et al.'s Bird Census Techniques [24]. Given the relatively small size of the Project area, the avifauna surveys were conducted from two (2) VP counts at optimum times of the day that coincide with peak bird activity, namely morning (7:00 am to 11:00 am) and afternoon (2:00 pm to 5:30 pm). During each VP count, the following details were recorded on data sheets:

- Species and approximate number;
- Habitat recorded; and,
- Behaviour (foraging, resting, flying) during each observation.

Furthermore, recording of birds was also undertaken during the driven and walked transect counts undertaken across the Project area. Birds were identified to a species level using available field guides (e.g., [25], [26]).

Mammals

The mammalian fauna surveys were undertaken using a combination of transect surveys, camera recordings and physical trappings (Sherman Traps). Furthermore, mammals were recorded when visually sighted and observations of evidence of presence including tracks, burrows, scats and other signs, if identifiable. Nocturnal torchlight surveys for mammals were also undertaken to determine the presence of any mammalian species such as rodents, bats and foxes. The specific methodologies employed for the mammalian surveys are further discussed below.

Volant Mammals (Bats) Survey

For the survey of volant mammals, a combination of the following methods has been undertaken:

- Visual inspection of any trees, or cave systems (or crevices) that may potentially serve as roosting sites; and,
- Deployment of Bat Call Recorders.

Areas deemed suitable for bat roosting and foraging at each habitat type (e.g., wadi with good vegetation cover) were selected for the deployment of Anabat call recorders. Furthermore, visual inspections were done with the aid of high-quality binoculars. Given the relatively small size of the Project area, one (1) Anabat call recorder was deployed for one (1) night. A sample set-up of the Bat Call Recorder is presented in Figure 4-20.





Figure 4-20: Sample Set-Up of Anabat Call Recorder at Sand Sheets and Dunes with Shrub Cover

Small Non-Volant Mammals Survey

Given the relatively small Project area, one (1) trap line comprising of ten (10) Sherman Traps was set-up in a suitable area within the centre portion of the Project area. A sample set-up of the deployed traps is presented in Figure 4-21. The traps were baited with rolled oats coated with peanut butter and deployed prior to sunset. All traps were collected within one (1) hour of sunrise the following day to limit stress on the captured animal and prolonged exposure to elevated temperatures.



Figure 4-21: Sample Set-Up of a Sherman Trap Deployed at Sand Sheets and Dunes with Shrub Cover

Supplemental Mammal Survey

To supplement the observations from the sampling, one (1) infra-red camera trap was deployed at a suitable location within the Project area for the duration of one (1) night. The camera trap was baited with chicken carcass immediately after the camera trap was deployed. This non-intrusive survey technique is aimed at recording species, including cryptic or shy vertebrate species, passing through the Project area. A sample set-up of a camera trap during the surveys is presented Figure 4-22.



Figure 4-22: Sample Set-Up High Definition (HD) Infrared Camera Trap at Sand Sheets and Dunes with Shrub Cover

Herpetofauna (Reptiles and Amphibians)

Diurnal reptile and amphibian surveys were undertaken by drive-by or walk-over assessments to determine the presence of reptiles and amphibians. In addition, diurnal surveys were undertaken concurrently with mammal surveys particularly during transect and quadrat assessments. Night-time surveys were also undertaken to document nocturnal reptiles.

Efforts were made to search under discarded plywood sheets and other anthropogenic debris, as well as under natural shelters (e.g., rocks and dead wood for reptiles). Where burrows, scats or sightings were observed, the Global Positioning System (GPS) location was recorded and photographs taken, when possible. The surrounding vegetation of the area was also noted to provide an indication of the possible diet of lizards. Anthropogenic disturbances such as the presence of tyre tracks and grazing were also noted.

The location of all sampling points (driven transects, VPs, Quadrats, Anabats, Camera, and Sherman Traps) that were established during the survey period in the Project area are presented in Figure 4-23.



Figure 4-23: Locations of Ecology Sampling Points in the Project Area



4.2.1.1.3 Limitation of the Study

The results of the survey conducted at the Project area are provided in Chapter 4.2.1.2 of this report. Chapter 4.2.1.1 details the baseline information on the terrestrial ecological features of the Project area as gathered during the field survey. The habitat within the Project area has been classified and mapped. In addition, floral and faunal species recorded within the Project area have been listed. Through the surveys, features of ecological significance have been highlighted and recommendations provided with the aim of helping planners to make informed decisions during the ESIA process.

One limitation considered in this study is the timing when the field survey was completed (i.e., summer period). During this time the field temperatures are high and typically exceed 40°C in the afternoon leading to low daily faunal activity and absence of any winter migratory birds in this specific region. However, concerns over a single season survey mainly include not being able to provide a full record of the species, particularly of animal activity or patterns of habitat usage. Observations taken at this time are typically of summer conditions and therefore do not reflect faunal activity during the cooler winter months. The small size of the sites and the nature of the proposed development structures also indicate low probability of influencing special seasonal migratory birds. In this case, the results presented in this report are considered acceptable as the information gathered can be considered useful as a basis for predicting future impacts from any development planned for the site or as a tool for highlighting any future full biodiversity archiving or profiling requirement.

Finally, the intention of this baseline survey was to provide a snapshot of, but enough information on, the existing biodiversity on site. This is considered acceptable as rapid ecological surveys can provide fundamental descriptive data necessary for continued biodiversity monitoring or as bases for subsequent comprehensive surveys (e.g. [27]; [28]; [29]). Whilst the rapid assessment methods cannot, and are not intended to, replace long-term studies and comprehensive scientific inventories, such surveys have been increasingly used to extend the geographical application of those studies and inventories that would otherwise have budgets and time schedules that are prohibitive (review in [30]). One of the reasons for this is that rapid ecological surveys comprised of flexible surveys accelerated and directed toward indicator species and vegetation types [29], such that it can be considered an important tool for quick identification of priority areas for biodiversity protection, and are useful for defining conservation strategies [30]. The results presented here therefore provides important information on the biodiversity of the site, which can be used to inform further design and planning processes for the Project or for any required further studies or inventory requirements.

4.2.1.2 Results

4.2.1.2.1 Site Conditions

The site conditions during the survey period reflects the typical summer conditions in the Arabian Peninsula with relatively high temperatures typically ranging from 33°C to 45°C. Humidity levels during the survey slightly fluctuated with a low of 8% and a high of 39%. Wind conditions during the survey also

varied, ranging from calm conditions (2.78 m/s) to the highest average wind speed recorded approximately 6.4 m/s. During the survey period, no rainfall events were recorded in the Project area and nearby surroundings.

4.2.1.2.2 Habitat Types

The habitat classification assessment showed that the Project area is comprised of one (1) habitat type based on the classification found in literature [31], [32], [33]. The extent [in hectares (ha) and land coverage (in percent (%)) of this habitat type is provided in Table 4-18.

Habitat Type	Area (ha)	Percent (%)
Sand Sheets and Dunes with Shrub Cover	50.059	100.00
Total	50.059	100.00

Table 4-18: Habitat Types in the Project Area

The distribution of the habitat type recorded in the Project area, along with habitats within the Area of Interest buffer is presented in Figure 4-24.



Haden BESS Project
Habitat Classification Map

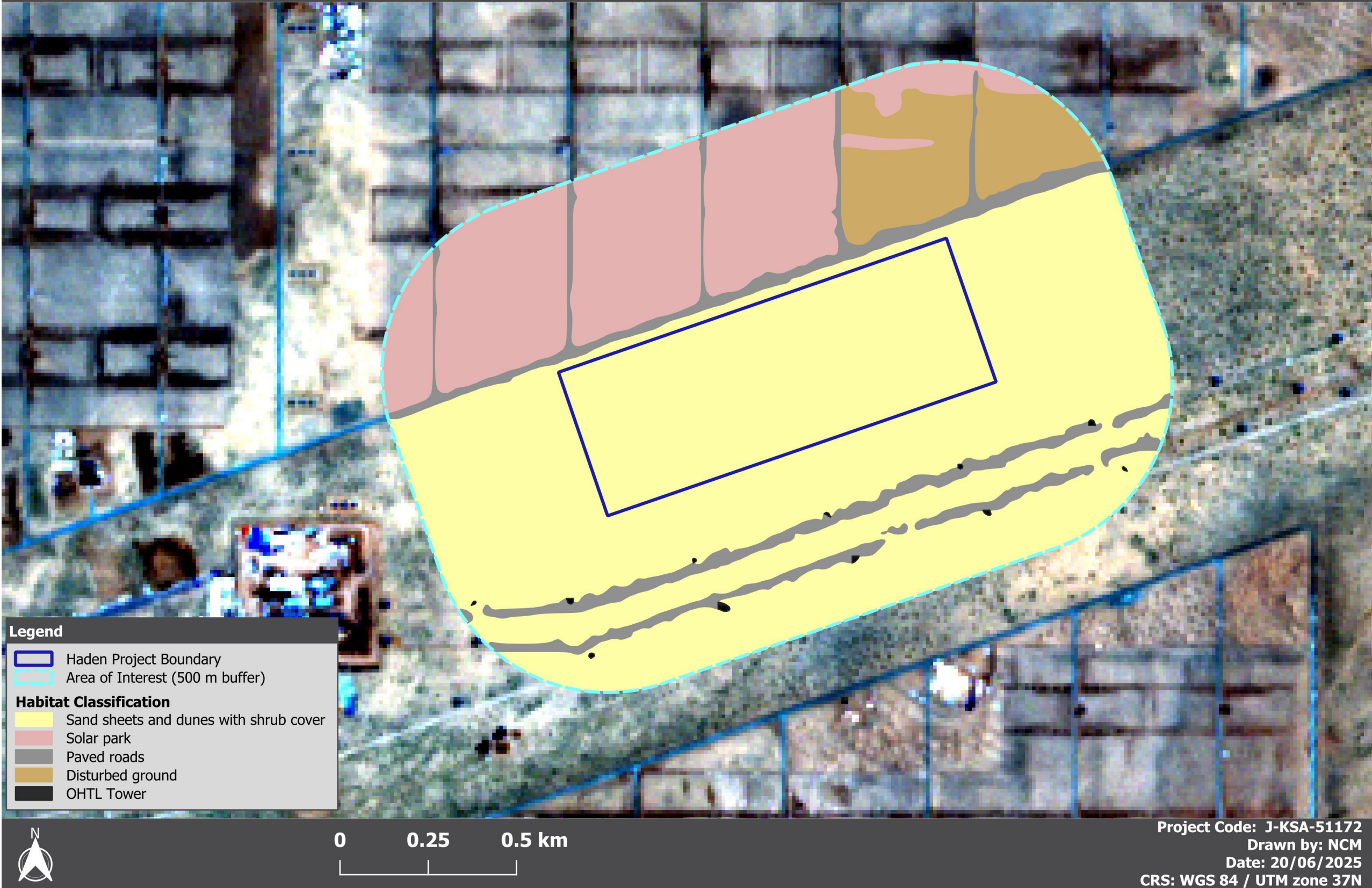


Figure 4-24: Preliminary Habitat Map of the Project Area



4.2.1.2.3 Habitat Types and Associated Flora and Fauna

Based on habitat mapping from remote sensing of available and suitable satellite imageries of the site, with validation from ground-truthed data from the surveys, the Project area is comprised of one habitat type as shown in Figure 4-24.

The vegetation of the Project area was assessed by identifying the main habitat types present and associated plant communities following classification based on Brown and Boer [34] [35] and these are further discussed in the following sections.

Sand Sheets and Dunes with Shrub Cover

The only habitat that covers the entire Project area which consists of coarse sandy plains with regularly spaced mounds of Harmal (*Rhazya stricta* Decne). The main shrubs and herbs include Clover-leaf Cleome (*Cleome amblyocarpa* Barr. & Murb.); along with grasses such as Plumose Triple-awned Grass (*Stipagrostis plumosa*), Desert Grass (*Panicum turgidum* Forssk.) and Sword-leaved Helleborine (*Centropodia forskalii* (Vahl) Cope).



Figure 4-25: Sand Sheets and Dunes with Shrub Cover

In terms of the ecological characteristics and condition of the Project area, few fauna species were recorded on site. This is anticipated given the relatively small Project area and the fact that fewer bird species may be present in the non-migration season. The Project area is also limited in features that would otherwise attract a number of species across a wide range of taxa.

4.2.1.2.4 Flora (Plants)

Species Richness and Composition

The results of the terrestrial ecology survey recorded a total of 11 plants species from seven (7) families and 11 genera. Analysis of growth forms shows that eight (8) species, constituting 72.73% of the recorded plants in the Project area are

Perennials, making them the predominant growth form on-site. Whereas three (3) species which represents 27.27% of the total recorded plant species in the Project area have Annual growth form.

The plant surveys were undertaken during the summer season, characterised by high temperatures, low humidity and sparse, unpredictable rainfall. It is important to note that that area is used as grazing land for livestock such as Camel, which could lead to a reduction in the number of plants herbs and forbs. A summary of regional affinities of plants recorded in the Project areas provided in Table 4-19.

Total Number			Growth Form			Life Form		
Family	Genera	Species	Type	No. of Species	Percent (%)	Type	No. of Species	Percent (%)
7	11	11	Annual (Grass)	1	9.09	Chamaephytes (Ch)	2	18.18
			Annual (Herb)	2	18.18	Hemicryptophytes (He)	3	27.27
			Perennial (Grass)	2	18.18	Phanerophytes (Ph)	3	27.27
			Perennial (Shrub)	6	54.55	Therophytes (Th)	1	9.09
						Chamaephytes (Ch) / Hemicryptophytes (He)	1	9.09
						Therophytes (Th) / Hemicryptophytes (He)	1	9.09
			Total	11	100		11	100

Table 4-19: Total Number of Species, Growth Form and Life Form of Plant Species in the Project Area



The analysis of the recorded flora on site, showed that Family Poaceae dominated with at least three (3) species. This is followed by families Apocynaceae and Zygophyllaceae each represented by two (2) species. Examples of two (2) species recorded within the Project area are shown in Figure 4-26.



Figure 4-26: Clover-leaf Cleome (*Cleome amblyocarpa* Barr. & Murb.) (Left) and Harmal (*Rhazya stricta* Decne.) (Right)

The distribution of species among plant families during the survey period on the Project site is summarised in Figure 4-27.

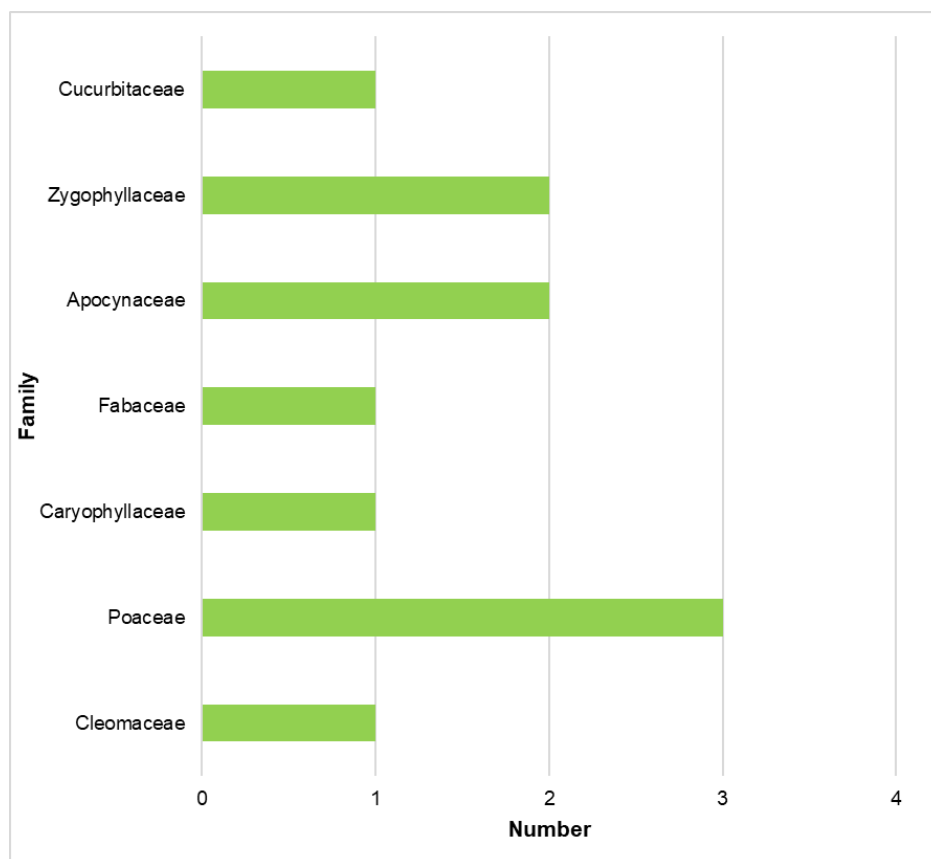


Figure 4-27: Number of Species per Plant Family in the Project Site

The composition of phyto-geographical origins for the flora recorded in the Project area showed three (3) groups. Bi-Regional affinities are dominant among the recorded plants, where a total of six (6) species or 54.55% have affinities, predominantly of the Irano-Turanian – Saharo-Arabian (IT-SA) origin with three (3) species, followed by Saharo-Arabian – Sudanian (SA-SU) origin with two (2) species and Mediterranean – Saharo-Arabian (ME-SA) origin with one (1) species, respectively. A summary of the regional affinities of the plant species recorded in the Project area during the survey period is provided in Table 4-20.

Phytochoria Code ¹	Number of Species	Percent (%)
Mono-Regional		
ME	1	9.09
SA	2	18.18
SU	1	9.09
Bi-Regional		
IT-SA	3	27.27
ME-SA	1	9.09
SA-SU	2	18.18
Pleuri-regional		
Cosm	1	9.09
Total	11	100

Notes:

The chorotypes based on Zohary (1973) are: Cosm – Cosmopolitan, IT – Irano-Turanian, ES – Euro-Siberian, ME – Mediterranean, SA – Saharo-Arabian, SS – Saharo-Sindian, SU – Sudanian, SZ – Sudano-Zambezian, and TR – Tropical

Table 4-20: Phyto-geographical Origins of Flora Recorded in the Project Area

In terms of the results of the quadrat sampling (shown in Table 4-21) the dominant flora and co-dominant species of the Project area consists of Sword-leaved Helleborine (*Centropodia forskoolii* (Vahl) Cope) and Plumose Triple-awned Grass (*Stipagrostis plumosa* (L.) Munro ex T.Anderson).



Common Name	Scientific Name	Life-form	Raunkiaer's Classification	Chorotype	Quadrant							
					QD1		QD2		QD3		QD4	
					% Frequency	DAFOR	% Frequency	DAFOR	% Frequency	DAFOR	% Frequency	DAFOR
Family Apocynaceae												
Sodoms Apple*	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Perennial (Shrub)	Ph	SA								
Harmal	<i>Rhazya stricta</i> Decne.	Perennial (Shrub)	Ph	IT+SA			2.8	R			3	R
Family Caryophyllaceae												
Creeping Carpetweed	<i>Polycarpaea repens</i> (Forssk.) Asch. & Schweinf.	Perennial (Shrub)	He	SA-SU	3	R	5	O	7	O		
Family Cleomaceae												
Clover-leaf Cleome	<i>Cleome amblyocarpa</i> Barr. & Murb.	Annual (Herb)	Th	SA-SU	15	F			7.7	O	4	R
Family Cucurbitaceae												
Desert Squash*	<i>Citrullus colocynthis</i> (L.) Schrad.	Perennial (Shrub)	He	ME-SA								
Family Fabaceae												
Creeping Indigo	<i>Indigofera spiniflora</i> Hochst. ex Boiss	Perennial (Shrub)	Ph	ME	0.3	R						
Family Poaceae												
Plumose Triple-awned Grass	<i>Stipagrostis plumosa</i> (L.) Munro ex T.Anderson	Annual (Grass)	He	IT-SA			45	A	19	F	15	F
Desert Grass	<i>Panicum turgidum</i> Forssk.	Perrenial (Grass)	Th / He	Cosm	0.7	R			2	R		
Sword-leaved Helleborine	<i>Centropodia forskaolii</i> (Vahl) Cope	Perennial (Grass)	Ch, He	IT-SA	80	D	45	A	65	D	77	D
Family Zygophyllaceae												
Indian Fagonia*	<i>Zygophyllum indicum</i> (Burm.f.) Christenh. & Byng	Perennial (Shrub)	Ch	SA								
-	<i>Tribulus</i> sp.	Annual (Herb)	Ch	SU			0.1	R			1	R



Common Name	Scientific Name	Life-form	Raunkiaer's Classification	Chorotype	Quadrant							
					QD1		QD2		QD3		QD4	
					% Frequency	DAFOR	% Frequency	DAFOR	% Frequency	DAFOR	% Frequency	DAFOR

Notes:
* Species recorded within the Project area but not recorded within the quadrant sampling plot
¹ Species names were based on accepted species treatments from the Global Biodiversity Information Facility (GBIF), Integrated Taxonomic Information System (ITIS) and IUCN. Where species names varied, GBIF.
² The life forms using Raunkiaer's (1937) classification [36] referenced in this are as follows: Ph, phanerophytes; Ch, chamaephytes; He, hemicryptophytes; Cryptophytes such as G, geophytes, H, Helophytes, Hd, Hydrophytes; and Th, therophytes. E, Epiphytes was formerly included in Ph; and Ae, Aerophytes were a later addition to the system. P pertains to a parasitic life form.
³ The chorotypes based on Zohary (1973) are: Cosm – Cosmopolitan, IT – Irano-Turanian, ME – Mediterranean, SA – Saharo-Arabian, SS – Saharo-Sindian, SU – Sudanian, SZ – Sudano-Zambezian, ME – Mediterranean, SD – Sudano-Deccanian, and SZ – Sudano-Zambezian
⁴ The phytochora Saharo-Arabian (SA) class is considered by some authors as a subregion of Saharo-Sindian (SS) region. We retained the phytochoria 'region' SA reference for these species per literature cited.

Table 4-21: DAFOR Percentage Cover per Species



Local Distribution

As there was only one (1) habitat type recorded within the Project area, there was no assessment of local flora species richness distribution patterns per habitat type.

Population and Conservation Status and Ecological Value of Plants

Based on the IUCN global population assessments [37], all plant species recorded in the Project area are all classified as Least Concern (LC) or Not Evaluated based on the IUCN regional and global threatened status list.

A systematic listing of the species of plants which includes the population statuses, life-forms and chorotypes recorded in the Project area during the survey period is provided in Table 4-22.

Common Name	Scientific Name	IUCN Red List (Population Status)	KSA National Priority Category	Life-form	Raunkiaer's classification	Chorotype
Family Apocynaceae						
Sodoms Apple	<i>Calotropis procera</i> (Aiton) W.T.Aiton	Not Evaluated	Not Evaluated	Perennial (shrub)	Ph	SA
Harmal	<i>Rhazya stricta</i> Decne.	Not Evaluated	Not Evaluated	Perennial (Shrub)	Ph	IT+SA
Family Caryophyllaceae						
Creeping Carpetweed	<i>Polycarpaea repens</i> (Forssk.) Asch. & Schweinf.	Not Evaluated	Not Evaluated	Perennial (Shrub)	He	SA-SU
Family Cleomaceae						
Clover-leaf Cleome	<i>Cleome amblyocarpa</i> Barr. & Murb.	Not Evaluated	Not Evaluated	Annual (Herb)	Th	SA-SU
Family Cucurbitaceae						
Desert Squash	<i>Citrullus colocynthis</i> (L.) Schrad.	Not Evaluated	Not Evaluated	Perennial (Shrub)	He	ME-SA
Family Fabaceae						
Creeping indigo	<i>Indigofera spiniflora</i> Hochst. ex Boiss	Not Evaluated	Not Evaluated	Perennial (Shrub)	Ph	SA
Family Poaceae						
Plumose Triple-awned Grass	<i>Stipagrostis plumosa</i> (L.) Munro ex T.Anderson	Not Evaluated	Not Evaluated	Annual (Grass)	He	IT-SA
Sword-leaved Helleborine	<i>Centropodia forskalii</i> (Vahl) Cope	Not Evaluated	Not Evaluated	Perennial (Grass)	Ch, He	IT-SA
Desert Grass	<i>Panicum turgidum</i> Forssk.	Not Evaluated	Not Evaluated	Perennial	He	SA
Family Zygophyllaceae						

Common Name	Scientific Name	IUCN Red List (Population Status)	KSA National Priority Category	Life-form	Raunkiaer's classification	Chorotype
Indian Fagonia	<i>Zygophyllum indicum</i> (Burm.f.) Christenh. & Byng	Not Evaluated	Not Evaluated	Perennial (Shrub)	Ch	SA
	<i>Tribulus</i> sp.	Not Evaluated	Not Evaluated	Annual (Herb)	Ch	SU

Notes:

¹ Species names were based on accepted species treatments from the Global Biodiversity Information Facility (GBIF), Integrated Taxonomic Information System (ITIS) and IUCN. Where species names varied, GBIF.

² The life forms using Raunkiaer's (1937) classification [36] referenced in this are as follows: Ph, phanerophytes; Ch, chamaephytes; He, hemicryptophytes; Cryptophytes such as G, geophytes, H, Helophytes, Hd, Hydrophytes; and Th, therophytes. E, Epiphytes was formerly included in Ph; and Ae, Aerophytes were a later addition to the system. P pertains to a parasitic life form.

³ The chorotypes based on Zohary (1973) are: Cosm – Cosmopolitan, IT – Irano-Turanian, ME – Mediterranean, SA – Saharo-Arabian, SS – Saharo-Sindian, SU – Sudanian, SZ – Sudano-Zambezian, ME – Mediterranean, SD – Sudano-Deccanian, and SZ – Sudano-Zambezian⁴ The phytochora Saharo-Arabian (SA) class is considered by some authors as a subregion of Saharo-Sindian (SS) region. We retained the phytochoria 'region' SA reference for these species per literature cited.

Table 4-22: Recorded Plants in the Project Area



4.2.1.2.5 Terrestrial Fauna (Avifauna, Mammals and Reptiles)

Avifauna (Birds)

Species Richness and Composition

A total of four (4) bird species representing four (4) families were recorded in the Project area during the survey period. The species on site comprised of breeding resident species.



Figure 4-28: Great Grey Shrike (*Lanius excubitor*) Recorded in the Project Area

The assessment of the distribution of species among the various avian families represented at the site indicated that there was no specific avian family that was found to be more dominant than the other within in the Project area.

Local Distribution

As there was only one (1) habitat type recorded within the Project area, there was no assessment of local avian species richness distribution patterns per habitat type.

Population Status (Global, Regional and National)

All four (4) species that were recorded during the survey are classified as Least Concern according to national, regional, and global assessments [37] [38] [39].



Figure 4-29: Black-crowned Sparrow-lark (*Eremopterix nigriceps*) Recorded in the Project Area

The species list which includes the local distribution, national, regional, and global population statuses of bird species recorded in the Project area is provided in Table 4-23.



Common Name	Scientific Name	Distribution Status [40, 39]	IUCN Regional (Arabian Peninsula) Status (2015) [39] and KSA National Priority Criteria [38]	IUCN Global Red List [41]
Family Laniidae				
Great Grey Shrike	<i>Lanius excubitor</i>	Breeding Resident	Least Concern	Least Concern
Family Alaudidae				
Black-crowned Sparrow-lark	<i>Eremopterix nigriceps</i>	Breeding Resident	Least Concern	Least Concern
Family Alaudidae				
Greater Hoopoe-lark	<i>Alaemon alaudipes</i>	Breeding Resident	Least Concern	Least Concern
Family Passeridae				
House Sparrow	<i>Passer domesticus</i>	Breeding Resident	Least Concern	Least Concern

Notes:

KSA National Red List – Set of criteria and the numbers in the species lists refer to which criterion or criteria qualify particular organisms for inclusion as “key taxa”

1. 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 NCWCD policy to reintroduce them.
2. Genera, species, or subspecies that are endemic to the Arabian Peninsula, the Red Sea, or the Gulf.
3. 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).
4. Relict genera, species, or subspecies that are of global, regional, or national significance.
5. 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).
6. Genera or species of significant economic importance.
7. 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).

Table 4-23: Recorded Bird Species in the Project Area



Mammalian Fauna (Volant and Non-volant Mammals)

Species Richness and Composition

No mammals were trapped or photographed using the nocturnal camera traps. Although there were signs of small rodent activity, it is possible that such species occasionally transit through the Project area. Mammals such as Libyan Jird, (*Meriones libycus*). The species account, composition and details of the mammalian fauna on site are discussed in the sections below.

Non-Volant Mammals (Foxes, Jirds)

The non-volant mammals on site are most likely composed mainly of small mammals such as Libyan Jird (*Meriones libycus*). Additionally, medium sized mammals such as Red Fox (*Vulpes vulpes*) are also likely to use or transit through the Project area as there were signs of its presence in surrounding areas in proximity to the Project area.

Volant Mammals (Bats)

The analysis of the Anabat Express deployed within the Project area indicated mostly 'noise' and that no Microchiropterans (insectivorous bats) were recorded to inhabit or transit through the Project area.

Local Distribution

As there was only one (1) habitat type recorded within the Project area, there was no assessment of local mammal species richness distribution patterns per habitat type.

Population Status (Global, Regional and National)

The global and regional populations of all mammalian species that were recorded in the Project area during the survey period are classified as Least Concern species [41]. Moreover, none of the species are listed as KSA High Conservation Priority (HCP) Taxa [38].

A summary of the distribution status, local, regional and global population status of mammals recorded in the Project area are provided in Table 4-24.



Common Name	Scientific Name	Distribution Status [41]	IUCN Mediterranean Region [41] and KSA National Priority Criteria [38]	IUCN Global Red List [41]
Family Canidae				
Red Fox	<i>Vulpes vulpes</i>	Native	Least Concern	Least Concern
Family Muridae				
Libyan Jird	<i>Meriones libycus</i>	Native	Least Concern	Least Concern

Notes.

KSA National Red List – Set of criteria and the numbers in the species lists refer to which criterion or criteria qualify particular organisms for inclusion as “key taxa”

1. 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 NCWCD policy to reintroduce them.
2. Genera, species, or subspecies that are endemic to the Arabian Peninsula, the Red Sea, or the Gulf.
3. 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).
4. Relict genera, species, or subspecies that are of global, regional, or national significance.
5. 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).
6. Genera of species of significant economic importance.
7. 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).

Table 4-24: Recorded Mammals in Project Area



Reptiles (Geckoes, Lizards and Snakes)

Species Richness and Composition

In terms of recorded reptile species, only Arabian Toad-headed Agama (*Phrynocephalus arabicus*) were recorded in the Project Area during the survey.

Local Distribution

As there was only one (1) habitat type and one (1) reptile species recorded within the Project area, there was no assessment of local reptile species richness distribution patterns per habitat type.

Population Status (Global, Regional and National)

The Arabian Toad-headed Agama (*P. arabicus*) is classified as Least Concern in both regional and global population assessments [42] [41].

A summary of the distribution status, national, regional, and global population status of the Arabian Toad-headed Agama (*P. arabicus*) is provided in Table 4-25.

Common Name	Scientific Name	Distribution Status [42]	IUCN Regional (Arabian Peninsula) Status (2015) [42] and KSA National Priority Category [38] ²	IUCN Global Red List [41]
Family Agamidae				
Arabian Toad-headed Agama	<i>Phrynocephalus arabicus</i>	Native	Least Concern	Least Concern

Notes:

KSA National Red List - Set of criteria and the numbers in the species lists refer to which criterion or criteria qualify particular organisms for inclusion as “key taxa”

1. 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 NCWCD policy to reintroduce them.
2. Genera, species, or subspecies that are endemic to the Arabian Peninsula, the Red Sea, or the Gulf.
3. 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).
4. Relict genera, species, or subspecies that are of global, regional, or national significance.
5. 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).
6. Genera or species of significant economic importance.
7. 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).

Table 4-25: Recorded Reptiles in the Project Area



Amphibians

During the survey period, no amphibians were recorded in the Project area. However, this is expected as no natural bodies of fresh water (e.g., lakes, marshes and rivers) or small different natural and artificial aquatic habitats (e.g., valley streams, irrigated farms, dam reservoirs, seasonal ponds and lagoons of treated sewage water) which are suitable habitats for amphibians in this region.

4.2.1.3 Summary and Conclusion

4.2.1.3.1 Overall Species Richness and Distribution

The terrestrial ecology baseline survey of the Project area recorded at least 11 plant species; four (4) bird species; Two (2) mammal species; and one (1) reptile specie. The summary of species richness, distribution status, IUCN threatened species, and KSA Priority species of plants and animals documented during the survey are provided in Table 4-26.

Group	Project Area	Saudi Arabia [38]
Plants	11	2,250
Birds	4	432
Mammals	2	79
Reptiles	1	103
Amphibians	0	7
Endemic	0	-a
Near-Endemic	0	- a
IUCN Threatened Species	0	- a
KSA Priority Category	0	346

Note:

a Unclear and require through review and assessment due to conflicting number provided in available information see [38] [39] [42]

Table 4-26: Comparison of Species Richness in the Project Area and Saudi Arabia

Although none of the flora or fauna species recorded during the survey are KSA HCP Taxa, the below section is included for informational purposes.

It is important to understand and disseminate such lists and associated criterion, especially if:

- There will be further surveys of the Project area and surroundings; and,
- Future changes in the KSA HCP designation of species recorded during the survey.

The Kingdom of Saudi Arabia (KSA) maintains a National Red List of Plants and Animals, also referred to as HCP species, as established in the First Saudi Arabian National Report on the Convention on Biological Diversity. This list serves as a national framework for identifying key taxa of high conservation

importance. While these species may not be classified as globally threatened under the IUCN Red List, they are recognised for their ecological, biogeographical, or conservation significance within the national context of Saudi Arabia. Each HCP species is classified according to specific criteria that reflect its national importance. Table 4-27 shows the different classification criteria used to assess and categorize HCP species.

Criterion	Description
1	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 NCWCD policy to reintroduce them
2	Genera, species, or subspecies that are endemic to the Arabian Peninsula, the Red Sea, or the Gulf
3	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).
4	Relict genera, species, or subspecies that are of global, regional, or national significance.
5	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).
6	Genera or species of significant economic importance.
7	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).

Table 4-27: KSA National Priority Criteria and Their Definitions

4.2.1.3.2 Distribution of Species Conservation Importance and Natural Habitats

Species of Conservation Importance

The result of the terrestrial ecology baseline survey indicates that none of the recorded flora or fauna species are currently classified as Species of Conservation Importance.

4.2.2 Critical Habitat Assessment

4.2.2.1 Institutional and Regulatory Framework

The Project site will be adopting an approach to environmental sustainability based on alignment with the International Finance Corporation’s (IFC) Sustainability Framework, principally IFC Performance Standards (PS) 1 to 8 on Environmental and Social Sustainability (International Finance Corporation, 2012), and respective Guidance Notes (GN). Of particular relevance to Critical Habitat Assessment (CHA) is IFC Performance Standard 6 (PS 6), which recognises that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development.

4.2.2.1.1 IFC Performance Standard 6 (PS 6)

The objectives of IFC’s PS 6 are to protect and conserve biodiversity; maintain benefits from ecosystem services; and promote the sustainable management of

living natural resources through the adoption of practices that integrate conservation needs and development priorities.

IFC PS 6 provides guidance on how to best identify three classes of area based on vegetation condition ('quality' or 'state'), and significance for biodiversity. PS 6 uses the term 'habitat' to refer to these areas, rather than the actual vegetation within them. These three area classes are: (i) Modified Habitat; (ii) Natural Habitat; and (iii) Critical Habitat (with Critical Habitat a subset of Modified and Natural Habitat).

Three Classes of Area identified in PS 6		Condition of the Area	
		Natural	Modified
High Biodiversity Values	Present	Critical Habitat	Critical Habitat
	Absent	Natural Habitat	Modified Habitat

Table 4-28: Summary of the PS 6 Scheme for Classifying Areas

Habitat condition is classified as either Natural Habitat or Modified Habitat based on the extent of human modification of the ecosystem. For example in the context of the KSA landscape, monoculture plantations such as date palm or other agricultural lands as well as urban areas typically show "substantial modification" and would usually be classified as Modified Habitats; whereas sand sheets and dunes with tree vegetation, albeit would have the undergrowth vegetation already to be most likely heavily grazed but retain most of the original tree species such as acacias would in most cases still be considered Natural Habitat.

Where such areas contain high biodiversity value, such can qualify as Critical Habitat based on IFC PS 6 definitions. In determining the value of biodiversity supported by the habitats, and therefore the criticality of the habitats, the principles of threat (e.g., vulnerability) and geographic rarity (e.g., irreplaceability) of the biodiversity are considered. The CHA is therefore an important process for identifying significant biodiversity risks associated with the Project.

4.2.2.2 Approach to the Critical Habitat Assessment

It is important to note that the Haden BESS Project site falls within the area that has already been set aside for the development of the "Haden PV Park." The Project location within the Haden PV Park is shown in Figure 1-2. Therefore, a broad level Critical Habitat Assessment was undertaken using the data obtained from the following sources:

- Environmental and Social Impact Assessment for "HADEN PV Park";
- Terrestrial Ecology Baseline Survey for Haden BESS Project; and,
- IUCN's Integrated Biodiversity Assessment Tool (IBAT).

A broad level review of the data was undertaken in order to determine if the habitat is considered a critical habitat based on the five criteria set by the IFC.

- Criterion 1: Critically Endangered (CR) and / or Endangered (EN) species;
- Criterion 2: Endemic and / or restricted range species;
- Criterion 3: Migratory and / or congregator species;

- Criterion 4: Highly threatened and / or unique ecosystems; and,
- Criterion 5: Key evolutionary processes.

Key Biodiversity Areas (KBAs), Important Bird Areas (IBA) and Important Plant Areas (IPA) are internationally recognised areas identified for their biodiversity value and are delineated based on biodiversity elements which trigger the established biological criteria by the International Union for Conservation of Nature (IUCN). There are no KBAs within 25 km of the Project site, nor are there any IBA's in the Project's vicinity. KBAs and IBAs are thus not considered during the CHA process for this Project.

Wetland and Marine Reserves serve as distinct ecological units for freshwater and marine biodiversity and potentially act as natural physical barriers to terrestrial biodiversity. There are no wetland and marine reserves within 25 km of the Project site. Considering that the Project will not have an interaction with the marine environment, evaluation of this environment has not been considered further in this assessment.

4.2.2.3 Protected Areas and Internationally Recognised Areas

The Performance Standard 6 recognises legally Protected Areas that meet the IUCN definition: "A clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." This includes areas proposed by governments for such designation. The Project site is not located within or adjacent to any protected areas and there are no protected areas within 25 km of the Project site.

4.2.2.4 Findings of the Critical Habitat Screening Assessment

The ESIA from the "Haden PV Park" determined that the area on which the PV Park was located did not meet the thresholds to be considered a critical habitat. This assessment was reviewed along with the Haden Terrestrial Ecology Baseline Survey and the results of this review are listed below.

Criterion 1: Critically Endangered (CR) and / or Endangered (EN) Species

There are no species that currently meet the threshold for Criterion 1 within the habitats directly within the Project site. No species classified as critically endangered or endangered were observed to be present within the project site during the Terrestrial Ecology Baseline Survey. There were also none recorded to be present during the ESIA process for the broader Haden PV Park.

Criterion 2: Restricted – Range Species

No species currently meet the thresholds of Criterion 2, as per IFC PS 6 definitions. All species recorded have a broad geographic range.

Criterion 3: Migratory / Congregatory Species

In terms of migratory species, none were observed during the Haden Terrestrial Ecology Baseline survey. This coupled with the sparse open nature of the of the project site mean it is highly unlikely that the Project site is an important stopover for migrating bird species.

The Project site is known to overlap with the migratory passage of a number of species including Asian Houbara (*Chlamydotis macqueenii*) and the Saker Falcon (*Falco cherrug*). As mentioned above the nature of the project site makes it unlikely to be a stopover and the Project site is a significant distance from known bottleneck sites. It is highly unlikely that the Project site can support a significant portion of the global population ($\geq 1\%$) on a regular or cyclic basis. Therefore, it does not meet the thresholds to be considered a critical habitat under criterion 3.

Criterion 4: Highly threatened and/or unique ecosystems

Habitat mapping undertaken for the Project using the latest habitat data determined the terrestrial component of the Project site and its wider extent is dominated by sand sheets and dunes with shrub cover. The habitats covered by Project site are considered relatively abundant across the Arabian Peninsula, and as such, they do not qualify for the first threshold under Criterion 4.

Criterion 5: Key Evolutionary Process

Since the habitats within the Project site are typical for the region and share common features, it is improbable that they possess the necessary uniqueness to qualify as triggers for critical habitat designation under Criterion 5.

4.2.2.5 Natural Habitat and Modified Habitat

Based on the evaluation conducted as part of this CHA the Project site consists of a majority natural habitats. A summary of the natural and modified habitats that are considered to be present within the Project site for this assessment, in line with IFC PS 6 is presented in Table 4-29

% of Total Area	Description	Assessment (Natural / Modified Habitat)
6.97	Disturbed Ground	Modified
7.17	Paved roads	Modified
64.89	Sand sheets and dunes with trees and shrubs	Natural
20.89	Low Density Urban	Modified
0.08	OHTL Tower	Modified

Table 4-29: Habitats within the Project Site defined as Natural or Modified Habitat

4.2.2.6 Summary of Critical Habitat Results

The Critical Habitat Assessment (CHA) findings indicate that none of the species or habitats within the Project site meet the thresholds outlined in Criteria 1-5. The Project site is also located within a larger area which has already been approved for the development of a large-scale PV Park. A Critical Habitat Assessment screening was completed during the ESIA process for the PV Park it was concluded that the Project site does not qualify as a Critical Habitat. The above findings align with previous assessment results for the area.



4.3 Economic and Social Aspects

4.3.1 Built Assets

4.3.1.1 Seaport

The Jeddah Islamic Port, located in Jeddah on the Red Sea, at the middle of an international shipping route between the east and west via the Suez Canal [43] is the nearest container seaport approximately 205 km east from the Project site. The port serves the commercial centres through which 65% of Saudi Arabia's imports by sea are being handled [43].

4.3.1.2 Airport

The nearest airport is the Taif International Airport situated north of Taif City and is approximately 70 km west of the Project site which is a 70-minute travel by vehicle.

4.3.1.3 Traffic and Transport

Access to the Project site originates from Taif city. It involves travelling northeast on Road 80 for approximately 100 km to connect with Road 4410. Following Road 4410, access continues via a left turn taken at a fire station onto an existing asphalt road. This section is followed for approximately 8 km until reaching an overhead transmission line. A final left turn is then made onto a dirt road which extends for approximately 4 km approaching the Project site. The asphalt road is suitable to accommodate transportation vehicles including heavy transport vehicles and container trucks.

Access to the Project site is provided by two (2) access roads. Route 80 is the initial access route from Taif City (Figure 4-30) and from Road 4410 towards the Project site. The first access road is asphalt road whereas the second access road is off-road, with a well-defined path, and requires to be reinforced for construction use (Figure 4-31). This may include clearing, levelling and compacting of the road for safe and efficient logistics processes. The reinforcement activities will reduce dust, ensure driver safety, accommodate heavy material and heavy machinery, such as over-size transport trucks, and ensure the integrity of materials that are to arrive at the Project site.





Figure 4-30: First Access Road from Route 80



Figure 4-31: Second Access Road Requiring Reinforcement

The nearest petrol station is located approximately 64 km from the Project site.

A new road alignment is proposed for the Project that will facilitate access from the main highway (Road 4410) to the substation. This alignment will ensure minimal disturbance to the surrounding terrain while allowing for vehicular access for construction, maintenance and operational personnel (strategic connectivity).

4.3.1.4 Demographic Background

The Makkah Region is the most populated region in KSA with a population of 6,915,006 recorded in 2010, more than a quarter of the Kingdom's population. Jeddah Governorate accounts for the largest portion of this population at 50.3%, with Makkah and Taif being the next largest centres at 24.2% and 14.1%, respectively [6]. The region's population is estimated to consist of 4.55 million Saudi nationals and 3,340 non-Saudis, representing one of the Kingdom's highest ratios of non-Saudi residents [6].

Population distribution for the Mekkah region is presented in Table 4-30.



Administrative Area - Makkah	Saudis			Non-Saudis			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
	2,085,813	2,030,252	4,116,065	1,828,412	970,529	2,798,941	3914225	3,000,781	6,915,006

Table 4-30: Makkah Population Distribution (2010)

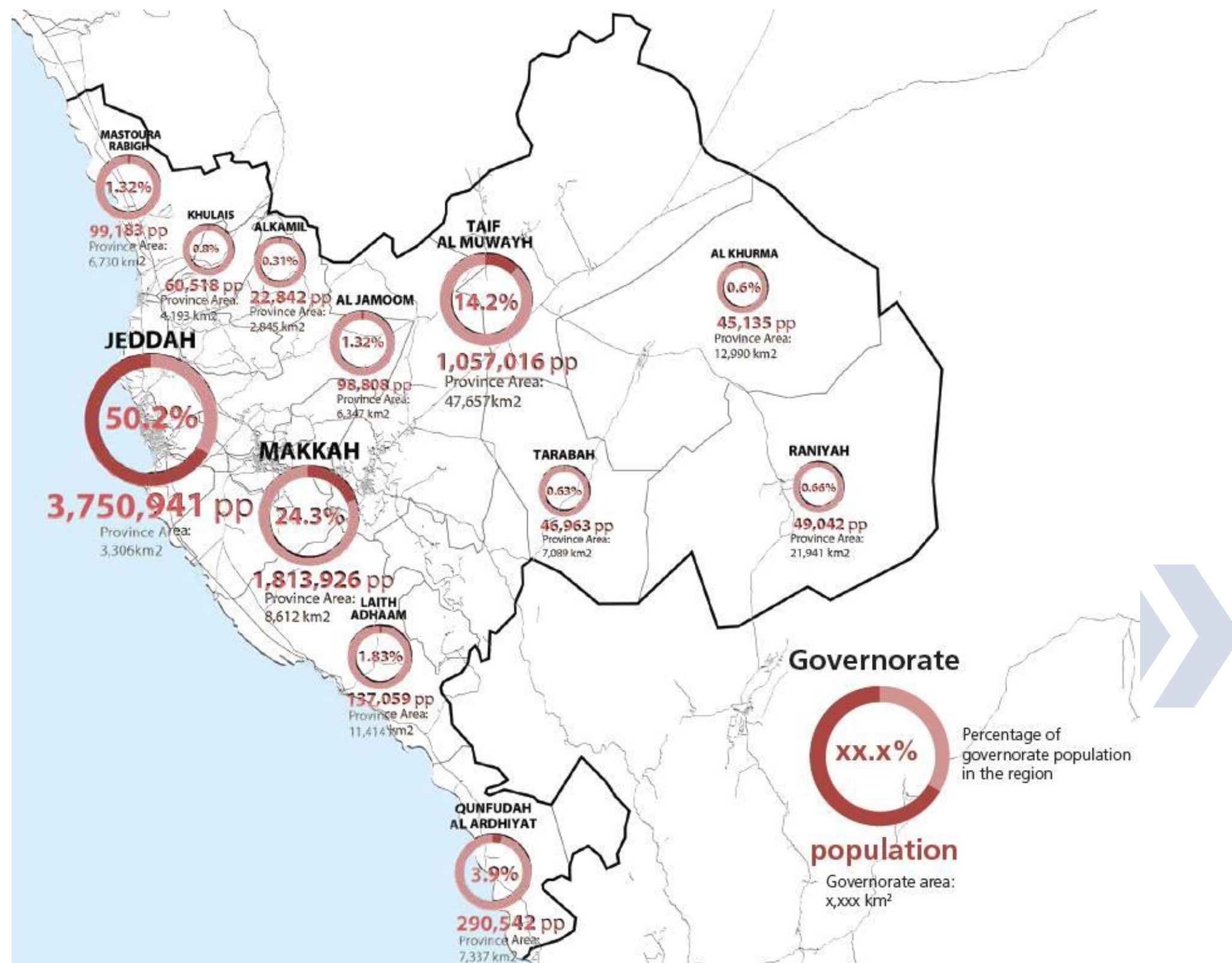


Figure 4-32: Population Distribution in the Governates according to the 2010 Census

4.3.1.5 Economy and Employment

The Makkah Region's economy, as measured by its 2012 gross domestic product (GDP) of 288 billion Riyals, accounted for 10.9% of the Kingdom's overall GDP and 20.8% of the non-oil and gas GDP [6]. The region's GDP saw a substantial average annual increase of 30% over the three-year period from 2009 to 2012 [6]. The primary drivers of the region's GDP were the real estate and financial services sectors, contributing 18%, followed by industry at 16.7%, trade at 16.7%, transport and communications at 9.5%, building and construction at 6.7%, and personal and community services at 3.3% [6] as presented in Figure 4-33.

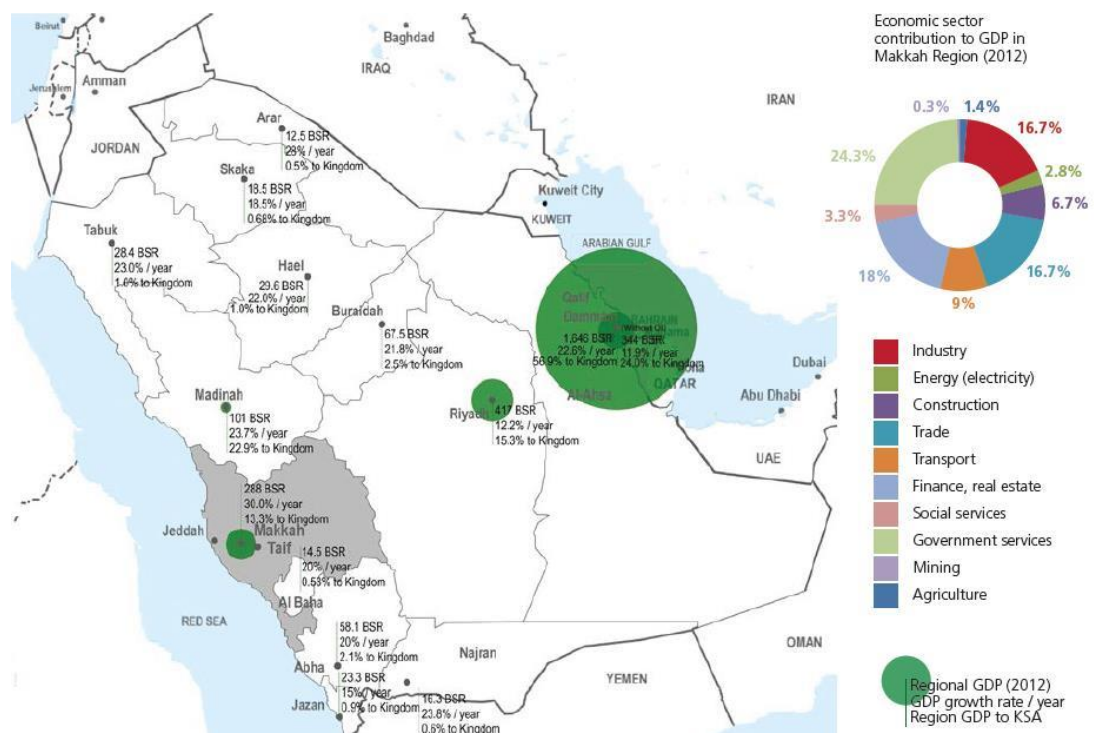


Figure 4-33: Regional Gross Domestic Product and Economic Sector Contribution

4.3.1.6 Community Adjacent to Project

The Project site is owned by the MoMAH.

The Project site would benefit from access to facilities shared with the neighbouring Haden village. Hotels are available in Taif City such as Mirna Apartments (3-star hotel), Remaj Hotel (4-star hotel) among others within a 100-minute car drive. A list of the nearest cities, towns and villages are detailed in Table 4-31.

City / Town / Village	Closest Distance to Project Boundary
Taif City	100 km
Turbah	110 km
As Sudayrah	40 km
Kulaikh	45 km
Bir Marra	55 km

Table 4-31: List of Cities, Towns and Villages in the Vicinity of the Project Site

Although the Project is situated in an area characterized by largely uninhabited land, proactive and early engagement with the local community shall be undertaken to avoid discontent and facilitate a conducive construction period.

4.3.1.7 Health Care System and Facilities

Healthcare services, including major emergency services are available in Turbah Town. The main hospital is the Al Ameen Hospital in Taif City which is approximately 100 km (100 minutes) away from Route 4410, 80, and 267 following Shehar Road. The ambulance emergency service phone number is local 997.

4.4 Archaeology and Cultural Heritage

4.4.1 Existing Data

According to the Haden PV Park ESIA report [6], no archaeological or cultural heritage sites are present within or close to the Project site. In addition, historical and cultural heritage sites included in the United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage List in Saudi Arabia are distant from the Project area [6].

4.4.2 Site Visit Results

The site visit undertaken on the 5th of April 2025 together with a review of available records revealed no known archaeological or cultural heritage assets within the Project area or immediate surrounding areas such as structures, artifacts, or other heritage features. Additionally, there was no evidence of historical human activities that may have disturbed the Project area [4].

The risk of encountering cultural heritage elements is considered negligible based on the site visit and available records. However, a chance-find procedure will be implemented during the Project construction phase as a precautionary measure.

4.5 Sensitive Receptors

Sensitivity / value of a receptor is understood as the sensitivity of the environmental or social receptor to change, including its capacity to accommodate changes that the Project may bring about.

For the purpose of this ESIA, sensitive receptors (SRs) are defined as:

- Elements of the environment that are of value to the functioning of natural systems (i.e., areas or elements of ecological, landscape or heritage value, species, habitats and ecosystems, soil, air and water bodies or land use patterns); and,

- Human receptors, such as stakeholders (i.e., users of dwellings, places of recreation, places of employment, community facilities or household relocation) and human systems (e.g., employment market, population disease susceptibility and disease communicability, exposure to toxicity of chemicals).

The anticipated SRs for each environmental and social value are summarised in Table 4-32.

Environmental / Social Aspect	SRs
Natural Vegetation Cover	Flora, habitat and fauna.
Biodiversity	- Ecological habitats; - Flora; - Avifauna; - Mammals; and, - Reptiles.
Air Quality	- Ambient air quality; - Construction workers; - Informal land users; and, - Flora and fauna.
Noise and Vibration	- Construction workers; - Informal land users; - Regular users of Road 4410; - Operational workforce; and, - Flora and fauna.
Odours	- Ambient air quality; - Construction workers; - Informal land users; - Residents of nearby cities; and, - Operational workforce.
Water Quality	- Standing surface water; - Groundwater quality and the groundwater table; - Domestic water; - Surrounding communities / informal land users and infrastructure; and, - Flora and fauna.
Soil, Landform and Land Use	- Soil and Sediments at Project area; and, - Flora and fauna.
Community Health and Safety	- Construction workers; - Informal land users; - Local communities adjacent to site; and, - Operational workforce.
Landscape and Visual Comfort	- Landform; - Motorists (visual amenity); - Informal land users (visual amenity); and, - Flora and fauna.

Environmental / Social Aspect	SRs
Land Use	▪ Informal land users; and, ▪ Flora and fauna.
Waste Generation	▪ Capacity of existing waste management facilities; ▪ Construction workers; ▪ Operational workforce; ▪ Nearby land users and informal land users; ▪ Soil and groundwater; ▪ Air quality; and, ▪ Ecology.
Socioeconomics	▪ Construction workers; ▪ Informal land users; ▪ Local communities; ▪ Local / regional economy; and, ▪ Employment market.
Archaeology and Cultural Heritage	▪ Known and unknown buried artefacts.

Table 4-32: SRs

Based on the results from the site visit, no SRs are noted within the Project area or within the Project's immediate surroundings. However, high voltage overhead power lines extend approximately 14.6 km in a south-west to north-east orientation, running parallel to the southern boundary of the Project site at an approximate distance of 0.35 km [6].

4.5.1 Area of Influence

An important aspect of the ESIA process is defining the Area of Influence (AoI) to assess potential environmental and social impacts arising from the Project. The AoI refers to the spatial extent within which project activities may cause direct or indirect impacts on environment and social receptors. These receptors include both physical and human elements that may be affected by the Project during various phases.

In accordance with IFC PS1, the AoI for the Project has been defined to ensure a comprehensive understanding of environmental and social risks, impacts and interactions. The AoI for this Project includes the following:

- **Direct Project Footprint:** This comprises the 0.5 km² BESS site and all associated on-site infrastructure, including storage units, power conversion systems, substations, control buildings and internal roads;
- **Associated Facilities:** These include facilities and infrastructure not financed by the Project but essential for its functionality, such as roads providing access to the site; and,
- **Indirect Impact Zone:** The area surrounding the Project that may be affected by construction- and operation-related activities such as dust emissions, traffic movements, stormwater runoff, and noise propagation.

The AoI forms the basis for identifying receptors, determining sensitivity and impact magnitude and evaluating risks, as explained in Section 5.1. It ensures

alignment with GIIP and supports robust assessment of environmental and social performance, in accordance with IFC requirements.

The Aol is defined based on the nature and scale of Project activities. Details of the Aol for each environmental and social aspect are provided in Table 4-33.

Aspect	Area of Influence	Rationale for Aol and Sensitive Receptors
Natural Vegetation Cover and Biodiversity	Footprint of the Project site and immediate surroundings	The project footprint includes sand sheets and dunes with shrub cover. <i>SRs: Transient fauna (e.g., birds) and desert flora adapted to arid conditions.</i>
Ambient Air	Footprint of the Project site and immediate surroundings	Emissions from construction machinery and dust during site clearance may affect local air quality. <i>SRs: Workers and ambient receptors within the immediate surroundings.</i>
Noise and Vibration	Footprint of the Project site and immediate surroundings	Construction activities and heavy machinery may generate noise and vibrations. <i>SRs: Construction workers, and transient users of nearby roads.</i>
Odours	Footprint of the Project site	No major odour sources expected therefore the Aol confined to the site. Temporary odour may arise from waste storage, affecting on-site workers. <i>SRs: On-site workers.</i>
Quality of Soil and Sediments	Footprint of the Project site	Soils consist mainly of very loose to loose sand. Construction and excavation may alter soil quality and compaction. <i>SRs: Site substrata and areas susceptible to erosion.</i>
Water Quality	Footprint of the Project site and any nearby drainage channels or water flow paths	No surface water bodies were identified, but water runoff patterns in surrounding areas suggest risk to ephemeral channels. <i>SRs: localised and seasonal water flow paths.</i>
Health and Safety (Occupational and Public)	Footprint of the Project site and access roads used by workers and support services	Construction and operations pose risks to worker health and passing traffic. <i>SRs: vehicle drivers, and temporary site visitors on access routes.</i>
Natural Landscapes and Visual Comfort	Footprint of the Project site and immediate surroundings including nearby roads	<i>Visual contrast with natural flat desert landscape and distant hills.</i> <i>SRs: motorists on nearby roads.</i>
Land Use	Footprint of the Project site and immediate surroundings	The land is largely unused but under MoMAH. <i>SRs: temporary nomadic settlers.</i>
Waste Generation	Footprint of the Project site including temporary storage and disposal areas	Waste will be generated during all project phases, with temporary storage on-site. <i>SRs: waste handlers and nearby environment if mismanaged.</i>
Economic and Social Aspects	Footprint of the Project site and neighbouring communities and roads used during construction	<i>Project may impact local livelihoods temporarily, especially during road upgrades or land access.</i> <i>SRs: local road users, herders, and contractors.</i>
Ruins and Cultural Heritage	Footprint of the Project site and adjacent areas with surface disturbance potential	<i>Low archaeological potential, but minor risk during excavation due to presence of ancient routes or features.</i> <i>SRs: buried artefacts or structures.</i>
Human Rights	Footprint of the Project site and worker accommodations (if any), and transport corridors	<i>Human rights risks are low but relate to labour standards and occupational health.</i> <i>SRs: Contracted workers and those involved in logistics and waste.</i>

Table 4-33: Aol Summary



5 IMPACT IDENTIFICATION, ANALYSIS AND ASSESSMENT

5.1 Methodology Used for Impact Identification, Analysis and Assessment

5.1.1 Preamble

The ESIA Study will be conducted in accordance with industry best practices and KSA requirements. The sections that follow provide information on the approach to be adopted for the ESIA process.

Section 5.1.4 provides an overview of the impact assessment process which will be followed in the ESIA Study, with the objective of removing potential impacts and risks from the Project through early identification followed by modification of design or proposed activities.

5.1.2 Screening

Screening is a process which determines if a project requires a formal ESIA process to be conducted, either as part of a regulatory requirement or for other purposes such as meeting reputable lender requirements. Screening not only defines the need for an ESIA but determines this through categorisation where regulatory processes categorise a project based on its potential to create an environmental impact.

5.1.3 NCEC Categorisation

The Project site is located within the jurisdiction of the NCEC. The NCEC applies a set of project screening criteria which categorises projects into three levels or types for the purposes of ESIA's. These are defined within the Implementing Regulations [44].

5.1.4 Generic ESIA Process

ESIA is the systematic process of identifying and assessing the potential effects on the biophysical and socio-economic environment due to a project or development. As a planning tool, the ESIA will aim to ensure that environmental and social issues throughout the entire Project lifecycle are anticipated and considered by the Project Proponent. It will also serve as a framework for establishing Project controls to reduce or prevent adverse environmental or social impacts. In this way, the Project's environmental performance is improved as impacts and risks of impacts are reduced in number and scale.

During the design stages of the Project life cycle, there will be an iterative process of design, impact identification, mitigation and (if necessary) redesign.

Following the iterative process, a time comes when the design is fixed, also referred to as a 'design freeze'. Once a final design freeze has been established and proposed mitigation has been approved and committed to, a final objective assessment of the Project's impacts on the receiving environment and any potential significant environmental effects will be identified and determined for their importance (significance).

5.1.4.1 Terminology of Basis of Assessment

The determination of effects, receptors and consequential impacts and their significance (importance) is a central aspect of an ESIA Study. It is important that, to the extent possible, a standardised approach is utilised, and that standard terminology is utilised when ascribing significance.

The process of determining the importance of a project-induced change in environmental conditions is based around two (2) functions. The magnitude of the change that is induced by the 'project effect', and secondly the perceived 'value or sensitivity of the receptor' being affected by the project. The result of an effect acting on a receptor is termed the Impact (i.e., $\text{Effect} \times \text{Receptor Value} / \text{Sensitivity} = \text{Impact}$). The terms effect and impact will not be used interchangeably within the ESIA Study Report. Definitions of the terminology are provided below.

5.1.4.1.1 Effect

In the ESIA, the term 'Effect' will be used to define any change to the environment, whether adverse or beneficial, wholly or partially resulting from the Project's activities (i.e., its environmental aspects). In many instances this change, or Effect can be measured.

Illustrative examples of project Effects (not specific to this Project) are provided in Table 5-1.

Environmental Aspect	Project Effect
Noise from On-Site Machinery	Increase of sound levels of 15 decibels (dB) at boundary line due to operational noise.
Clearance of Site	Loss of 5 hectares of semi natural ecological habitat due to site clearance.
Emissions of Air Pollutants from On-Site Sources	Increase in ground level concentrations of NO ₂ of 20 micrograms per cubic metre (µg/m ³) due to operation of new boiler.

Table 5-1: Illustrative Examples of Effects

From Table 5-1, an Effect describes the physical change in condition due to a project activity. They are, wherever possible, measurable and have an actual magnitude ascribed to the Effect.

Within the ESIA, the magnitude of Effect will be reported as physical values. However, to produce a standardised approach to the assessment of Impact Significance (see Section 5.1.4.1.4), the Effect magnitude will also have a semantic scale of High, Medium, Low and Negligible.

Whilst the actual change in physical condition is the main consideration in determining Effect magnitude, other inherent factors are considered when assigning values to High, Medium, Low and Negligible categories. These include duration, reversibility and frequency of the Effect. Within the ESIA process, subject specialists will utilise the guidance set out in the thresholds of Effects statements but will be allowed flexibility to change the Effect level based on these

other factors and professional judgement. Where this has occurred, justification will be provided on the reasoning for changing the Effect level.

Within the ESIA Study Report, each of the environmental topics 'Scoped In' will provide thresholds of Effect which relate physical magnitudes to the semantic scale.

5.1.4.1.2 Receptor Sensitivity

The second function in determining the significance of a project-induced change to the environmental conditions is the identification of those aspects of the environment which may be affected by the effect.

Those environmental aspects which may be affected by a project effect are termed SRs, and can be defined as:

- Elements of the environment that are of value to the functioning of natural or human systems (i.e., areas or elements of ecological, landscape or heritage value, soil and sediment, air and water bodies); and,
- Human receptors, such as people (i.e., users of dwellings, places of recreation, places of employment and community facilities), and human systems (e.g., employment market).

The choice of receptors and the importance placed upon them is project-specific and generally are a function of human value systems. Most ESIA Studies use standard types of physical receptors such as residential areas, rare or protected species or archaeological resources for example. In addition, local stakeholders such as regulators and local population will have their own perceptions on what are important aspects of the environment and the relative value, they place on them. Such aspects may be reflected in legislation and regulations but also stakeholder's views should be considered in determining receptors.

As part of the ESIA process, these receptors will be ascribed a level of value based on their perceived value at a geographical scale and / or the sensitivity of the receptor to change. The semantic terminology proposed for the ESIA is presented in Table 5-2.

Value / Sensitivity	Definition
International / High	High importance and rarity, international scale and limited potential for substitution (e.g., school or hospital receptor).
National / Medium	High importance and rarity, national scale, and limited potential for substitution (e.g., residential receptor).
Regional / Low	High or medium importance and rarity, regional scale, limited potential for substitution (e.g., commercial or recreational receptor).
Local / Negligible	Low or medium importance and rarity, local scale.

Table 5-2: Semantic Descriptions of Receptor Sensitivity Value

In addition to actual physical receptors, an important aspect of the ESIA process is determining if the project's environmental releases (e.g. air emissions) are in accordance with national standards set out in legislation or in authoritative

relevant guidance. The approach to assessing impacts on regulatory standards will be set out in the individual chapters where appropriate. Any variations in this standard approach to suit specialist topics will be highlighted and justified within the specialist assessment chapters.

5.1.4.1.3 Impact

As noted above, the product of an Effect interacting with a Receptor Value / Sensitivity is termed the 'Impact'. An Impact can only occur if there is an Effect and a receptor. Impacts may be either positive and negative and will be ascribed to a significance level based on the correlation between the Effect Magnitude / Severity and Receptor Value / Sensitivity.

5.1.4.1.4 Ascribing Significance Level to an Impact

The ESIA process to be undertaken for this Project will use a two-dimensional matrix to ascribe Significance to an identified Impact. The matrix uses four levels of "Magnitude" or "Effect" and four levels of "Receptor Value" or "Sensitivity" to change. The matrix is presented in Table 5-3 and shows four levels of Impact Significance, namely Major, Moderate, Minor and Non-Significant (N/S). The semantic definition of these terms is provided in Table 5-4.

Magnitude / Effect	Receptor Value / Sensitivity			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	N/S
Medium	Major	Moderate	Minor	N/S
Low	Moderate	Minor	Minor	N/S
Negligible	Minor	N/S	N/S	N/S

Note: N/S = Non-Significant

Table 5-3: Matrix for Determining Significance of Impact

Term	Definition
Major	Impacts with Major Significance will be readily apparent and lead to permanent and irreversible changes to receptors and / or permanent interruption of natural, physical or socio-economic systems.
Moderate	Impacts with Moderate Significance will be observable and may lead to permanent change to receptors or long-term interruption of natural, physical or socio-economic systems.
Minor	Impacts with a Minor Significance will be observable but not anticipated to cause long term irreversible changes to natural, physical or socio-economic systems.
N/S	An impact which does not exceed the threshold standard, is on a low sensitivity receptor or group of receptors and where the change in status is imperceptible.

Table 5-4: Semantic Description of Significance of Impact Terminology



5.1.4.2 Probability of Impacts Occurring

Impacts can be divided into two (2) groups of probability of occurrence. The first are planned events, where Impacts can be reasonably expected to occur as a result of the normal course of project activities. Thus, the loss of habitat due to ground clearing for a project is a certainty if that activity occurs.

On the contrary, environmental and social Impacts can occur from unplanned events, such as accidental incidents and / or loss of containment during the construction or operational phases of the project.

Within the proposed ESIA process, the description of Impacts includes the definition of its status, i.e. planned or unplanned. If an unplanned event is predicted, a definition of the likelihood of the event occurring based on worldwide experience and, where available, risk assessments conducted for the Project, will be provided. These are grouped as High, Medium and Low probability or likelihood.

5.1.4.3 Mitigation

Mitigation refers to measures which either remove or reduce environmental Impacts or risks of Impacts occurring. These can take the form of normal design elements which reduce Impacts. For example, standard use of low NOx burners in heaters or boilers, or additional measures recommended to further reduce impact magnitude and / or risk such as raising stack height.

The ESIA process has adopted the mitigation hierarchy recommended in the IFC Performance Standards and Guidance Notes [45]. Table 5-5 presents the approach to be adopted in the ESIA Study.

Condition	Mitigation Approach	Explanation / Process to Achieve
Preferred Approach	Avoidance	Through site selection / Project design changes / technological solutions.
Where Avoidance is Not Possible	Minimisation	Site layout / technological solutions.
Where Residual Significant Impacts Remain	Offset or Compensation	Topic dependent but may include financial / resettlement / alternative land management / habitat creation / relocation of resources.

Table 5-5: Approach to Mitigation

5.1.4.4 Residual Impacts

Following the initial identification of Impacts and risks and the commitment of mitigation measures, a final assessment of Impact Significance will be conducted. For the purpose of the ESIA, any impacts which remain significant (Minor, Moderate, Major) after mitigation measures have been applied shall be considered and reported as Residual Significant Impacts.



5.1.5 Scope of Assessment

5.1.5.1 Physical Project Scope

The ESIA process will include all elements of the proposed Project as set out in the Project description in Chapter 3. It also includes any directly associated temporary facilities such as newly constructed access roads and laydown areas as required for the Project. Where possible, actual Project data will be used for construction assessments or assessments will be based on experience of similar projects in similar conditions regarding manpower requirements, construction activities and machinery to be used on-site.

5.1.5.2 Spatial Scope of Assessment

The ESIA process will include all temporary work areas and required land-take such as laydown areas and construction areas which will be specifically developed for this Project. Any existing facilities to be used by the Project, will not fall within the study scope of the ESIA (though these will be mentioned at a high-level, as seen appropriate).

5.1.5.3 Temporal Scope of Assessment

The ESIA process will evaluate all stages of the Project which are listed as follows:

- Early Works and Construction;
- Operations; and,
- Decommissioning and post decommissioning phases have been addressed where sufficient information is available.

5.2 Analysis and Assessment of the Potential Impacts

5.2.1 Natural Vegetation Cover and Biodiversity

An assessment has been conducted to determine the potential impacts of activities associated with the Project on the natural vegetation and biodiversity occurring on-site. Impacts to natural vegetation cover and biodiversity were identified during all Project phases. These impacts and risks are described in the following sections with evaluation of their ratings.

The identified receptors for natural vegetation cover and biodiversity include the natural habitat, flora (plants), and fauna (animals) present within, and in proximity to, the Project area.

Natural Habitat

The habitat classification assessment revealed that the Project area is comprised of one (1) habitat type, namely Sand dunes with shrub cover, based on the classification found in literature.

Flora (Plants)

During the survey period, a total of eleven (11) species of plants from seven (7) families and eleven (11) genera have been recorded across the Project area. Based on the regional and global IUCN assessments, all the flora species documented in the Project area are currently classified as Not Evaluated / Not

Assessed. Moreover, none of the recorded species are included in the KSA list of HCP Taxa. This indicates that the populations of the species found on-site are currently not under the risk levels meeting the criteria for the various IUCN threatened taxa categories.

Fauna (Animals)

In terms of fauna, a total of four (4) species of birds, two (2) species of mammals, and one (1) species of reptile have been recorded across the Project area. All the Fauna species documented in the Project area are currently classified as Not Evaluated / Not Assessed. Moreover, none of the recorded species are included in the KSA list of HCP Taxa.

The results of the terrestrial ecology baseline survey indicate that Project area has relatively low terrestrial ecological activity.

5.2.1.1 Potential Interactions of Project with Receptors

The habitats, along with the associated flora and fauna in the project area, have been assessed based on the conservation value of the identified habitats and species. Assigning values to these habitats and species helps pinpoint areas of significant ecological importance and supports the development of effective mitigation and management strategies.

5.2.1.1.1 Construction Phase

Potential impacts on natural vegetation and biodiversity during operation phase may include:

- Loss or Change of Habitat within the Development Area;
- Loss of Flora and Fauna due to Construction Activities (i.e. Site Clearance); and,
- Disturbance of Terrestrial Vertebrates due to Construction Activities including Noise.

5.2.1.1.2 Operational Phase

Potential impacts on natural vegetation and biodiversity during operation phase may include:

- Behavioural Change of Wildlife as a Result of Increased Human Activity; and,
- Injury or Mortality of Terrestrial Vertebrates due to Collision with Vehicles.

5.2.1.1.3 Decommissioning Phase

Potential impacts on natural vegetation and biodiversity during decommissioning may include:

- Vegetative metabolic distress; and,
- Injury and mortality of wildlife.

5.2.1.1.4 Unplanned Events

Potential impacts on natural vegetation and biodiversity during unplanned events may include:



- Potential, Accidental Introduction and Proliferation of Invasive Alien Species (IAS).

5.2.1.2 Threshold of Impact Magnitude

5.2.1.2.1 Construction Phase

The thresholds of impact magnitude for Low, Medium, or High impact are shown in Table 5-9. The impact magnitudes are applicable for the construction, operation and decommissioning phases.



Magnitude / Effect	Species	Habitats / Designations	Ecosystem Functioning
Low	Loss or displacement of one High Priority Conservation (HCP) or one IUCN Near Threatened or higher species	Loss or significant degradation of: Less than 0.0025 km ² of internationally/nationally protected area; Less than 0.01 km ² of any habitat listed in the Saudi National Biodiversity Action Plan; Less than 0.02 km ² of locally important habitat; and, Areas of land which have limited ecological value up to 0.10 km ² .	Impact on minor components of the ecosystem which does not threaten current status or functioning
Medium	Loss or displacement of two (2) to three (3) HCP or two IUCN Near Threatened or higher species	- Loss or significant degradation of: - More than 0.0025 km² and less than 0.01 km² of internationally/nationally protected area; - More than 0.01 km² and less than 0.02 km² of any habitat listed in the Saudi National Biodiversity Action Plan; - More than 0.02 km² but less than 0.04 km² of locally important habitat; and, - Areas of land which have limited ecological value of 0.10 km² – 0.25 km².	Loss of key species from ecosystem or reduction in size which threatens ecosystem stability
High	Loss or displacement of more than four or more HCP or three IUCN	- Loss or significant degradation of: - More than 0.01 km² of internationally/nationally protected area; - More than 0.02 km² of any habitat listed in the Saudi National Biodiversity Action Plan; - More than 0.04 km² of locally important habitat; and, - Areas of land which have limited ecological value more than 0.25 km².	Clear loss of ecosystem viability and functioning through removal of species, interference with energy flows or food chains

Table 5-6: Threshold of Impact Magnitude for Natural Vegetation Cover and Biodiversity



5.2.1.3 Impact Assessment

5.2.1.3.1 Construction Phase

Loss or Change of Habitat within the Development Area

During the construction phase several activities contribute directly or indirectly to the loss or alteration of habitats. These include land clearing, soil compaction, installation of infrastructure, and disturbances to local hydrology.

The initial steps of the Project construction often involves clearing areas of land to create space for infrastructure. In arid regions, where vegetation is already sparse and plants are specially adapted to harsh conditions, removing native flora can lead to significant habitat loss.

In general, the majority of flora and fauna that occupy the natural habitat onsite are common and adaptive and therefore the anticipated loss of natural habitats will have a limited impact on flora and fauna that are of national importance. However, given the (1) relatively short duration of construction activities for the specific infrastructure as part of the Project; (2) the small Project footprint of the infrastructure in relation to the wider already permitted PV Park; and (3) the notable modification and fragmentation of the areas surrounding the Projects, the direct impact of this specific Project is relatively limited. Due to the limited and temporary nature of the initial construction activities, the magnitude of the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

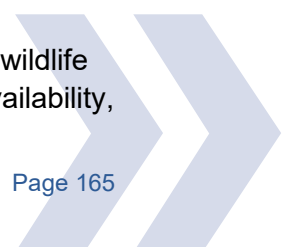
Loss of Flora and Fauna due to Construction Activities (i.e. Site Clearance)

The majority of native flora and fauna recorded in the Project area are a highly resilient or highly adaptive species that are commonly found in the desert environment.

Given the anticipated construction activities, it is highly likely that the terrestrial flora and fauna will experience direct impacts during the early civil works, such as site clearance and preparation. According to the results of the terrestrial ecology baseline survey, most of the recorded flora and fauna in the Project area are classified as Least Concern on both Regional and Global Red Lists and are considered common and widespread in desert habitats like those in the Arabian Peninsula. However, there is a possibility that terrestrial species of conservation concern can still inhabit (colonise / burrow) within the Project post-survey. Although it is possible that site preparation works may lead to the mortality of the species, given the (1) relatively short duration of construction activities for the specific infrastructure as part of the Project; (2) the small Project footprint of the infrastructure in relation to the wider already permitted PV Park; and (3) the present condition of then site in terms of flora and fauna, the direct impact of this specific Project is relatively limited. Due to the limited and temporary nature of the initial construction activities, the magnitude of the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

Disturbance of Terrestrial Vertebrates due to Construction Activities including Noise

In general, disturbances are significant events that disrupt ecosystems, wildlife (particularly vertebrates), population structures, and/or alter resource availability,



such as foraging and roosting sites. Construction-related disturbances to nearby foraging and roosting areas are often linked to the increased human presence associated with these activities. Additionally, a review of existing literature suggests that noise alone may not cause a disturbance unless it is accompanied by a perceived visual threat. Historical data also indicates that a noise level of about 85 dB at the bird's ear is required to effectively scare birds.

Construction is typically carried out in a series of steps or phases, with noise levels varying significantly depending on the phase. However, due to similarities in the sources of noise, construction equipment can generally be categorized into three types: heavy equipment (e.g., excavators, backhoes), stationary equipment (e.g., pumps, generators), and impact equipment (e.g., pile drivers). As a result, construction noise is likely to temporarily affect birds and other wildlife that seek refuge in natural habitats near Project sites.

Research on the impact of construction noise on terrestrial vertebrates, particularly birds, indicates that while initial construction activities (such as noise from machinery during site clearance and piling) may cause disturbances, birds may become more accustomed or habituated to the noise over a period of several weeks. The significant disturbance caused by uncontrolled noise during construction could disrupt the daily foraging patterns of resident fauna living near natural habitats. However, considering the 1) results of the terrestrial ecology survey which show that the Project area has relatively low ecological activity; 2) the small Project footprint of the infrastructure in relation to the wider already permitted PV Park; and 3) the relatively short duration of the construction activities, the unmitigated impact of the Project (primarily from noise) on foraging and resting terrestrial vertebrates, especially birds, magnitude of the impact is the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

5.2.1.3.2 Operation Phase

During the operation phase for this specific Project, the potential for additional impacts on ecosystems is relatively low compared to the more intense impacts that occur during construction (such as habitat loss or alteration, and changes in species composition and diversity). The development will create artificial habitats, including buildings (for roosting or refuge), water sources (such as ponds and water points), and waste areas (which may attract both pest and non-pest species). As a result, various species may be drawn to these new resources and may thrive in response to the opportunities provided by the Project.

Behavioural Change of Wildlife as a Result of Increased Human Activity

Disturbance to foraging and resting terrestrial vertebrates (especially birds) may occur due to operational noise from the project. The primary source of anthropogenic noise during operations is typically increased traffic and maintenance activities. The presence of anthropogenic activity and associated waste may lead to an increase in pest species and predators of those species. It is highly probable that birds and wildlife, in general, will eventually become accustomed to the occasional increases in noise levels and human presence. Considering the 1) results of the terrestrial ecology survey which show that the Project area has relatively low ecological activity; 2) the small Project footprint of the infrastructure in relation to the wider already permitted PV Park; and 3) the

relatively short duration and infrequency of maintenance activities which may have minimal effects, the magnitude of the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

Injury or Mortality of Terrestrial Vertebrates due to Collision with Vehicles

There is a likelihood of vehicle encounters and collisions with small to medium-sized non-volant mammals (e.g., Red Fox (*V. vulpes*) and reptiles, particularly at night. Any localized mortality or injury to species, especially threatened vertebrates, caused by vehicle collisions would be permanent. However, considering the 1) results of the terrestrial ecology survey which show that the Project area has relatively low ecological activity; 2) the surrounding area is already a permitted PV Park with ongoing construction activities, the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

5.2.1.3.3 Decommissioning Phase

Disturbance to the natural vegetation and biodiversity within and around the Project area due to decommissioning activities could result in biodiversity loss and alterations to the surrounding ecosystem. Potential impacts on natural vegetation and biodiversity during decommissioning may include:

- Vegetative metabolic distress; and,
- Injury and mortality of wildlife.

Vegetative Metabolic Distress

The activities that generate dust during the operational phase of the Project will continue to produce fugitive dust during the decommissioning phase, although the earthmoving activities in this phase will be more restorative than extractive. Project activities involving earthmoving or ground disturbance, such as vegetation removal, traffic movement, restorative work in pits and waste disposal areas, as well as crushing and material processing, have the potential to generate fugitive dust. However, the surrounding area is modified and fragmented as well. Therefore, considering the small Project footprint of the infrastructure in relation to the wider already permitted PV Park, the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

Injury and Mortality of Terrestrial Vertebrates due to Collision with Vehicles

The Project area is in a relatively isolated region. Vehicle encounters and collisions with small to medium-sized non-volant mammals (such as Red Foxes (*Vulpes vulpes*)) and reptiles are likely, particularly at night. Any localized mortality or injury to species, especially threatened vertebrates, caused by vehicle collisions would be permanent. However, considering the 1) results of the terrestrial ecology survey which show that the Project area has relatively low ecological activity; 2) the surrounding area is already a permitted PV Park with a fragmented and modified landscape, the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.



5.2.1.3.4 Unplanned Events

Potential, Accidental Introduction and Proliferation of IAS

The potential introduction and spread of IAS such as Black Rats (*Rattus rattus*) and Feral Cats (*Felis catus*) on-site could pose further risks to native terrestrial vertebrates, particularly birds and reptiles. Increased local population pressures from predation are likely to affect the current community assemblages of fauna and flora within the Project area and surroundings. Any localized species loss resulting from predation by Feral Cats (*F. catus*) and rat species would be permanent. Without mitigation, the impacts of IAS are considered to be *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.

5.2.1.4 Cumulative Impacts

The BESS is located within the footprint of a permitted Haden PV Park, as such, the cumulative impacts of land disturbance and habitat loss have been assessed under the broader Haden PV Park development. The BESS occupies a relatively small area and will not result in additional meaningful loss of vegetation or biodiversity. No further cumulative impacts are anticipated.

5.2.2 Ambient Air

5.2.2.1 Potential Interactions of Project with Receptors

5.2.2.1.1 Construction Phase

The significance of dust impacts is largely dependent on local meteorological conditions, including the wind direction, rainfall and the distance from the point of emission, as dust formation is considered low during wet and calm periods.

The US EPA indicates that precipitation levels > 0.2 millimetres per hour (mm/hr) will effectively attenuate dust, while wind speeds > 5.3 m/s will typically lift dust from open surfaces [46]. This will be lower for dust generated by mechanical means (i.e., due to the movement of vehicles over unpaved surfaces and earth moving activities), at around 3 m/s. At most wind speeds, dust will typically travel a maximum distance of 200 m from the source before falling from the air column [47]; and, at high wind speeds (5.3 m/s), dust is unlikely to travel more than 500 m from the source [47]. Early works and construction related air quality impacts are therefore likely to occur within a 500 m distance from the construction activities. Given that precipitation is extremely low at the Project area, rainfall is unlikely to attenuate dust formation within the early work and construction areas.

Dust may also negatively affect the natural processes of photosynthesis, respiration, and transpiration of plant communities. Impacts from dust emissions on flora are discussed in Section 5.2.1.

A qualitative assessment of the generation and dispersion of dust PM₁₀ and PM_{2.5}, associated with the Project has been undertaken using the experience of similar projects, the nature and scale of activities, the prevailing wind directions and the sensitivity of receptors.

5.2.2.1.2 Operation Phase

No significant risks on air quality are anticipated once the Project and access road are in operation. Operational impacts will be limited to fugitive dust and airborne particles from vehicle movement.

5.2.2.1.3 Decommissioning Phase

Impacts during the decommissioning phase are likely to be the same as those from the construction phase and will be limited to dust and PM₁₀, and PM_{2.5} emissions.

5.2.2.2 Threshold of Impact Magnitude

5.2.2.2.1 Construction Phase

Threshold for Dust Impacts

The assessment of potential construction impacts requires the classification of receptor sensitivity [48]. The receptor sensitivity categories and descriptions are provided in Table 5-7, with the impact of magnitude thresholds provided in Table 5-8.

Sensitivity of Receptor	Condition
High Sensitivity	- Locations where users can reasonably expect enjoyment of a high level of amenity; - Appearance, aesthetics or value of property would be diminished by soiling; or, - People / property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land e.g. residential dwellings, museums, medium/long-term car parks, car showrooms.
Medium Sensitivity	- Locations where users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or, - Appearance, aesthetics or value of property could be diminished by soiling; or, - People or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land e.g. parks and places of work.
Low Sensitivity	- Enjoyment of amenity would not reasonably be expected; - Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or, - There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the

Sensitivity of Receptor	Condition
	land e.g. playing fields, farmland (unless commercially sensitive horticultural), footpaths, short term car parks and roads.
Negligible Sensitivity	Open desert or uninhabited areas with limited ecological sensitivity.

Table 5-7: Threshold of Receptor Sensitivity

Magnitude of Impact	Condition
Earthworks	
Large	Total site area >110,000 m ² , potentially dusty soil type (e.g. clay, which will be prone to suspension when dry due to small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >6 m in height.
Medium	Total site area 18,000 m ² – 110,000 m ² , moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 3m - 6m in height.
Small	Total site area <18,000 m ² , soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <3 m in height.
Construction	
Large	Total building volume >75,000 m ³ , on site concrete batching, sandblasting.
Medium	Total building volume 12,000 m ³ – 75,000 m ³ , potentially dusty construction material (e.g. concrete), on site concrete batching.
Small	Total building volume <12,000 m ³ , construction material with low potential for dust release (e.g. metal cladding or timber).
Trackout	
Large	>50 HDV (>3.5t) outward movements (1) in any one day (2) potentially dusty surface material (e.g. high clay content), unpaved road length >100 m.
Medium	20-50 HDV (>3.5t) outward movements (1) in any one day (2) moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m.
Small	<20 HDV (>3.5t) outward movements (1) in any one day (2) surface material with low potential for dust release, unpaved road length <50 m.

(1) A vehicle movement is a one-way journey i.e. from A to B, and excludes the return journey
(2) HDV movements during a construction project vary over its lifetime, and the number of movements is the maximum not the average

Table 5-8: Threshold of Construction Impacts for Air Quality Pollutants

5.2.2.2.2 Operations Phase

Risk levels for the operations phase are based on the terminology and factors in Section 5.1 and the impact matrix in Table 5-3.

5.2.2.2.3 Decommissioning Phase

Risk levels for the decommissioning phase are the same as those for the construction phase.

5.2.2.3 Impact Assessment

Construction activities associated with the development of the Project are expected to generate fugitive dust and PM₁₀ emissions due to ground disturbance, excavation, material handling, and vehicle movement on unpaved surfaces. Given the nature and limited scale of construction activities, the exhaust emissions from on-site and surrounding traffic suggests are unlikely to significantly impact the local air quality and have therefore been screened out of this assessment [49].

Regarding the Operation phase, the BESS system will not include combustion processes and will typically operate within sealed containers under passive or active thermal management systems.

While climate change does not represent an air quality-related risk, both physical risks (e.g., increased ambient temperatures) and transitional risks (e.g., evolving regulatory frameworks or energy market dynamics) have been considered within the operational phase assessment.

Decommissioning activities are anticipated to mirror those of the construction phase, including dismantling, ground disturbance, and increased vehicular movement, all of which may contribute to short-term dust emissions. These impacts have been considered below.

5.2.2.3.1 Construction Phase

The air quality impact assessment has been carried out to determine the risk ranking of construction related dust emissions to the atmosphere from key activities associated with the early works and construction phase of the Project, which are earthworks, general construction activities and vehicle movements. These activities are further described below:

- Clearing and earthworks, including site levelling and excavation; and,
- Site preparation activities and the movement of vehicles over the cleared work area.

Impact of Increased Fugitive Dust and PM₁₀ Emissions

An increase in dust and PM₁₀ emissions from early works and construction activities may affect air quality. Construction activities required for the Project ground earthworks. Therefore, dust generation is usually confined to the work areas with transient and temporary potential impacts.

Construction vehicles will include a variety of vehicle classifications, e.g., heavy goods vehicles (HGV), light duty vehicles, trucks, pick-up trucks, and other equipment. These construction vehicles will commute to the Project site. Heavy equipment includes earth-moving equipment, such as excavators as well as materials handling equipment like graders. Given the small scale of the Project, there will only be a small number of HGVs travelling towards and away from the site that will vary throughout the early works and construction period. As far as possible, the Project site will be accessed via the future access road. The ground surface material is likely to be dusty, and sections of unpaved roads may be traversed by construction vehicles.

The IAQM methodology has been adapted and conservatively simplified in this assessment in order to be applicable to the typically dry and arid environment, as well as to improve the overall readability of the impact assessment approach and outcomes.

In accordance with the IAQM, the main potential air quality impacts associated with construction are:

- Dust deposition resulting in the soiling of surfaces;
- Elevated PM₁₀ concentrations resulting from dust emissions of on-site activities; and,
- Harm to ecological receptors.

The IAQM methodology ranks the sensitivities of receptors to the construction impacts based on the baseline air quality, number of receptors, and critically, the proximity of the receptors to the construction activities. In accordance with a conservative screening assessment approach, assuming all sensitive areas are within the highest baseline air quality category, the threshold of proximity to construction impacts is 200 m. Therefore, beyond 200 m, the sensitivity of SRs is considered to be low, and beyond 350 m, impacts are considered to be negligible.

Based on the overall negligible impact on human receptors from the IAQM assessment, the impact of dust and fugitive emissions from early works and construction activities prior to mitigation is *Negligible*. Construction workers have a sensitivity of *Negligible*. Therefore, the significance is classified as **Non-Significant**.

Impaired Visibility for Road Users

General construction activities and earthworks will cause dust generation, leading to impaired visibility for road users due to windblown dust, potentially increasing vehicle collisions [50].

Particulate matter suspended in the air is the main cause of visibility degradation which may impact driving conditions in certain instances [51]. However, the nearest main road is located approximately 6 km south of the Project site, which is further than dust is likely to travel. Therefore, the significance is classified as **Non-Significant** (*Negligible* impact and *Negligible* sensitivity).

5.2.2.3.2 Operations Phase

No significant risks on air quality are anticipated once the Project and associated access road are installed and in operation. Whilst impacts to air quality are not anticipated during the operation phase, there are potential risks associated with climate change, which are assessed below.

Vulnerability of the Project to Climate Change

The Project within Haden PV Park has been screened for vulnerability to both physical and transition climate risks in alignment with IFC Performance Standards (PS1 and PS3), Equator Principles IV, and guidance from the Task Force on Climate-related Financial Disclosures. The site, located on a plateau in Makkah Province at approximately 1,100 m above sea level, is not close to

permanent water bodies and shows very low levels of vegetative cover, indicating generally low exposure to climate-sensitive hazards.

Physical climate risks include extreme heat, flash flooding, dust storms, and wildfires. Summer temperatures regularly exceed 40°C, but the BESS will be housed in climate-controlled enclosures with thermal management systems designed to withstand ambient conditions of -20°C to +50°C. Flash flooding risk is mitigated through extension of the solar farm's surface water management infrastructure, with further protection to be confirmed via site-specific hydrological studies and refined design during the Engineering, Procurement, and Construction stage. Dust storms, although common, are managed through enclosures and maintenance protocols. Wildfire risk is negligible given the sparse vegetation and low biomass loading near the BESS pad.

Risks such as projected temperature increases of 1.5–2.0°C by 2050 are within the operational tolerances of the BESS design, and ongoing performance will be supported by robust thermal controls. The system has no operational dependency on water, and thus water scarcity is not considered a material risk.

Transition climate risks have also been considered. The BESS does not emit greenhouse gases during its operation. Importantly, it enables greater integration of renewable energy by allowing solar-generated electricity to be dispatched on demand, displacing fossil fuel-based generation. This functionality directly supports Saudi Arabia's Vision 2030, the Saudi Green Initiative, and the country's commitments under the Paris Agreement. No significant policy, market, or technology transition risks have been identified that would negatively affect the operation or viability of the Project.

Design and operational measures include integrated HVAC and fire suppression in battery enclosures, flood protection, and emergency response protocols. Maintenance routines are tailored for dust-prone environments, and climate risk exposure will be reviewed periodically under the management systems.

Overall, the Project is deemed to have low vulnerability to climate change impacts. It does not materially contribute to GHG emissions and plays a supporting role in national and international decarbonisation efforts. The magnitude of effect is considered *Negligible*, and the receptor sensitivity is *Negligible*, hence an overall rating of **Non-Significant**.

5.2.2.3.3 Decommissioning Phase

Impacts from decommissioning activities will be the same as those from the construction phase. These have been assessed below.

Impact of Increased Fugitive Dust and PM₁₀ Emissions

Due to the distance to the nearest receptor, based on the overall negligible impact on human receptors from the IAQM assessment, the Impact of dust and fugitive emissions to identified SRs from decommissioning activities prior to mitigation is *Negligible*. The receptor sensitivity is *Negligible*, due to the distance from the nearest boundary. Therefore, the Significance is classified as **Non-Significant**.

Impaired Visibility for Road Users

Particulate matter suspended in the air is the main cause of visibility degradation [51]. The nearest main road is located approximately 6 km south of the Project site, which is further than dust is likely to travel. Therefore, the significance due to decommissioning activities is classified as **Non-Significant** (*Negligible* magnitude and *Negligible* sensitivity).

5.2.2.3.4 Unplanned Events

In the case of uncontrolled fires in the area, battery fires / thermal runaway could occur. This could potentially lead to the release of smoke and other gases affecting the surrounding areas. There are key measures in place to minimise the consequences of fires / thermal runaway.

Unplanned events such as uncontrolled fires in the surrounding area pose a potential risk of thermal runaway within the Project, which could result in the release of smoke and harmful gases. To mitigate this risk, several integrated safety measures have been incorporated into the system design and operation. Early detection of thermal anomalies is achieved through sensors that monitor temperature, smoke, and gas release, enabling immediate response actions such as targeted cooling using HVAC or liquid-based systems. Fire propagation is further limited through physical isolation, including the use of fire-resistant barriers and a minimum separation distance of 3 m between battery modules. Passive design features, such as climate-adaptive sealed containers with dehumidifiers and condensation sensors, help prevent moisture-induced failures. Strategically located fire hydrants ensure external firefighting resources can respond effectively, supported by site access for emergency vehicles. Internally, fire suppression systems are linked to a SCADA platform that provides real-time alerts and activates aerosol-based suppression, while simultaneously notifying local fire services. Explosion risks are minimised through SCADA-controlled inert gas injection, explosion suppression agents, and deflagration vents to safely redirect pressure. Operationally, battery management systems and power control redundancies enable fault detection, emergency shutdown, and isolation of affected components, thereby maintaining operational continuity across the facility. All systems are designed in compliance with EN 60079-14, NFPA 86, NFPA 855, and NFPA 15, ensuring alignment with internationally recognised fire and explosion safety standards for flammable environments.

Due to the control measures put in place, if an unplanned event takes place it is anticipated to be short lived and have a **Medium** effect on the surrounding areas which have a **Low** sensitivity. The overall significance is anticipated to be **Minor**.

5.2.2.4 Cumulative Impacts

The BESS is located within a permitted Haden PV Park that is currently under construction. Construction of the BESS may coincide with Haden PV Park activities, resulting in temporary, localised emissions from vehicles and equipment. These emissions are expected to be minor and not significant in combination with those from Haden PV Park. No emissions are anticipated during BESS operation. Therefore, cumulative impacts are not anticipated.

5.2.3 Noise and Vibrations

An assessment of the possible impacts of noise from the Project has been conducted, given that there are no SRs identified nearby, the impacts are considered for the construction workers, regular users of Road 4410, informal land users, fauna, and operational workforce. For this reason, a qualitative assessment has been undertaken.

5.2.3.1 Potential Interactions of Project with Receptors

5.2.3.1.1 Construction Phase

During the construction phase of the Project there is the potential for receptors to experience increases in noise levels due to the operation of equipment used during the construction of the Project facilities. The following activities are anticipated to lead to noise emissions during the construction phase and are assessed in the below sections:

- Site clearance;
- Foundation work;
- Civil works;
- Vehicle movements;
- Construction and installation of BESS infrastructure; and,
- Internal road paving / compacting.

5.2.3.1.2 Operation Phase

The Project is not considered a high noise operation, as the Project will not involve any continuously operating mechanical plant or equipment that generates elevated noise levels. Operational activities are limited to infrequent maintenance visits and routine system monitoring, which are not expected to result in any appreciable increase in ambient noise levels. The primary sources of noise such as cooling systems and inverters are enclosed within containerised units designed to meet international acoustic insulation standards. These components typically operate at low power and only intermittently, depending on thermal demand, and are not expected to produce tonal, impulsive or high-frequency noise. Given the relatively low baseline noise environment and the absence of SRs near the Project site, operational phase noise emissions are anticipated to be negligible. On this basis, operational noise has been screened out of this assessment as it does not present a credible pathway to adverse environmental or community impact.

5.2.3.1.3 Decommissioning Phase

Impacts during the decommissioning phase are likely to be the same as those from the construction phase.

5.2.3.2 Threshold of Impact Magnitude

5.2.3.2.1 Construction Phase

The construction noise impact magnitude / effect criteria developed for the Project is detailed in Table 5-9.

Magnitude / Effect	Exceedance of the NCEC Limit (dB(A))	Definition
Negligible	0.1 – 5 dB(A) above applicable noise limit	Construction noise levels that exceed the applicable noise limit by up to 5 dB(A) are considered to be of Minor consequence.
Low	5.1 – 10 dB(A) above applicable noise limit	Construction noise levels that exceed the applicable noise limit by 5 – 10 dB(A) are considered to be of Moderate consequence.
Medium	>10 dB(A) above applicable noise limit	Construction noise levels that exceed the applicable noise limit by more than 10 dB(A) are considered to be of Major consequence.
High	> 10 dB(A) above applicable noise limit AND 75 dB(A)	Construction noise levels that exceed the applicable noise limit by more than 10 dB(A) and exceed 75 dB(A) are considered to be of Severe/Catastrophic consequence.

Table 5-9: Construction Noise Impact Magnitude / Effect Criteria

5.2.3.3 Impact Assessment

5.2.3.3.1 Construction Phase

Noise emissions will be generated from equipment used during the construction of the Project facilities. Given there are no identified SRs, a qualitative assessment of the potential noise from the Project's construction phase has been carried out based on experience from similar projects.

Following the inverse square law, if noise at the Project boundary is conservatively assumed to be 90 dB(A) at 1 m from the Project boundary due to the operation of construction equipment, the noise levels from construction would decrease by 6 dB(A) at every doubling of distance, assuming free-field conditions. Therefore at 100 m it could be assumed that the construction noise could only contribute 50 dB(A) to the surrounding area. With no SRs identified for the Project it is anticipated that construction noise is not expected to exceed the NCEC noise limits at any of the SR locations. The receptor sensitivity is considered to be *Negligible*, with a *Negligible* magnitude of effect resulting in a significance rating of **Non-Significant**.

5.2.3.3.2 Decommissioning

The potential impacts during the decommissioning phase are expected to be similar to those predicted during the construction phase. In this case, noise emissions are expected to be emitted due to the use of decommissioning equipment and tools.

Decommissioning activities can include:

- Infrastructure demolition and piling of infrastructure rubble;
- Transport and dumping of building rubble;
- Transport and dumping of overburden for filling;



- Transport and dumping of topsoil;
- Smoothing of stockpiles by bulldozer; and,
- Grading and reinstatement of sites.

The potential impact identified for the decommissioning phase is a potential increase in the environmental noise levels outside of the Project boundary.

Based on the outcomes of the noise assessment for early works and construction, noise disturbances to receptors the receptor sensitivity is considered to be *Negligible*, with a *Negligible* magnitude of effect resulting in a significance rating of **Non-Significant**.

5.2.3.4 Cumulative Impacts

Temporary noise from BESS construction may occur alongside permitted Haden PV Park works but will remain short-term and localised. Operational noise from the BESS will be limited to sources such as inverters and cooling systems. In combination with Haden PV Park, overall operational noise levels are expected to remain low. No significant cumulative noise impacts are anticipated.

5.2.4 Odours

Considering the nature of the Project, the remote location of the site, the absence of sensitive human receptors, and the lack of substantial odour generating processes, odour has been Scoped Out of this report. Although minor and temporary odour emissions may occur during specific activities such as construction, maintenance, or decommissioning, these are not expected to be significant or lead to adverse environmental or social impacts. Therefore, no further assessment of odour is considered necessary as part of this Category II report.

5.2.5 Water Quality (Surface Water, Ground Water, Seawater)

This section assesses the potential impact on water quality throughout the lifecycle of the Project. The assessment considers the interaction of Project-related activities with groundwater resources, surface water bodies and the influence of flood risk from extreme rainfall events on Project-related activities, as well as limitations in natural surface water drainage associated with the predominantly flat terrain.

5.2.5.1 Identified Environmental Receptors

The key environmental receptors associated with water quality typically include surface water bodies, such as drainage channels, and groundwater resources. These receptors are often identified due to the potential for contamination from accidental spills or leaks of hazardous substances. While extreme weather events may result in temporary surface runoff, the risk of widespread surface water contamination remains low due to the flat topography and arid conditions. Furthermore, groundwater beneath the site occurs at significant depth, well beyond the reach of surface-level contaminants under normal or extreme conditions. As such, groundwater is not considered a sensitive receptor for this assessment.

5.2.5.2 Construction Phase

5.2.5.2.1 Contamination of Surface Run-Off from Site Preparation and Disturbance

As discussed in Section 5.2.6, construction activities associated with the Project are expected to disturb soils and surface materials, increasing the risk of erosion and sediment transport. During periods of heavy rainfall or flooding, these disturbed materials may be mobilised and carried off-site as surface runoff, potentially leading to elevated turbidity and sedimentation in accumulation of flood waters within the Project area due to its flat topography or nearby low-lying areas. The temporary accumulation of floodwater, particularly in the absence of effective mitigation measures, may further increase the likelihood of contaminant mobilisation and off-site transport.

In addition to erosion-related impacts, changes in site topography and surface permeability during land grading and compaction may alter stormwater flow patterns and reduce infiltration rates. This may result in greater runoff volumes and increase for surface water accumulation and diversion.

The BESS Project area is located within a zone classified as a light flood hazard and lies just outside the boundaries of the highest-risk flood zones. However, the risk of groundwater contamination during construction is considered low due to the absence of groundwater within the active construction zone. In addition, considering the implementation of relevant mitigation measures, the impact is assessed to have *Medium* magnitude. As there is no water bodies present on-site and the Project area having a low flood risk, the receptor sensitivity is considered to be *Low*, resulting in an overall impact significance of **Minor**.

5.2.5.3 Operation Phase

5.2.5.3.1 Contamination from Battery Leaks or Fluid Spills and Maintenance Activities

During the daily operation of the BESS, there is potential of leaks or spills from battery units or other components containing hazardous operational fluids. Improper containment of these fluids can result in contamination of surface run-off during a flood event. In addition, an extreme rainfall event could pose a risk to infrastructure integrity if water enters electrical equipment or mobilises stored materials. However, the likelihood of this occurrence is expected to be low given the design of the system. If any spills or leaks do occur, it will be in a limited volume and confined to the immediate vicinity of the incident. Occasional maintenance activities, such as servicing, fluid replacement and cleaning, can lead to mishandling of substances that could potentially pose a risk to water quality. These activities are conducted under controlled conditions, with standard operational procedures in place.

Therefore, these risks are considered to have negligible impact to water quality. The impact is assessed to have *Negligible* magnitude with the receptor sensitivity of *Low*, resulting in an overall impact significance of **Non-Significant**.

5.2.5.4 Decommissioning Phase

5.2.5.4.1 Contamination of Surface Run-Off from Dismantling Activities

Decommissioning activities include removal of BESS infrastructure, batteries and associated components which contain hazardous materials. Potential impacts to

water quality may arise from improper handling or accidental spills of residual chemicals, such as battery electrolytes, oils, or coolants, could lead to localised contamination of surface run-off or infiltration into surrounding soils. In addition, scheduling decommissioning activities during periods of heavy rainfall could result in mobilisation of uncontained contaminants. While the absence of shallow groundwater reduces the likelihood of significant groundwater impacts, the potential for surface water contamination remains if mitigation measures are not implemented. With the implementation of appropriate waste management procedures, spill containment systems, and site-specific decommissioning plans, the impact is assessed to have *Medium* magnitude. Considering the *Low* receptor sensitivity and that the impact can be effectively mitigated, the overall significance of the impact is assessed as **Minor**.

5.2.5.5 Unplanned Events

5.2.5.5.1 Contamination of Flood Pathways and / or Drainage during Emergency Events

Unplanned incidents, such as accidental fuel spills or inadequate waste handling, could result in localised impacts on soil, surface water and groundwater. Should a fire involving the battery units occur, the use of fire suppression systems may generate contaminated run-off containing chemicals. This run-off has the potential to enter temporary surface flow paths.

However, the lack of shallow groundwater at the Project site significantly reduces the risk of deeper groundwater contamination. During periods of heavy rainfall, accumulated floodwater could enhance the spread of contaminants across the site. These risks are expected to be minimised through the implementation of effective fire prevention, management and containment measures, designed drainage systems, and emergency response protocols. The potential impact is assessed to have *Medium* magnitude. Due to the absence of shallow groundwater, the receptor sensitivity is considered to be *Low*, resulting in an overall impact significance of **Minor**.

5.2.5.6 Cumulative Impacts

Given the small scale of the BESS in relation to the larger, already permitted Haden PV Park, and the limited potential for off-site water quality impacts, no significant cumulative effects are expected. The Project is located in a sparsely vegetated area with no nearby surface water features or sensitive water bodies that could be affected by surface run-off or contamination. As a result, the likelihood of cumulative impacts on water quality are considered to be unlikely.

5.2.6 Quality of Soil and Sediments

This section assesses the potential impact on soil and sediment quality throughout the lifecycle of the Project. The assessment considers the effects of Project activities based on site-specific conditions such as the presence of very loose to loose sandy soils and the arid nature of the Project area.

5.2.6.1 Identified Environmental Receptors

Construction and operation of the Project may disturb the natural condition of surface soils, especially since the site is made up of loose sandy material. If not properly managed, this disturbance could lead to long-term changes in soil

quality, including increased erosion and localised contamination from fuel, oil or chemical spills. While there are no active surface water flows at the site, erosion from wind and dust movement is still possible during periods when soil is exposed and dry. Sediment runoff is expected to be low, but temporary erosion may still occur if ground surfaces are not stabilised during key phases of work.

5.2.6.2 Construction Phase

5.2.6.2.1 Soil Erosion and Sediment Mobilisation

Land clearing, grading and excavation works required for site preparation and infrastructure development will disturb the existing topsoil and subsoil layers. Given the arid environment and very loose sandy nature of the soils, the site is particularly susceptible to soil erosion and sediment transport. While vegetation clearance will be minimal, even the limited removal of natural ground cover can destabilise the soil surface, especially in areas exposed to high wind activity. These conditions increase the potential for off-site sediment deposition.

Considering the temporary nature of this impact, the limited vegetation clearance, and the use of mitigation (i.e. best site management practices), the impact is assessed to have *Medium* magnitude. Given its localised extent, the value of topsoil, and the ease of control, the receptor sensitivity is *Low*, resulting in an overall impact significance of **Minor**.

5.2.6.2.2 Soil Contamination during Construction Activities

The use of heavy machinery, fuel storage tanks and chemical substances introduces a potential risk of accidental spills and leaks. If not managed correctly, substances such as diesel, hydraulic oil and lubricants may contaminate the upper levels of soil, alter their chemical properties and pose risks to the surrounding environment. The lack of cohesive soil structure at the site increases the risk of downward migration of contaminants into the subsurface. Although these impacts are expected to be limited in scale and duration, they are avoidable through implementation of best practices, secure storage and rapid spill response procedures.

Given the potential for small-scale and short-duration contamination events, the impact is assessed to have *Medium* magnitude due to the nature of planned construction activities. With proper environmental controls and mitigation, the receptor sensitivity is *Low*, and the overall impact is assessed to have a significance of **Minor**.

5.2.6.2.3 Soil Contamination from Wastewater and Sanitation Sources

Liquid waste generated from worker facilities and vehicle washing will be produced on-site. If not properly managed, this wastewater could infiltrate the soil, introducing nutrients, organic matter, or pathogens into the surrounding environment. The absence of a formal sewage network increases this risk if containment and disposal systems are not rigorously implemented. To mitigate these risks, best management practices will be adopted, including the use of sealed, regularly maintained holding tanks and the engagement of licensed service providers for the collection, transport, and off-site treatment or disposal of wastewater. These measures will ensure compliance with regulatory requirements and prevent uncontrolled discharges. The impact is considered to

have *Medium* magnitude due to the nature of potential contamination. With the remote location and absence of nearby SRs, sensitivity of receptors is *Low*. Therefore, the significance of impact is **Minor**.

5.2.6.3 Operation Phase

5.2.6.3.1 Soil Contamination from Equipment Maintenance and Hazardous Materials Handling

Although the Project does not produce direct emissions during normal operation, routine maintenance activities, such as servicing of transformers, cooling systems, and battery enclosures, may involve the handling of lubricants, coolants and cleaning agents. Spills during these activities, or improper waste disposal, may lead to gradual degradation of soil quality in localised areas. Furthermore, the long operational life of the Project (20 years) increases the risk of cumulative contamination if waste is not managed properly. While the magnitude of a single incident is expected to be low, the extended duration of operations makes adherence to containment, storage and handling protocols critical to maintaining long-term soil integrity.

Given that contamination is likely to be small-scale and localised, the impact is assessed to have *Medium Magnitude*. As this is a planned activity occurring over a long operational period, and considering the controlled nature of the site, limited exposure area, and the effectiveness of standard mitigation measures, the receptor is considered to have *Low Sensitivity*. Therefore, the overall impact significance is considered as **Minor**.

5.2.6.3.2 Soil Contamination from Hazardous Material Leakage

Leaks from improperly managed storage of batteries, oils, or other hazardous materials could affect both the physical and chemical properties of the soil. If left unaddressed, such leaks could lead to groundwater risk or long-term soil degradation.

The risk is mitigated by bunded containment, strict housekeeping, and preventative maintenance. Impact magnitude remains *Medium*, and receptor sensitivity is *Low*, resulting in an impact significance of **Minor**.

5.2.6.4 Decommissioning Phase

5.2.6.4.1 Soil Contamination from Fuel and Lubricant Spills

Dismantling and removal of infrastructure will involve machinery operation, transport, and fuel use. Improper handling or storage of oils and fuels during decommissioning could cause spills, contaminating the topsoil or temporary access paths.

Due to the potential for small-scale contamination events and the effectiveness of standard mitigation measures, the impact is assessed to have *Medium* magnitude. Considering the controlled site conditions and *Low* receptor sensitivity, the overall impact is assessed as **Minor** significance.



5.2.6.5 Unplanned Events

5.2.6.5.1 Soil Contamination from Emergency Fire Response

In the event of a battery fire or thermal runaway, large quantities of water or suppressant agents may be deployed. Contaminated firewater containing heavy metals or battery residues may infiltrate the soil or be dispersed into surrounding areas.

Due to the permeability of the soil, the potential for downward movement exists. While these events are rare and mitigation systems (e.g. bunded areas, emergency response) are in place, the impact is rated as *Medium* magnitude. Receptor sensitivity remains *Low*, resulting in an overall significance of **Minor**.

5.2.6.6 Cumulative Impacts

Due to the limited footprint of the BESS within the larger, already permitted Haden PV Park, and the localised and manageable nature of soil and sediment-related impacts, cumulative effects beyond the Project boundary are not expected. The site consists of loose, sandy soils in an area with minimal vegetation and no nearby SRs or water bodies that could be affected by off-site sediment transport or contamination. Therefore, cumulative impacts to soil and sediments are considered unlikely.

5.2.7 Health and Safety (Occupational and Public)

The section assesses the potential health and safety risks to workers and the public throughout the lifecycle of the Project. The assessment considered site-specific factors such as the remote location of the Haden BESS site, the use of high-voltage infrastructure, battery systems and heavy equipment during various phases.

This chapter also addresses labour and working conditions, including aspects related to recruitment, wages, occupational health and safety (OHS), grievance mechanisms, and subcontractor oversight. These topics are in alignment with IFC PS 2: Labour and Working Conditions and underscore the need for the Project Owner to develop and enforce Worker Management Plans during both construction and operations.

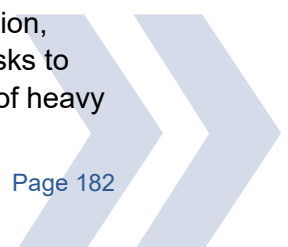
5.2.7.1 Identified Environmental Receptors

The primary receptors for health and safety risks include onsite construction and operation personnel, as well as any third-party contractors involved in the decommissioning. Due to the remote nature of the site, and the controlled access, the risk to the general public is minimal. However, workers may be exposed to hazards related to construction activities, electrical infrastructure, battery systems, heat stress and emergency incidents such as fires or chemical exposures.

5.2.7.2 Construction Phase

5.2.7.2.1 Occupational Health and Safety Risks during Construction

The construction phase involves multiple activities such as site preparation, earthworks, equipment installation and trenching, all of which present risks to worker health and safety. Hazards include potential injury from the use of heavy



machinery, exposure to noise and dust, working at height, and the handling of hazardous materials such as fuel and lubricants. The arid conditions of the site may also increase the risk of heat-related stress and dehydration.

The Engineering, Procurement, and Construction Contractor will be responsible for implementing a detailed Worker Management Plan that includes:

- Transparent recruitment practices;
- Compliance with local labour laws and fair wages;
- Access to grievance mechanisms;
- Accommodation standards that align with international best practices;
- Provisions for training and enforcement of occupational safety standards; and,
- Oversight of subcontractor practices, particularly those involving vulnerable or migrant workers.

The Project Owner will retain ultimate responsibility for ensuring implementation and oversight of the Plan.

As these risks are common to construction sites and can be mitigated through established safety protocols, the impact is considered to have a *Medium* magnitude. Considering the presence of trained personnel, implementation of safety procedures and the availability of medical support, the receptor sensitivity is considered *Low*, resulting in an overall impact significance as **Minor**.

5.2.7.3 Operation Phase

5.2.7.3.1 Occupational Health and Safety Risks during Operation

During the operation phase, the main risks relate to electrical hazards, battery maintenance, and exposure to stored chemicals or fire suppression systems. Workers may face routine hazards such as slips, trips and falls during inspections or maintenance. Although the site has a very low staff contingent, periodic inspection and servicing of BESS components (such as inverters, transformers and cooling systems) require trained personnel to work in proximity to high-voltage infrastructure.

A separate Worker Management Plan shall be prepared by the Project Owner for the operations phase. This will include procedures for:

- Regular training on operational risks and emergency response;
- Management of third-party maintenance contractors;
- Clearly defined grievance redressal mechanisms;
- Safety protocols around live equipment; and,
- Scheduled reviews of worker conditions.

These activities are routine and predictable, and industry-standard safety measures are expected to be in place. Therefore, the impact is assessed to have *Low* magnitude. Given the trained workforce and managed access to sensitive components, the receptor sensitivity is *Low*, and the overall impact significance is assessed as **Non-Significant**.

5.2.7.4 Decommissioning Phase

5.2.7.4.1 Health and Safety Risks during Decommissioning Activities

Decommissioning will involve dismantling and removing infrastructure such as batteries, transformers and underground cables. The use of cranes, trucks and electrical tools introduces typical occupational hazards including crushing, trips and electrocution and chemical exposure. Improper handling of decommissioned battery units may also pose risks of leakage or thermal runaway. These risks are comparable to those during construction and will be addressed through standard safety protocols and decommissioning plans.

The impact is assessed to have *Medium* magnitude. As workers will be trained and the site will remain restricted, it will have *Low* receptor sensitivity, and overall, the impact significance is considered to be **Minor**.

5.2.7.5 Unplanned Events

5.2.7.5.1 Health and Safety Risks from Emergency Incidents

Although unlikely, incidents such as battery fires, thermal runaway or chemical leaks could pose serious risks to personnel. These events may result in injuries from heat, smoke inhalation, or exposure to toxic substances. However, the Project will include fire detection and suppression systems, battery management systems and emergency response procedures to limit the likelihood and severity of such events.

Due to the potential severity, the impact is assessed to have *High* magnitude. The sensitivity of onsite receptors is considered *Low*, but with emergency preparedness in place, the overall impact significance is assessed as **Moderate**.

5.2.7.6 Cumulative Impacts

Cumulative health and safety impacts are unlikely. The Project is located within a restructured, standalone site with controlled access. No SRs or other projects are located nearby that could increase health and safety risks to workers or the public. All impacts are expected to be contained within the site and managed through routine procedures. Therefore, cumulative health and safety impacts are not expected.

5.2.8 Natural Landscapes and Visual Comfort

This section assesses the potential impacts of the Project on the surrounding landscape character and visual comfort throughout the Project lifecycle. The assessment considers the site's flat and arid setting, its location with Haden PV Park, and absence of sensitive visual receptors in immediate vicinity.

5.2.8.1 Identified Environmental Receptors

The Project is situated within a largely undeveloped, flat desert landscape characterised by sparse vegetation and minimal topographical variation. It lies within the boundary of the permitted Haden PV Park, an area allocated for utility-scale renewable energy development. The nearest potential receptors include transient users of Road 4410 and occasional nomadic herders. There are no known residential, tourism or cultural sensitivity areas in proximity to the site. As a result, the visual sensitivity of the surrounding environment is considered Low.

5.2.8.2 Construction Phase

5.2.8.2.1 Temporary Visual Disruption from Construction Activities

Construction activities such as land clearing, grading, installation of infrastructure, and movement of heavy machinery will temporarily alter the visual character of the site. These activities will introduce noticeable changes to the natural landscape, including exposed soils, construction vehicles, storage containers, and other temporary facilities. However, due to the limited duration of construction and the low number of sensitive viewers in the area, the visual impacts will be short-term and localised.

Considering the temporary nature of this impact, the visual containment within the larger Haden PV Park, and the absence of SRs, the impact is assessed to have *Low* magnitude. With the surrounding landscape considered to have *Low* receptor sensitivity, the overall impact significance is considered as **Non-Significant**.

5.2.8.3 Operation Phase

5.2.8.3.1 Presence of Permanent Infrastructure

Once operational, the site will include permanent infrastructure such as battery enclosures, inverters, transformers, fencing and lighting. These structures will introduce long-term visual changes to the site, replacing the natural desert appearance with engineered elements. The height of infrastructure is limited to the container height (3-4m), and the layout will be regular and consistent. The Project's location within a designated development zone further reduces its visual prominence.

Given the scale and long-term existence of the infrastructure, the impact will have a *Low* magnitude. As the area has *Low* receptor sensitivity to visual changes, the overall significance of the impact is assessed as **Non-Significant**.

5.2.8.4 Decommissioning Phase

5.2.8.4.1 Visual Disruption from Removal Activities

Decommissioning will involve the dismantling and removal of infrastructure, including containers, cables, and fencing. Temporary impacts may arise from increased vehicle activity, exposed ground surfaces and the presence of dismantled materials on-site. These effects will be similar in nature and scale to those during construction and will be followed by site restoration.

Given the short duration and reversibility of disturbance, the impact is considered to have *Low* magnitude. The visual setting creates a *Low* receptor sensitivity, resulting in an overall impact significance of **Non-Significant**.

5.2.8.5 Unplanned Events

5.2.8.5.1 Visual Impact from Emergency Incidents

Unplanned events such as battery fires, equipment malfunction or emergency response actions may result in short-term changes to the site's visual appearance. These may include temporary visible of smoke, emergency lighting

or the presence of response vehicles. However, such events are expected to be rare, brief in duration and contained within the Project site.

Due to the short-lived nature of these events, the remote location of the site, and the lack of sensitive visual receptors, the impact is considered to have *Low* magnitude. With the landscape having *Negligible* receptor sensitivity, the overall impact significance is assessed as **Non-Significant**.

5.2.8.6 Cumulative Impacts

The Project is visually consistent with the other infrastructure planned for the surrounding area. There are no known visual receptors in the vicinity that would be affected by cumulative visual impacts. Due to the low sensitivity of the surrounding landscape and the Project's alignment with existing land use, cumulative impacts on landscape and visual comfort are considered unlikely.

5.2.9 Land Use

This section assesses the potential impacts of the Project on land use throughout its lifecycle. The assessment considers current and designated land users, the footprint of the Project and its integration into the wider Haden PV Park.

5.2.9.1 Identified Environmental Receptors

The Project area is located within the boundaries of a previously permitted Haden PV Park (currently under construction). The surrounding area is characterised as flat, arid desert terrain with sparse vegetation. The site visit confirmed no evidence of active land use such as Bedouin camps, grazing activity, or other socio-economic infrastructure within or adjacent to the Project area. The key land use receptors include:

- The designated land use classification (renewable energy infrastructure);
- Informal or traditional users of open desert land (e.g. occasional passage or grazing); and,
- The broader Haden PV Park layout.

5.2.9.2 Construction Phase

5.2.9.2.1 Temporary Disruption of Land

During construction, land will be cleared and levelled for access roads, laydown areas, and installation of infrastructure. This will temporarily alter the land's existing condition, removing any informal use (e.g. occasional grazing) and restricting access to the site. However, as the land is already designated for renewable energy development and no formal land users will be displaced, the impact is considered limited.

Due to the limited and temporary nature of these activities, the magnitude of the impact is *Medium*. The receptor sensitivity is considered *Low*, resulting in an overall impact significance of **Minor**.



5.2.9.3 Operation Phase

5.2.9.3.1 Long-Term Conversion to Utility Infrastructure

During operation, the Project site will be occupied by permanent infrastructure (battery containers, inverters and transformers) and access restrictions will remain in place. This results in a long-term change in land use from informal open land to a fenced utility facility. However, this change aligns with the permitted land use of Haden PV Park, and no competing land uses will be displaced.

Given the alignment with approved land use planning and absence of competing land use claims, the impact is considered to have a *Negligible* magnitude and a *Low* receptor sensitivity, resulting in an overall impact significance of **Non-Significant**.

5.2.9.4 Decommissioning Phase

5.2.9.4.1 Temporary Disturbance from Infrastructure Removal

The dismantling of above and below ground infrastructure may cause short-term surface disruption, dust, and limited access restriction. This may result in visual degradation or minor surface damage until reinstatement is complete.

Considering the reversibility of land use impacts and the temporary nature of disruption, the impact is considered to have *Low* magnitude and *Low* receptor sensitivity, resulting in an overall impact significance of **Minor**.

5.2.9.4.2 Opportunity for Restoration of Land

Once infrastructure is removed, the site presents an opportunity to reinstate the land to its original undeveloped state. This supports landscape integration, allows for informal land use (e.g. grazing or access), and enables alignment with future land use planning.

Considering the positive nature of this opportunity, the reversibility of impacts and the low-intensity use of the land prior to development, the opportunity is assessed to have *Low* magnitude and *Low* receptor sensitivity, resulting in an overall beneficial significance of **Minor**.

5.2.9.5 Unplanned Events

5.2.9.5.1 Temporary Land Exclusion or Surface Damage

Unplanned events, such as battery fires or accidents may lead to temporary restrictions on access or limited damage to land surfaces. Such incidents are expected to be rare and localised, with no long-term impacts on land use patterns. Emergency response may require temporary access by external services.

Due to the short-term and highly localised nature of such events, the impact is considered to have *Low* magnitude. Given the *Negligible* receptor sensitivity of land use in the area, the overall impact significance is assessed as **Non-Significant**.



5.2.9.6 Cumulative Impacts

The development of the Project aligns with long-term land use planning. Land use change from natural desert to energy infrastructure was previously assessed and permitted. As the Project is an ancillary component of the permitted energy facility, no cumulative land use conflicts or additional pressures are expected. Therefore, cumulative impacts on land use are considered unlikely.

5.2.10 Waste Generation

This section assesses the potential impacts associated with waste generation during the construction, operation and decommissioning of the Project. The assessment considers the nature, types and volumes of waste expected at each phase, the sensitivity of the surrounding environment and the potential for unplanned releases.

5.2.10.1 Identified Environmental Receptors

The primary receptors associated with waste generation include the Project site itself (soil, surface conditions), any temporary waste storage locations, and authorised off-site waste disposal or recycling facilities. The area surrounding the site is undeveloped with no nearby residential areas, water bodies or sensitive ecosystems. However, poor handling, storage or disposal of waste could still result in localised pollution or nuisance, particularly during construction and decommissioning.

5.2.10.2 Construction Phase

5.2.10.2.1 Solid Waste Generation from Construction Activities

Solid waste will be generated during earthworks, road and building construction, perimeter fencing and temporary facilities setup. This waste will include non-hazardous combustible materials such as paper, cardboard, wood and plastic, as well as non-combustible materials such as excavated earth, metal, fragments and food waste. Hazardous waste may also be produced, including empty chemical containers, used oil drums and solvent-contaminated rags.

If not properly managed, this waste can result in localised pollutions, contamination of on-site soil and degradation of the surrounding environment. The risk of pests and odours may also increase in areas with unmanaged or decomposing waste. Improper waste storage and disposal practices can lead to significant health and safety risks for workers, especially near high-volume work zones.

Given the moderate expected waste volume and short construction period (3 years), the use of licenced waste management facilities and contractors, the magnitude of the impact is considered *Medium*. The receptor sensitivity is *Low*, due to the site's remote setting and absence of sensitive land uses. Therefore, the overall impact significance is assessed as **Minor**.

5.2.10.2.2 Liquid Waste from Sanitary and Domestic Sources

Liquid waste will be generated from on-site sanitation facilities, temporary worker accommodation, and daily washing activities. If not correctly managed, this

wastewater may leach into the soil or be released as surface runoff, potentially transporting pathogens or organic matter into the environment.

As described in Section 5.2.6.2.3, the risk is localised and temporary, and adequate containment systems and management practices can significantly reduce this impact. The magnitude is considered *Medium*, with *Low* receptor sensitivity, and the overall impact significance considered as **Minor**.

5.2.10.2.3 Accidental Spills and Hazardous Liquid Waste

Hazardous liquids such as paints, fuel, lubricants and coatings may be present during construction for machinery maintenance and building works. If spilled or leaked during transfer, storage or use, these substances can infiltrate the soil and pose a threat to both the natural environment and worker health.

Uncontrolled spills may result in long-term contamination of the worksite, requiring remediation or special disposal measures. Nevertheless, the Project will implement hazardous waste storage protocols and spill response procedures, reducing the risk of uncontrolled release. As such, the magnitude is rated *Medium*, receptor sensitivity is *Low*, and the resulting impact significance of **Minor**.

5.2.10.3 Operation Phase

5.2.10.3.1 Solid Waste Generation from Routine Operations

During the operation phase, solid waste will be generated as part of the daily maintenance and servicing of the BESS infrastructure and associated facilities. Waste sources include packaging materials, administrative waste (e.g. paper, cardboard), used cleaning supplies, and other non-hazardous general refuse. While these volumes are expected to be low and generated intermittently, poor handling or irregular removal may lead to accumulation, causing workplace hygiene issues.

The Project will implement routine cleaning and waste removal protocols, but in the absence of proper management, there is a potential for minor nuisance and environmental degradation within the Project footprint.

Considering the small waste quantities, long intervals between generation and standard waste management protocols, the impact magnitude is *Medium*. The sensitivity of the receptors and site is *Low*, resulting in an overall impact significance of **Minor**.

5.2.10.3.2 Liquid Waste and Potential Soil Contamination

Liquid waste will be generated from sanitary facilities, stormwater runoff and equipment maintenance activities such as transformer oil replacement, chemical handling and battery servicing. These may produce hazardous liquid waste if oils or cleaning agents are spilled or not correctly contained. If left unmanaged, these materials may leach into the soil or surface runoff, affecting site drainage and posing a risk to human health and environmental quality.

Although routine operations are expected to follow standard procedures for containment, transport and disposal, unintentional mismanagement or equipment failure could result in pollution hotspots around storage or servicing areas.

The impact magnitude is assessed as *Medium*, given the potential to risk soil quality. The receptor sensitivity remains as *Low* due to the isolated nature of the site and absence of nearby SRs. Therefore, the overall impact significance is assessed as **Minor**.

5.2.10.3.3 Management and Disposal of Spent Batteries and Associated Components

During the operational life of the Project, a considerable volume of batteries will require replacement due to natural degradation over time. Based on industry experience with these types of battery systems, it is anticipated that between 50% and 100% of the installed battery units will reach end-of-life and require replacement at least once within a 20-year project lifespan. These batteries contain hazardous constituents such as solvents, and heavy metals, which necessitate careful handling and disposal.

To manage this, a proactive battery replacement programme will be established. Replaced battery modules will be safely removed and stored in secure, ventilated, fire-resistant enclosures on-site until transfer can be arranged. Only licensed hazardous waste service providers will be used for the collection, transport, and off-site treatment or recycling of battery units. Where feasible, the Project will prioritise recycling or refurbishment pathways to support material recovery and circular economy objectives. All handling, transport, and disposal activities will adhere to applicable national hazardous waste regulations and best international practice.

Given the scale of activities and the likelihood of standard controls being applied, the impact magnitude is assessed as *Medium*. With *Low* receptor sensitivity, the overall significance remains **Minor**.

5.2.10.4 Decommissioning Phase

5.2.10.4.1 Solid Waste from Infrastructure Removal

The decommissioning phase will generate a significant amount of solid waste from dismantling the BESS infrastructure. This includes battery containers, PCS units, foundations, cabling, fencing, and associated structural elements. These materials will mostly be non-hazardous (e.g. concrete, steel, packaging), but may also include hazardous components such as battery residues or oil-contaminated parts.

If not handled correctly, this waste may accumulate on-site, attract pests, cause visual degradation, or result in improper disposal at unauthorised locations. Occupational health and safety risks may also arise from the handling and movement of heavy or hazardous items.

Given the limited duration (<1 year), established mitigation protocols, and the Project's ability to manage dismantling activities systematically, the impact magnitude is assessed as *Medium*. The receptor sensitivity remains *Low*, resulting in an overall impact significance of **Minor**.

5.2.10.4.2 Liquid Waste and Soil Contamination Risk

Decommissioning will also produce liquid waste from equipment cleaning, vehicle washing, and the use of chemicals for surface preparation or deactivation. Sanitary wastewater and stormwater may also accumulate during the

deconstruction process. If not properly stored, treated, or removed, this liquid waste may leach into soils or contaminate temporary access routes.

The potential for temporary soil degradation exists, particularly if chemicals or oils are spilled during the dismantling and transport of equipment. However, the use of bunded areas, spill kits, and scheduled liquid waste disposal practices will significantly reduce the risk.

Given the scale of activities and the likelihood of standard controls being applied, the impact magnitude is assessed as *Medium*. With *Low* receptor sensitivity, the overall significance remains **Minor**.

5.2.10.4.3 Management and Disposal of Spent Batteries and Associated Components

At the end of the Project's operational life, the remaining battery units and associated components (e.g. electrical control systems, HVAC equipment, enclosures) will be dismantled and removed from the site. Given the hazardous nature of batteries and the potential for residual charge or damage, these materials present specific environmental and health and safety risks if not managed appropriately.

A detailed decommissioning and waste management plan will be developed to guide the responsible handling, classification, storage, and off-site movement of all battery-related waste. This plan will include a full inventory of battery units, hazard characterisation, and identification of suitable disposal or recycling routes. All activities will be conducted using licensed waste management contractors and facilities that are approved for the treatment of hazardous and electronic waste.

Chain-of-custody documentation will be maintained for all waste streams, and preference will be given to recycling pathways that facilitate the recovery of valuable materials such as lithium, cobalt, and nickel. The Project will ensure compliance with all relevant local legislation and international conventions governing the transport and disposal of hazardous waste and will seek to minimise environmental harm by promoting reuse and resource recovery wherever practical.

Given the scale of activities and the likelihood of standard controls being applied, the impact magnitude is assessed as *Medium*. With *Low* receptor sensitivity, the overall significance remains **Minor**.

5.2.10.5 Unplanned Events

5.2.10.5.1 Accidental Generation of Hazardous Waste

Unplanned events during any phase, including battery fires, thermal runaway, mechanical failure, or chemical spills, may lead to the generation of large volumes of hazardous waste. This could include burned equipment, charred insulation, damaged battery components, and contaminated firewater. If not contained and disposed of promptly, such waste can cause localised environmental contamination.

Although such events are expected to be rare and isolated, the impact could be significant if containment measures fail. The Project will rely on emergency response protocols, hazardous waste classification, and approved removal contractors to address these risks quickly and effectively.

As these are short-term and infrequent, the magnitude is considered *Medium*, with a *Low* receptor sensitivity due to the remoteness of the site and the absence of water bodies or residential areas nearby. Therefore, the overall significance of this unplanned event impact is **Minor**.

5.2.10.6 Cumulative Impacts

The Project is located within a permitted utility development area where other renewable energy infrastructure may be constructed. However, given the limited waste volumes, low environmental sensitivity and routine transport to off-site licensed facilities, cumulative waste-related impacts are considered unlikely.

5.2.11 Economic and Social Aspects

This section assesses the potential economic and social impacts of the Project during the construction, operation, decommissioning and unplanned event phases. The assessment considers employment, opportunities, local business involvement, informal land use and potential risks to public well-being and social infrastructure.

5.2.11.1 Identified Environmental Receptors

The primary receptors associated with economic and social aspects include local and regional workers, nearby service providers, and informal land users. While the site is in a remote area with no nearby communities or public infrastructure, minor interactions with informal users (e.g. nomadic herders) and regional supply chains are possible. Social risks are considered low due to the Project's isolation and alignment with approved land use for the permitted Haden PV Park under construction.

5.2.11.2 Construction Phase

5.2.11.2.1 Employment, Procurement and Community Interaction

The construction phase is anticipated to generate short-term employment opportunities and associated benefits to regional service providers and suppliers. Given that the Project is located entirely within the boundary of an approved solar Haden PV Park that is currently under construction, the associated land has already been designated for energy development, and relevant access controls are in place.

Considering the limited scale and short duration of construction activities (3 years), the impact magnitude with short-term employment and procurement benefits, is assessed as *Medium*. Given the remote location, the receptor sensitivity is *Low*, therefore, the overall impact significance is assessed as **Minor**.

5.2.11.2.2 Access Restrictions and Local Interaction

While temporary restrictions on access may occur for nomadic herders or other transient users, these are expected to be infrequent and localised due to the limited additional footprint of the BESS infrastructure and the pre-existing security and land use parameters already implemented for the solar Haden PV Park.

The impact is considered to have *Medium* magnitude with *Low* receptor sensitivity, resulting in an overall impact of **Minor**.



5.2.11.3 Operation Phase

5.2.11.3.1 Limited Employment and Economic Influence

During operation, the Project will require minimal staffing and will be largely automated. Routine maintenance will involve independent technical teams with a little reliance on the local economy. Consequently, the socio-economic benefits will be minimal.

Considering the long duration of the operation phase (20 years) and the minimal staffing requirements associated with an automated facility, the magnitude the impact is considered *Low*. Given the limited reliance on the local economy and absence of nearby dependent communities, the receptor sensitivity is considered *Low*. Therefore, the overall impact significance is assessed as **Minor**.

5.2.11.3.2 Restricted Access and Long-Term Land Use Change

The operational phase will involve fenced infrastructure and restricted access. This may prevent informal users from returning to the area. Simultaneously, the Project contributes positively to Saudi Arabia's renewable energy goals and supports long-term infrastructure investment, although it offers minimal permanent employment.

Given the alignment with national development plans and limited local impact, the impact is considered to have *Low* magnitude and *Low* receptor sensitivity, resulting in an impact significance of **Minor**.

5.2.11.4 Decommissioning Phase

5.2.11.4.1 Short-Term Employment and Site Closure

The decommissioning phase will include dismantling works, temporary site services, and material handling, which are expected to create modest short-term employment and procurement opportunities. These will likely benefit local labourers and contractors.

Given the short duration and limited scale of effect, the magnitude is assessed as *Low*, with *Low* receptor sensitivity. The impact significance is **Minor**.

5.2.11.4.2 Minimal Long-Term Disruption

No long-term economic or social disruption is anticipated following site closure, as the facility is not deeply integrated into community structures.

Given the short duration and limited scale of effect, the magnitude is assessed as *Low*, with *Low* receptor sensitivity. The impact significance is **Minor**.

5.2.11.5 Unplanned Events

5.2.11.5.1 Public Safety Concerns from Emergencies

Although unlikely, battery fires or accidents could raise concerns among the public or nearby service providers. Due to the remote location and absence of residential areas, these impacts would be limited to reputational or perception-based concerns.

The impact is considered to have *Low Magnitude* and *Low Sensitivity*; therefore, the impact result is **Minor**.



5.2.11.6 Cumulative Impacts

The Project is part of the broader Haden PV Park and aligns with national energy strategies. While minor short-term economic benefits may arise during construction and decommissioning, the Project is unlikely to contribute to cumulative negative impacts on local economic or social structures. Therefore, cumulative impacts are considered unlikely.

5.2.12 Ruins and Cultural Heritage

This section assesses the potential impacts of the Project on cultural heritage and archaeological resources throughout the lifecycle of the Project. The assessment considers known heritage features, the potential for chance finds during ground disturbance, and site-specific conditions at the Project site.

5.2.12.1 Identified Environmental Receptors

There are no registered archaeological sites, historic ruins or formally protected cultural heritage assets located within or immediately adjacent to the Project area. The site lies within the boundary of Haden PV Park, which has undergone permitting processes. However, the region's broader desert context may hold undocumented archaeological materials below the surface.

The key receptor is therefore the subsurface archaeological record, and the potential for chance finds of cultural or historical value during construction or ground disturbance activities.

5.2.12.2 Construction Phase

5.2.12.2.1 Risk for Disturbing Unknown Subsurface Heritage

Construction activities such as land clearance, grading, trenching and excavation may disturb unknown subsurface archaeological or cultural heritage materials. Although no known heritage features are present, the risk of encountering such remains cannot be entirely ruled out.

The Project footprint is relatively small, and the site has been classified as low potential through prior assessment. The impact is considered to have *Low* magnitude and *Low* receptor sensitivity, resulting in an overall impact significance of **Minor**. Implementation of a Chance Finds Procedure will be essential to managing this risk. The Chance Finds Procedure should outline roles, responsibilities, notification steps, and "stop work" protocols in case of unexpected discoveries of archaeological, paleontological, or cultural items during excavation. Site workers and contractors need to be trained on the procedure prior to ground disturbance activities, and a qualified cultural heritage expert should be on call to guide verification or further study where required.

5.2.12.3 Operation Phase

During the operation phase, the Project will not involve additional excavation or land disturbance. As infrastructure will remain in place and no interaction with archaeology or cultural heritage receptors is expected, this phase does not warrant further assessment with respect to archaeology.

5.2.12.4 Decommissioning Phase

5.2.12.4.1 Disturbance of Previously Unaffected Subsoil

Decommissioning activities may involve the removal of below-ground infrastructure such as cabling or footings. This may disturb previously undisturbed areas of soil, introducing low risk of encountering archaeological materials not exposed during construction.

The impact is expected to be similar in nature and scale to the construction phase and is assessed to have *Low* magnitude and *Low* receptor Sensitivity, resulting in an impact significance of **Minor**. The application of the chance finds procedure will remain important.

5.2.12.5 Unplanned Events

5.2.12.5.1 Accidental Exposure to Emergency Groundworks

Unplanned events such as emergency repairs or recovery activities will involve unscheduled excavation. If this occurs in a previously undisturbed area, there is a low risk of encountering undocumented cultural heritage.

Given the low likelihood and very localised nature of such activities, the impact is considered to have *Low* magnitude, *Low* receptor sensitivity and is therefore assessed as having a **Minor** significance.

5.2.12.6 Cumulative Impacts

The Project is located within a designated utility development zone and involves minimal subsurface disturbance. No known regional archaeological sensitivity exists, and nearby developments are similarly industrial in nature. Therefore, cumulative impacts on cultural heritage are considered unlikely.

5.2.13 Human Rights

In accordance with the EP4 GN and aligned with IFC PSs 1 and 2, a screening-level Human Rights Risk Assessment has been undertaken for the Project. The assessment focused on salient labour-related risks that may affect both the local community and the workforce throughout all phases of the Project (site clearance, construction, operation and decommissioning).

The identified SRs include workforce personnel (including migrant workers), nearby residents and land users (including Bedouins), and vulnerable groups such as women and children.

The screening addressed the following key risk areas:

- Forced labour / modern slavery;
- Child labour;
- Discrimination and unequal pay;
- Unsafe or unhealthy working conditions;
- Excessive working hours;
- Restrictions on freedom of association or collective bargaining; and,
- Exploitation of migrant labour, especially during the construction phase.

According to the EP4 GN, human rights risks are classified into:

- Low-Risks – Where risks are unlikely to occur. If these risks did occur, it would not impact the Project (due to scale, severity, locality etc.) or can be eliminated or mitigated through adherence to operating procedures, environmental, social and health & safety standards; and,
- High-Risks – Which are those where further assessment and an in-depth analysis is required, and where risks could cause a delay, reputational risk or breach of national or lender requirements for the Project and, consequently, affect the ability of the Project to secure finance.

5.2.13.1 Construction Phase

During construction, human rights risks are heightened due to the presence of temporary, often external workforce. Key concerns include the fair and transparent recruitment of workers, particularly migrants, as well as ensuring decent and safe working conditions, non-discriminatory practices, equitable wages, and access to rest, medical care and grievance mechanisms. Risks are further increased by the potential use of subcontractors, whose practices may vary and require oversight.

To address these issues, the Contractor will be required to comply with national labour laws and adhere to international best practices, supported by supervision from the Project Proponent. A Worker Management Plan (WMP) must be implemented to formalise commitments related to worker welfare, including provisions for recruitment, accommodation, working hours, wages and freedom of association. A grievance mechanism, accessible to all workers and maintained with confidentiality and responsiveness, will also be in place.

Although these measures are expected to mitigate most risks, the scale and nature of the construction result in a *Medium* magnitude. Considering the remote and low-density setting, receptor sensitivity is assessed as *Low*, resulting in an overall impact significance of **Minor**.

5.2.13.2 Operation Phase

During the operation phase, the number of personnel on-site is significantly reduced, limited primarily to maintenance and monitoring staff. Human rights risks are correspondingly lower but still require attention to ensure fair treatment, non-discrimination, and access to effective grievance mechanisms. These are expected to be managed through internal procedures and ongoing Contractor oversight.

As operational activities are minimal and workforce numbers are low, the magnitude is *Low*, and the receptor sensitivity is *Low*. Therefore, the overall impact is assessed to have a significance of **Minor**.

5.2.13.3 Decommissioning Phase

Decommissioning will involve dismantling works and temporary employment of a contractor workforce. Human rights-related concerns may relate to worker welfare, occupational safety, fair pay, adequate working hours and safe working conditions. These are not expected to differ from construction-phase conditions and can be addressed through similar contractor controls and monitoring.

The same mitigation measures adopted during the construction phase, such as enforcing compliance with labour legislation, supervising contractor performance, and maintaining an effective Worker Management Plan and grievance mechanism must be applied.

Due to the short-term nature and limited scale of decommissioning works, the magnitude is *Medium*, and the receptor sensitivity is *Low*. Therefore, the overall impact is assessed to have a significance of **Minor**.

5.2.13.4 Unplanned Events

Unplanned events such as labour grievances, disputes or improper worker treatment may occur if Contractor oversight or communication channels are inadequate. These risks are not anticipated but should be addressed through adherence to existing health, safety and welfare plans, supported by a clear grievance resolution process.

As these risks are unlikely and manageable through standard procedures, the magnitude is *Negligible* and the receptor sensitivity is *Negligible*, therefore the overall impact significance is **Non-Significant**.

5.2.14 Cumulative Impact Assessment

In alignment with IFC PS1 (Assessment and Management of Environmental and Social Risks and Impacts), the cumulative impact assessment (CIA) provides a framework for understanding broader risks associated with development activities, especially those influenced by systemwide pressures such as climate change, biodiversity loss and regional socio-economic shifts. For projects such as the BESS, which is developed under a wider network of energy infrastructure, including the adjacent Haden PV Park, CIA is essential to ensure that potential overlays and interactions with other developments are considered.

Cumulative impacts are defined by the IFC as impacts that result from the successive, incremental and / or combined effects of an action, project or activity when added to other existing, planned or reasonably foreseeable future actions.

Given the confirmed footprint of the Project and its location within a designed and already permitted Haden PV Park, the majority of environmental and social impacts beyond the Project boundary are unlikely. However, the potential for minor cumulative effects, particularly relating to waste management during decommissioning, cannot be entirely excluded.

To address this, general mitigation measures have been incorporated into the Project's environmental and social management framework (refer to Section 6.3) to minimise the risk of cumulative impacts. These include adherence to best practices in construction, operation, decommissioning and unplanned events.

5.3 Summary of the Expected Impact Assessment

A summary of the environmental impacts relating to the Activity are provided below.

5.3.1 Natural Vegetation Cover and Biodiversity

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
TEB01	Natural Habitat	Loss or change of habitat within the development area	Minor
TEB02	Flora and fauna	Loss of flora and fauna due to construction activities	Minor
TEB03	Terrestrial vertebrates	Disturbance of terrestrial vertebrates due to construction activities including noise	Minor
Operation Phase			
TEB04	Terrestrial vertebrates	Behavioural change of wildlife as a result of increased human activity	Minor
TEB05	Terrestrial vertebrates	Injury or mortality of terrestrial vertebrates due to collision with vehicles	Minor
Decommissioning Phase			
TEB06	Flora	Vegetative metabolic distress	Minor
TEB07	Terrestrial vertebrates	Injury and mortality of wildlife	Minor
Unplanned Events			
TEB08	Flora and fauna	Potential, accidental introduction and proliferation of IAS	Minor

Table 5-10: Summary of Identified Potential Impacts on Natural Vegetation Cover and Biodiversity for the Project



5.3.2 Ambient Air

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
AQ01	Fauna, flora, and informal land users.	Increased Fugitive Dust and PM ₁₀ Emissions	Non-Significant
AQ02	Road users	Impaired Visibility for Road Users	Non-Significant
Operation Phase			
AQ03	Surrounding area	Vulnerability of the Project to Climate Change	Non-Significant
Decommissioning Phase			
AQ04	Fauna, flora and informal land users.	Increased Fugitive Dust and PM ₁₀ Emissions	Non-Significant
AQ05	Road users	Impaired Visibility for Road Users	Non-Significant
Unplanned Events			
AQ06	Surrounding area	Release of smoke / fumes due to fires / thermal runaway	Minor

Table 5-11: Summary of Identified Potential Impacts on Ambient Air for the Project



5.3.3 Noise and Vibrations

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
NBV01	Fauna and informal land users.	Construction noise	Non-Significant
Decommissioning Phase			
NBV02	Fauna and informal land users.	Construction noise	Non-Significant

Table 5-12: Summary of Identified Potential Impacts on Noise and Vibrations for the Project



5.3.4 Water Quality (Surface Water, Ground Water, Seawater)

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
WQ01	Nearby infrastructure such as the permitted Haden PV Park, project area and low-lying areas	Potential run-off causing pollution and accumulation of flood waters in Project area or nearby low-lying areas during flooding.	Minor
Operation Phase			
WQ02	Surface water bodies	Contamination of surface water bodies from battery leaks or fluid spills and maintenance activities.	Non-significant
Decommissioning Phase			
WQ03	Nearby infrastructure such as the permitted Haden PV Park, project area and low-lying areas	Potential run-off from decommissioning related activities causing pollution downstream during heavy rainfall events.	Minor
Unplanned Events			
WQ04	Existing nearby infrastructure such as the permitted Haden PV Park, Project and surrounding area.	Contamination of flood pathways and / or drainage from fire suppression during emergency events (battery fire / thermal runaway)	Minor

Table 5-13: Summary of Identified Potential Impacts on Water Quality for the Project



5.3.5 Quality of Soil and Sediments

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
SSQ01	Soil and Sediments	Disturbance of loose sandy soils from land clearing, grading and excavation may result in wind-driven erosion and short-term sediment transport.	Minor
SSQ02	Soil and Sediments	Accidental spills or leaks of fuel, lubricants, and chemicals from construction machinery may contaminate surface soil and alter its composition.	Minor
SSQ03	Soil and Sediments	Inadequate handling of wastewater from sanitation and vehicle washing could lead to soil infiltration by pathogens or organic contaminants.	Minor
Operation Phase			
SSQ04	Soil and Sediments	Routine maintenance involving oil, coolant or chemical use could result in gradual localised soil contamination if spills are not well contained.	Minor
SSQ05	Soil and Sediments	Leakage from poorly stored transformers, batteries, or oils may alter soil chemistry and pose risks to subsurface quality over time.	Minor
Decommissioning Phase			
SSQ06	Soil and Sediments	Small-scale fuel or lubricant spills during infrastructure removal activities may result in short-term soil degradation along transport routes.	Minor
Unplanned Event			
SSQ07	Soil and Sediments	Emergency fire response may lead to firewater infiltration, potentially introducing heavy metals and toxic substances into permeable soil.	Minor

Table 5-14: Summary of Identified Potential Impacts on Quality of Soil and Sediments for the Project



5.3.6 Health and Safety (Occupational and Public)

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
HS01	Construction workforce	Risk of injuries, heat stress, and exposure to dust, chemicals, or machinery during construction.	Minor
Operation Phase			
HS02	Operational maintenance staff	Electrical hazards, battery servicing risks, and chemical exposure during periodic inspections.	Non-Significant
Decommissioning Phase			
HS03	Decommissioning workforce	Injuries from dismantling activities, dust exposure, and residual chemical handling.	Minor
Unplanned Event			
HS04	Site personnel and responders	Health emergencies or injury due to fires, spills, or thermal runaway events.	Moderate

Table 5-15: Summary of Identified Potential Impacts on Health and Safety (Occupational and Public) for the Project



5.3.7 Natural Landscapes and Visual Comfort

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
LCV01	Visual receptors	Temporary visual disruption due to clearing, machinery, and equipment during construction.	Non-Significant
Operation Phase			
LVC02	Visual receptors	Presence of permanent infrastructure replacing natural landscape.	Non-Significant
Decommissioning Phase			
LV03	Visual receptors	Temporary visual disturbance from dismantling works and vehicle activity during decommissioning.	Non-Significant
Unplanned Event			
LCV04	Visual receptors	Temporary smoke, lighting, or emergency vehicle presence during fire or equipment incidents.	Non-Significant

Table 5-16: Summary of Identified Potential Impacts on Natural Landscapes and Visual Comfort for the Project



5.3.8 Land Use

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
LU01	Undeveloped land within permitted energy zone	Temporary disruption of land during site preparation and infrastructure installation.	Minor
	Informal land users (e.g. occasional grazing or movement)	Restricted access to open land during construction activities.	Minor
Operation Phase			
LU02	Designated utility development land within permitted Haden PV Park	Long-term land use change to fenced energy infrastructure with no displacement of existing uses.	Non-Significant
Decommissioning Phase			
LU03	Previously developed land within permitted Haden PV Park boundary	Temporary disturbance from infrastructure removal causing surface disruption and limited access.	Minor
Unplanned Event			
LU04	Project site and immediate surroundings	Temporary land exclusion or surface damage due to unplanned events (e.g. fire, emergency response).	Non-Significant

Table 5-17: Summary of Identified Potential Impacts on Land Use for the Project

Impact ID	Receptor	Opportunity	Significance before Enhancement
Decommissioning Phase			
LU05	Previously developed land within Haden PV Park boundary	Opportunity for restoration of land following removal of infrastructure.	Minor

Table 5-18: Summary of Identified Potential Opportunities on Land Use for the Project



5.3.9 Waste Generation

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
WG01	Project area and on-site workers	Generation of construction and domestic waste including improper segregation or storage of hazardous and non-hazardous waste	Minor
WG02	Soil and on-site environment	Liquid waste from sanitation and domestic sources resulting in potential leaching and localised contamination.	Minor
WG03	Soil and construction workers	Accidental spills or mismanagement of hazardous liquids such as paint, oil, and fuel leading to soil contamination and health risk.	Minor
Operation Phase			
WG04	Project site and personnel	Solid waste generation from routine maintenance, including office waste and cleaning supplies.	Minor
WG05	Soil and site drainage systems	Liquid waste from sanitary use, transformer oil handling, and battery servicing with potential for leaching.	Minor
WG06	Project site and licensed hazardous waste providers	Generation of hazardous waste from spent batteries requiring replacement, handling and disposal; and risk of contamination if not managed per regulatory and best practice standards.	Minor
Decommissioning Phase			



Impact ID	Receptor	Impact	Significance before Mitigation
WG07	Project site and waste handlers	Solid waste from dismantling infrastructure (e.g. PCS units, batteries, cables) including hazardous residues.	Minor
WG08	Soil and immediate surroundings	Liquid waste from equipment washing and chemical use during decommissioning with potential for contamination.	Minor
WG09	Project site	Management and disposal of spent batteries and hazardous components at end-of-life.	Minor
Unplanned Events			
WG010	Project site	Accidental generation of hazardous waste due to battery fires, chemical spills, or thermal runaway incidents.	Minor

Table 5-19: Summary of Identified Potential Impacts of Waste Generation for the Project



5.3.10 Economic and Social Aspects

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
ES01	Local workforce and regional service providers	Short-term employment and procurement benefits.	Minor
ES02	Informal land users (e.g. nomadic herders)	Temporary restrictions on access to informal users.	Minor
Operation Phase			
ES03	Local economy and project area	Minimal long-term economic influence and employment during the automated operational phase.	Minor
ES04	Informal land users and national development context	Restricted access to site and long-term land use change.	Minor
Decommissioning Phase			
ES05	Local workforce and regional suppliers	Short-term job creation and procurement benefits during decommissioning.	Minor
ES06	Community and social structures	Minimal disruption to communities following decommissioning.	Minor
Unplanned Event			
ES07	Public or emergency service perception	Public safety concerns during emergency events (e.g. fires, accidents), with no significant socio-economic disruption expected.	Minor

Table 5-20: Summary of Identified Potential Impacts on Economic and Social Aspects for the Project



Impact ID	Receptor	Opportunity	Significance before Enhancement
Construction and Decommissioning Phases			
ES01	Local workforce and suppliers	Short-term job creation and procurement benefits during construction and decommissioning phases.	Minor
Operation Phase			
ES02	National energy sector	Contribution to long-term national renewable energy targets through sustained BESS operation.	Minor

Table 5-21: Summary of Identified Potential Opportunities on Economic and Social Aspects for the Project



5.3.11 Ruins and Cultural Heritage

Impact ID	Receptor	Impact	Significance before Mitigation
RCH01	Subsurface archaeological heritage	Potential disturbance of undocumented cultural heritage or artefacts during excavation or earthworks.	Minor

Table 5-22: Summary of Identified Potential Impacts on Archaeology and Cultural Heritage for the Project



5.3.12 Human Rights

Impact ID	Receptor	Impact	Significance before Mitigation
Construction Phase			
HR01	Construction workforce	Potential exposure to improper labour practices, including excessive working hours, delayed or unfair wages, poor living or working conditions, lack of freedom of association, and inadequate access to grievance mechanisms, particularly affecting migrant workers.	Minor
HR02	Nearby informal land users (e.g. Bedouins)	Possible disturbance and reduced access to traditional land due to workforce influx and associated construction activities, which may affect mobility, cultural practices, or grazing patterns.	Minor
Operation Phase			
HS03	Operational workforce	Limited but present risk of unfair treatment, discrimination, or denial of grievance channels for permanent or contracted personnel performing maintenance and monitoring duties.	Minor
Decommissioning Phase			
HS04	Decommissioning workforce and local users	Temporary risks related to worker welfare during dismantling activities, including fair pay, occupational safety, and working hours. Additionally, minor disturbance to nearby land users may arise from short-term site traffic and workforce presence.	Minor

Table 5-23: Summary of Identified Potential Impacts on Human Rights for the Project



6 PLANS

6.1 Emergency Preparedness and Response Plan

An Emergency Preparedness and Response Plan (EPRP) is adhered to in the event of an emergency. In addition, all Contractors must have their own EPRP in place prior to the commencement of works. Contractor EPRPs must align with the EPRP provided methodology outlined below.

6.1.1 Purpose

The likelihood of an incident can be minimised by effective preparedness and planning of reasonably foreseeable emergency situations. As such, the purpose of this Plan is to eliminate, reduce and / or mitigate the environmental impact of an uncontrolled, unplanned, or accidental release of a hazardous material into the environment. Further, this Plan addresses requirements for prevention, preparedness, response, recovery and reporting of identified environmental emergencies.

The Project will prepare certain complimentary plans / procedures associated with potential emergency situations but will be guided by the overarching 'Emergency Preparedness and Response Plan' procedure as outlined below. Any risk assessments conducted for the Project will include consideration of the potential for environmental incidents.

The Plan will identify procedures for reasonably foreseeable emergency situations, taking into consideration the following factors:

- The most appropriate method for responding to an emergency situation;
- Internal and external communication process (with stakeholders and responders);
- Action required to prevent or mitigate health and safety, and environmental impacts;
- Mitigation and response actions to be taken for different types of emergency situations;
- Post-emergency evaluation to determine and implement corrective and preventative actions;
- Periodic testing / drills related to planned emergency response actions;
- A list of key personnel and aid agencies, including contact details (such as the fire department); and,
- Evacuation routes and assembly points.

This Plan covers environmental emergencies which are related to how to prevent, prepare, respond, and recover from adverse environmental impacts associated with the Project.

Possible environmental emergencies in this scope may include but are not limited to:

- Thermal runaway fires;
- Fuel / oil spill on land;

- Chemical spill on land;
- Wastewater spill on land;
- Heavy winds;
- Flash floods and washout; and,
- Lightning.

6.1.2 Emergency Roles and Responsibilities

6.1.2.1 Emergency Control Commander

The Emergency Control Commander is responsible for the control and implementation of all emergency response procedures. The Emergency Control Commander's responsibilities include managing all incident operations, allocation of emergency resources as well as the reporting and recording of all incidents. The Emergency Control Commander develops the organisation of the Incident Response Team and oversees the overall Emergency Incident Action Plan. The Emergency Control Commander is responsible for ensuring the Emergency Response Plan is periodically reviewed to ensure actions and responses remain current.

Further, the Emergency Control Commander is responsible for communication with internal and external emergency teams to provide status reports. He / she will act as the single point of contact, both internally and externally, for communicating status updates on the emergency.

The information to be conveyed during status updates includes:

- Type of incident;
- Location of incident;
- Possible number of injuries and types, if applicable; and,
- Evacuation Status.

After notifying the relevant stakeholders of a possible emergency, the Emergency Control Commander will proceed to the site main office and assess the situation further as well as direct all emergency protocols. If injuries are suspected or reported, the Site Nurse / Emergency Health Team should be directed to the locations of the affected parties via the **Emergency Control Commander**.

All incidents must be assessed through and post incident review protocol within 48 hours after the incident occurs. Such incidents must be accurately reported and considered during review of response plans and training procedures.

6.1.2.1.1 Deputy Emergency Control Commander

The role of the Deputy Emergency Control Commander is to undertake the duties of the Emergency Control Commander if he / she is unavailable.

The Deputy Emergency Control Commander will also provide support to the Emergency Control Commander from the start of an emergency through to its conclusion. This is required to ensure the continuation of protocols in the event that the Emergency Control Commander is required to relinquish his / her duty and is to leave the site at any time during the emergency.

6.1.2.1.2 Emergency On-Site Communication Manager

The Emergency On-Site Communication Manager shall wait instruction from the Emergency Control Commander. Upon instruction, the Emergency On-Site Communication Manager shall summon the Evacuation, Crowd Control, Emergency Response Team and Fire Fighting Team if necessary.

The duties of the Emergency On-Site Communication Manager are primarily to ensure clear lines of communication on site and provide updates to the Emergency Control Commander from the emergency location. The Emergency On-Site Communication Manager shall contact relevant emergency response services as required (in coordination with the Site Nurse / Medic). The Emergency On-Site Communication Manager must maintain up-to-date schematics of the BESS and coordinate with local emergency services to ensure they are informed of the unique hazards associated with BESS infrastructure.

6.1.2.1.3 Site Nurse / Medic

The primary duties of the Site Nurse / Medic involve first aid treatment to personnel suffering from minor injuries such as burns, cuts, bruises and abrasions. Furthermore, the Site Nurse / Medic shall provide stabilisation, resuscitation and any other first aid response measures, as required.

Additional duties of the Site Nurse / Medic include:

- The Site Nurse / Medic shall operate emergency equipment and machinery in emergency situations and shall manage vital functions of the patient until the relevant offsite medical team arrives;
- The Site Nurse / Medic must keep a well organised and well-prepared medical treatment room to ensure adequate treatment during emergency responses;
- The Site Nurse / Medic shall ensure that casualty patients with minor injuries are provided with proper after-care;
- The Site Nurse / Medic shall ensure that patients with moderate to severe injuries are appropriately managed, i.e., procedures for obtaining external medical care are followed;
- The Site Nurse / Medic shall inform the Emergency On-Site Communication Manager of any injuries to personnel;
- The Site Nurse / Medic shall be trained in recognising and treating injuries specific to battery fires, such as smoke inhalation and chemical burns. The medical treatment room shall be equipped with materials to treat respiratory distress potentially resulting from fire incidents in the BESS.
- In addition to keeping medical stock at adequate levels, the Site Nurse / Medic shall administer medication as required, and;
- The Site Nurse / Medic shall provide monthly updates on medical reports.



6.1.2.1.4 First Aider and Ambulance Driver

The First Aider / Ambulance Driver shall aid the Site Nurse / Medic with regards to the transportation of patients to the site trauma room / hospital in cases of emergency.

6.1.2.1.5 Crowd Control (Safety Officer)

The Crowd Control Officer is responsible for setting up barricades or rope lines to cordon off emergency incident areas. In addition, the Crowd Control Officer shall direct any crowds to emergency assembly areas.

6.1.2.1.6 On-Site Fire Crew

In the event of a fire, the On-Site Fire Crew shall report directly to the incident location upon receiving an instruction from the Emergency On-Site Communication Manager. The On-Site Fire Crew shall respond to the specific need of the situation such as fire suppression. The On-Site Fire Crew shall be trained in the management of lithium-ion battery fires, including identification of thermal runaway events. Fire suppression equipment suitable for electrical fires (e.g., Class C fire extinguishers, aerosol extinguishing agents) must be available at the BESS container locations.

6.1.2.1.7 Construction Manager

The Construction Manager is required to attend incident meetings as required as well as conduct investigations and prepare reports for any incidents. Further, the Construction Manager shall provide support and technical assistance to the Emergency Response Commander during emergencies.

6.1.3 Hazardous Materials On-Site

The Project's general activities will entail the use of various petroleum products and hazardous materials that may pose a risk to the environment if spilled or mismanaged.

Such materials can be found in locations where the following activities take place on site:

- Materials associated with the BESS, including lithium-ion electrolyte compounds and other flammable chemicals, pose specific risks such as thermal runaway. These must be stored and labelled according to international hazardous materials standards.
- Fuel / oil storage at the site office fuel tank;
- Fuel delivery / transfer to the site fuel tank;
- Fuel dispensing for machinery and vehicles;
- Equipment storage;
- Bathrooms / toilets;
- Hazardous material storage; and,
- Hazardous material handling.

The Developer HSE Manager should ensure that the list of hazardous materials on site is always up to date or inform the relevant parties when these materials change, in order to determine the specific site hazards when responding to an environmental emergency.

6.1.4 Identification of Potential Environmental Emergencies

Based on the information of the properties and characteristics of hazardous materials on-site (refer to Section above), potential exists for the following substances to be released into the surrounding atmosphere, water body or land:

- Fire or explosion originating from the Battery Energy Storage System due to thermal runaway or mechanical damage.
- Hazardous Chemicals; and,
- Hydrocarbon Products.

Other environmental emergencies that may occur naturally include events of high wind or lightning.

6.1.5 Contingency Procedures

During unplanned events on site such as oil spills or fuel leaks, construction and operational personnel will follow the contingency measures (spill response procedures) outlined within this section and reference other relevant plans, such as material handling and storage plans.

6.1.5.1 Prevention of Significant Effects from Spills

Spill response / control materials shall be stored in a safe location on-site in proximity to the storage and waste areas. This material is to be used to contain and clean up spills, and care shall be taken to dispose of any absorbent materials properly. The absorbent material is not to be washed away. The Developer HSE Manager shall keep stocks well maintained and replenished.

Inspections of high-risk areas (i.e., refuelling / maintenance areas, equipment) are to be undertaken daily to avoid any potential spills and associated contamination to soil and groundwater. Storage of hazardous materials / waste are to be secured and covered to prevent rain ingress.

Spill response materials shall include the following:

- Sand;
- Sandbags;
- Buckets and shovels;
- Suitable stock of chemical and hydrocarbon spill kits; and,
- Storage containers.

Sand is one of the most versatile containment materials, which can be used to soak up spillages of oil and chemicals and used in sandbags to block off substances from sensitive areas or channel them to a predetermined collection point. Sand stocks must be dry and buckets and shovels readily available. Mechanical loading shovels, excavators and dump trucks may also be used for distribution and clean up. Storage containers for contaminated materials and

earth shall be banded. The containers shall be labelled, placed in the waste storage area and treated as hazardous waste.

6.1.5.2 Prevention of Leaks from Equipment

Incorrect or inefficient maintenance programmes and operation of on-site equipment can increase the risk of the occurrence of an environmental emergency related to spills and leakages of hazardous materials such as fuel. In order to ensure risks arising from the aforementioned are minimised, the following measures should be employed by all on-site personnel:

- The construction Contractor and Operator will maintain a preventative maintenance programme for equipment in accordance with manufacturer recommendations;
- All on-site equipment shall be properly maintained and only used when in good working condition;
- All equipment maintenance shall be performed in designated areas equipped with the appropriate spill response equipment;
- When equipment is parked or being stored, a drip tray shall be placed such that it catches all potential leaking fluids;
- All on-site equipment shall be operated only according to the manufacturer's specifications and by approved personnel;
- Materials associated with equipment should only be stored with compatible materials;
- All petroleum, oil and lubricant products shall be stored in a permitted location; and,
- All drum type storage shall be placed on appropriate spill containment platforms and proper secondary containment measures shall be mandatory for hazardous materials.

6.1.5.3 Emergency Environmental Response Training

Personnel training on how to implement emergency response measures is imperative to outline responsibilities and procedures of how to respond to an environmental emergency. Personnel should become familiar with the use of spill kits and how to react in an emergency situation.

Training should be conducted at regular intervals and be planned and overseen by the Emergency Control Commander.

Training shall include the following key components:

- Emergency Protocol Reviews and Drills

The Environmental Preparedness and Response Plan and measures will be reviewed, evaluated and drilled on a bi-annual basis to ensure continued adequacy and suitability or following changes in site activities. Based on the review, evaluation and practice drill, the environmental response measures are to be updated and amended, as required. Records of the reviews and drills will be kept on site and in an easily accessible area. Having records of these reviews and drills demonstrate that the site implements (and continuously improves)

environmental emergency response mechanisms. Emergency drills shall include simulated BESS fire scenarios. Personnel must be trained to recognise early warning signs of thermal runaway and to respond with appropriate containment measures.

- Communication Response Time

The Developer HSE Manager shall be notified of the incident within one (1) hour of its occurrence, be provided a notification report within 24 hours and an investigation report within 72 hours.

- Health and Safety

An evaluation of risks to human health shall be conducted during every training event. Where new risks are identified, these will be addressed accordingly, and relevant mitigation measures proposed and included in the training protocols.

- Use of Spill Kits

Spill kits and PPE will be placed at all locations where the potential for a spill exists, such as the site fuel tank, generators and near any storage area where chemicals are likely to be stored. Each area should have a spill kit that contains appropriate material to clean up the hazardous product. It is recommended that each spill kit contain a 'List of Contents' to identify the specific materials for that particular spill kit and will help with the spill kit inspections. Training of the use of spill kits will be undertaken through drills.

- Evacuation Routes and Assembly Points

The training drill will cover evacuation routes and assembly in a pre-determined scenario. Evacuation route and assembly point maps will be placed in relevant, easily visible areas throughout the Project site.

6.1.6 Emergency Procedures

An Emergency Management Plan is a strategy developed to mitigate the impact of potential events that could jeopardise an organisation's ability to function. A plan of this type should include measures to ensure the safety of personnel, developments and facilities. Identifying potential emergency situations and appropriate responses to each emergency situation is a component of emergency management planning.

In the event of an environmental emergency, on-site personnel will need to determine the level of response required. The Emergency Control Commander will assume the roles and responsibilities during an emergency. The level of response required shall be based on a determination of the associated emergency level, which shall be determined by the Emergency Control Commander. The Emergency Control Commander shall be responsible for determining the course of action required, as per their discretion.

6.1.6.1 Emergency Level One

An Emergency Level One is an incident for which the response and recovery is managed within a proponent department's immediate area of responsibility. The response normally involves locally available resources and equipment, may require assistance from neighbouring areas and / or limited third party assistance.

This type of incident results in limited consequences to company operations, facilities or employees; with no impact to off-site environment or public. Potential reputational impact is limited to external stakeholders or community.

6.1.6.2 Emergency Level Two

An Emergency Level Two is an incident that requires a wide range of company resources and equipment, additional assistance from government / external agencies, or partial evacuation of the site. This type of incident results in multiple injuries, a single fatality, missing persons, an impact on company operations and / or facilities, or potential loss of company revenues. Consequences of the incident are currently limited to the site property but have the potential for migrating off-site and affecting the public health, safety and / or environment for a limited period of time. Potential reputational impact may result from negative domestic mass media commentary. Some containment control(s) and / or relief systems are not operational; however, imminent control of the incident exists.

6.1.6.3 Emergency Level Three

An Emergency Level Three is an incident that requires multi-organisational response and recovery from emergency teams within the company and external agencies. This type of incident may result in multiple fatalities, a major impact on company operations, sustained loss of company facilities, critical IT, or power systems. Consequences of the incident may extend beyond the site property and can impact public health, safety and / or environment. The incident may provoke sustained national or international media commentary. Imminent control of the incident is not possible and containment control(s) and / or relief systems are not operational or effective.

6.1.6.4 General Procedures

The general procedures to be followed during an emergency onsite are as follows:

- Report to the Emergency On-Site Communication Manager in the first instance of an emergency event;
- The Emergency On-Site Communication Manager will immediately inform the Emergency Control Commander who will quickly evaluate the incident to determine the appropriate controls;
- If required, the Emergency Control Commander shall advise the Construction Manager and Developer HSE Manager regarding the emergency; and,
- When necessary, the Emergency Control Commander will report the accident / incident to the appropriate emergency services.

6.1.6.4.1 Site Emergency Evacuation Procedures

In an emergency event due to a significant unplanned event (earthquake, fire, explosion, gas leaks, etc.), all work areas will be simultaneously evacuated, and the following actions will be undertaken:

- A *Site Evacuation Siren* for one (1) minute shall signal evacuation protocols;

- All personnel including office-based personnel and visitors must evacuate, in an orderly manner, and assemble at the designated *Assembly Points* located in strategic locations throughout the site;
- Roll calls will be undertaken by the Emergency On-Site Communication Manager to ensure that all personnel and visitors are accounted for, and the numbers are to be advised to the Emergency Control Commander; and,
- All construction personnel and visitors will remain at their designated *Assembly Point* until the 'All Clear' signal has been given by the Emergency Control Commander or responding competent government authorities (i.e., fire brigade).

6.1.6.4.2 Spill Response Procedures

Regular inspections and training should be carried out to enable early detection of any spills. It is everyone's responsibility to be aware of potential spill risks.

The following spill response procedure should be applied:

- Notify your supervisor / emergency team;
- Notify supervisor, who shall notify the Emergency On-Site Communication Manager or the Emergency Control Commander. Emergency clean-up services shall be notified as necessary;
- Assess safety risk to personnel;
- Only attempt containment and clean-up operations of spilt substances when this can be performed safely;
- If spilled material is flammable, eliminate sources of ignition near spill area;
- Evacuate personnel and neighbours if they are at risk;
- Secure the area and establish perimeter control at a safe distance from the spill;
- Spill kits, protective equipment, and other necessary equipment will be available onsite, where hazardous materials are handled, to clean and mitigate spills;
- Stop the source of the spill;
- When it can be performed safely, stop the source of the spill. Spill control equipment shall be available from the contractor or its sub-contractors site administration offices, storage and re-fuelling areas;
- Contain the spill;
- If the spill is liquid, its path will be blocked or diverted and then soaked up using an absorbent material;
- Clean up;
- No spills shall be rinsed away;
- Contaminated soils and clean-up materials from spills shall be handled properly using PPE, stored in a suitable container that is then labelled and stored in the appropriate location for subsequent disposal;

- Any stockpiles of remnant contaminated materials shall be covered;
- Dispose with care;
- Contaminated soils and used clean-up materials shall be treated as hazardous waste and be disposed of accordingly at a designated disposal site by approved practitioners;
- Document incident; and,
- The Emergency On-Site Communication Manager shall be responsible for ensuring a report is filed containing information on date, time, location, type and quantity of spilled material, description and cause of incident, action taken, name of person reporting the incident and recommended actions for ensuring the incident does not reoccur.

6.1.6.5 Releases to Atmosphere Procedures

If a release to the atmosphere occurs (e.g., leaking compressed gas cylinder, ozone depleting substance release from air conditioning system, a natural gas leak) the following steps shall be taken:

- Assess the material involved. If safe to do so, shut off the source of the leak, contain the material or move the leaking material outdoors;
- If unsafe, evacuate area and call for outside assistance; and,
- In case of emergencies, relevant emergency coordinators will be called. The respective contact numbers will be displayed at various locations on site, in locations that are easily visible. In case of complaints regarding the management of incidents, personnel can contact the relevant Developer HSE Manager.

6.1.6.5.1 Fire Safety

BESS Thermal Runaway

In lithium-ion batteries, thermal runaway is a chain reaction that can result in fire or explosion when a cell fails due to high heat, releasing energy that warms nearby cells. It may be brought on by:

- Deep discharge or overcharging;
- Poor ventilation, malfunctioning cooling systems, or external heating; and,
- Defects in production or internal short circuits.

The reaction can spread quickly among battery modules and is self-sustaining once it is initiated. Even days after the fire is first put out, "re-ignition" is not guaranteed due to the self-regenerating heat of the runaway process. The following recommendations are suggested as a response to the numerous high-profile BESS plant fires that have occurred in recent years:

- Thermal runaway can only be stopped once it has begun by promptly detecting the conditions that lead to it and cooling the impacted cells;
- Fire-resistant barriers and battery modules must be physically isolated in order to safeguard assets and allow fire conditions to "let burn" or exhaust on their own; and,

- The requirement for proactive design and operational alertness is demonstrated by the incident history of multiple BESS plant fires.

BESS Fire Protection

The primary line of protection against such fire initiate is heating, ventilation, and air conditioning (HVAC) and overall container design. To ensure acceptable operating temperatures, Thermal Management Systems use liquid cooling and sophisticated HVAC systems. In order to manage site-specific humidity and sun radiation, which impact interior cabinet temperatures and condensation risks, containers also use climate-adaptive design by incorporating drying and humidity purge systems. Since humidity and condensation pose serious dangers, many precautions are taken:

- Enclosed spaces equipped with dehumidifiers; and,
- Condensation sensors to prevent defects caused by moisture.

Passive Design Measures

A minimum safety distance of three meters should normally be maintained between battery containers and other buildings or structures as part of passive safety measures to stop fires from spreading to adjacent buildings or equipment. If necessary, a perimeter fire break (a cleared area with conditions maintained to prevent the growth of combustible vegetation or the presence of flammable material) and vegetation removal within the building constitute passive safety measures. Depending on the battery system's fire safety certification, these safety distances may be lowered or even removed, allowing battery containers to be placed next to one other.

External Firefighting System

A pumping station and a sufficient water supply network are part of the exterior firefighting system. To guarantee access for firefighters, fire hydrants will be positioned thoughtfully around the BESS site. Later project phases will need to evaluate the viability of using a nearby water source, like a pond, or connecting to the public water delivery network. As an alternative, the facility will include a large enough water storage tank that is conveniently placed.

Firefighting vehicles must have direct access to the water storage tank, fire hydrants, and any battery containers as part of the system design. During subsequent design stages, the precise dimensions and features of the firefighting system will also be established.

Integrated Fire Safety Systems – DC Block Fire Protection

Every battery container will have a fire extinguishing mechanism and advanced interior safety features, such as temperature, gas, smoke, and thermal sensors. Water sprinklers and an aerosol-based combustion suppressor are two (2) possible uses for this technique. It may be possible to include extra passive design elements like separation walls with a one-hour fire rating.

The Supervisory Control and Data Acquisition (SCADA) platform, which offers alarms and early warnings, is used to monitor these systems. In order to ensure prompt reaction in the event of an incident, systems for automatic communication to nearby firefighting services may also be necessary.

A variety of fire detection and firefighting techniques, including water-based or aerosol-based active extinguishing techniques, are included in each ESS container. These techniques include:

- Smoke Detector: The controller will initiate a sequence of pre-programmed firefighting logic activities upon detecting smoke;
- Thermal Detector: Identifies unusually elevated temperatures;
- Exhaust system for flammable gas detection and ventilation: accumulation of gases emitted during lithium-ion battery burns, overcharging, or other misuse scenarios poses a risk of explosion. When a flammable gas is detected, the ventilation exhaust system and combustible gas detection system activate, allowing the hazardous gases to be expelled through electric shutters;
- Aerosol generators: Automated devices that are either electrically or thermally actuated. When a predetermined temperature is reached, these units self-activate;
- Battery system controller (BSC) and fire alarm control panel (FACP): In order to send fire safety signals to the BESS controller (including for shutdown operations), the FACP communicates with the BSC and receives signals and fire safety logic; and,
- Water Sprinkler (if available): heat-sensitive automated sprinklers. Numerous sprinklers are installed in each battery compartment. External sources supply water to often dry pipes.

Explosion Prevention

Energy Storage System (ESS) containers use a variety of techniques to prevent explosions, such as automatically injecting inert gases that are activated by sensors and introduced to reduce internal oxygen concentrations. Pressure sensors initiate the discharge of gases and chemicals used in explosion suppression. Deflagration vents are used to guarantee that pressure and flames are diverted away from populated regions.

Operational Control Systems: Detection and Protection

Redundancy for fire propagation situations is also considered in the design of operating control systems, such as:

- Battery Management Systems (BMS) detect abnormalities in cell-pack-rack electrical behaviour and use real-time temperature, voltage, and current monitoring to determine the likelihood of thermal runaway;
- Emergency shutdown procedures notify operators to start fire-mitigation measures and disconnect malfunctioning modules; and,
- Other electrical components and BESS assets are protected in the event of a fire thanks to redundant protective layers in the Power Conversion System (PCS) and switchgear.

Compliance to Standards

Electrical equipment must be designed to reduce the possibility of an explosion or fire caused by using electricity in locations that may contain flammable liquids,

vapours, or gases. The following guidelines and standards must be followed while choosing and installing electrical equipment:

- EN 60079-14 Electrical apparatus for explosive gas atmospheres;
- NFPA 69 – Standard on Explosion Prevention Systems;
- NFPA 68 – Standard on Explosion Protection by Deflagration Venting;
- NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems; and,
- NFPA 15 – Standard for Water Spray Fixed Systems for Fire Protection.

6.1.6.5.2 Lightning

In the event of a thunderstorm with lightning that may be nearby, workers must be reminded to stay away from electrical equipment and take shelter until the storm has passed. All metal poles at the site will be covered to prevent people touching them during a storm.

Workers must be reminded of the dangers of working outside during the thunderstorm and informed that if they cannot get to shelter then they should crouch with their shoes on and their hands resting on their knees or covering their ears. They should be reminded not to let their knees or hands touch the ground and not to lie flat on the ground. This will be communicated via signage whilst the communications involved with directing people to safety shall be communicated via the *Emergency On-Site Communication Manager*.

Specific areas of shelter from lightning should be provided around the site which are fitted with an insulating material and a barrier.

In addition, the following measures will be implemented during a lightning storm:

- All generators must be earthed;
- Personnel from high elevations, such as structural steel members, pipe racks, rooftops, process columns, antennas, etc. must stop work and proceed to areas of safety’;
- Personnel shall not group together under or near tall structures;
- No standing water should be allowed on site; and,
- All crane booms shall be lowered to the ground or retracted to the shortest boom length.

6.1.6.5.3 High Wind Procedures

Should inclement weather be forecast for a time period before the weather event, then all on site staff will be informed and work will be altered or cancelled accordingly. If the conditions on site become inclement without warning, then the appropriate action will be taken as described below for each condition.

For wind speeds which fall under 6 m/s, work may continue as normal. This wind speed category is considered safe for work; however, monitoring of wind speed every two (2) hours should be undertaken as a safety precaution. When wind speeds fall between 7 – 11 m/s, a safety advisor must perform a risk assessment in relation to work tasks at hand.

Moderately heavy winds are considered winds between 12 – 14 m/s. When these winds create a hazard to the workforce or work being performed, i.e., instability in elevated areas, limited visibility due to dust particles in the air, unmanageable materials, etc., supervisors must stop work and reassign activities until the winds subside. All standard and critical crane lifts shall be halted, and crane booms shall be secured as per the manufacturer's instructions and / or tied down until the winds subside. Where the safety advisor deems all work to be unsafe, an evacuation may be required. For winds in excess of 15 m/s, a full site evacuation must be executed.

6.1.7 Environment Incident Investigation and Reporting

The Emergency On-Site Communication Manager will assign a competent and experienced Incident / Accident Investigation and Response Team based on the severity of the incident. The Investigation Team will thoroughly delve into the incident in order to find the root cause and ensure recommended corrective and preventive actions to be implemented to prevent reoccurrence of the same / similar incident.

In summary, the Investigation Team will, in general:

- Cordon off the scene of the incident;
- Ensure that the area is safe for the Investigation Team;
- Use of barriers in the event of excessive noise and air emissions;
- Shutting down operations and / or stopping all works where pertinent;
- Gather information on how the incident happened, casualty information, job title, experience, etc.;
- Carry out clean-up activities in the event of potential contamination (depending on its extent);
- Collect witness/es details present during / at the incident; and,
- Obtain photographs / sketches of the incident area.

An Incident Report is issued in the event of an exceedance of applicable environmental standards or upon the occurrence of a significant environmental incident. All employees are responsible for reporting any incident or hazard to the Emergency Department. After verbally reporting any incident, the personnel involved must submit an Incident Report.

The Incident Report shall include, at a minimum:

- Type, size location and extent of incident;
- Photographic documentation;
- Immediate response actions undertaken;
- Root cause investigation results; and,
- Planned follow up / close out and corrective actions.

All records shall be kept on-site for at least five (5) years following the date of issue, or more as required, (e.g., human health exposure records and training records are to remain on-site indefinitely).

Incidents of significance must be reported to the Developer HSE Manager and other relevant authorities as soon as practicable about any environmental incidents with actual or potential significance for impacts on the environment. The Developer HSE Manager shall be notified of the incident within one (1) hour of its occurrence and be provided with a Notification Report within 24 hours and an Investigation Report within 72 hours. For BESS incidents, investigations must determine whether the root cause was thermal, electrical, mechanical, or due to environmental stressors such as ambient temperature fluctuations.

6.2 Environmental Rehabilitation and Remediation Plan

6.2.1 Objectives

A Degraded Sites' Environmental Rehabilitation Plan is required as part of an environmental impact assessment study of the activities of categories 2, as defined in the Executive Regulations for Environmental Permits to Establish and Operate Activities. A plan for the remediation of polluted sites is required when any environmental pollution incident occurs while the activity is being set up, operated, or closed.

The plans for environmental rehabilitation of degraded sites and remediation of polluted sites will be developed at later stages of the Project prior to demobilisation and the plans shall outline how the land disturbed by the project will be restored to its natural (pre-construction) condition or better.

6.2.2 Content

The site's Environmental Rehabilitation Plan will comply the Executive Regulations for the Environmental Rehabilitation of Degraded Sites and Remediation of Polluted Sites, for the Environmental Law Issued by the Royal Decree No. (m/165), dated 19/11/1441 Hijri.

The outline and content of the Environmental Rehabilitation Plan will include:

- Regulatory Requirements;
- Activity Description;
- Land Uses Following Environmental Rehabilitation;
- Site Description, including:
 - » Study Area;
 - » Climate;
 - » Land Use;
 - » Topography;
 - » Geology;
 - » Hydrology and Water Resources;
 - » Biological Resources;
 - » Historical and Cultural Features;
 - » History of Site Activities; and,
 - » Summary of SRs;

- Environmental Rehabilitation Plan, including:
 - » Environmental Rehabilitation Objectives;
 - » Land Stability;
 - » Aquifers and Surface Water Recovery;
 - » Restoring Wildlife and Vegetation Cover;
 - » Managing Chemicals and Waste;
 - » Facilities and Equipment;
 - » Public Safety;
 - » Monitoring Plan;
 - » Physical Monitoring;
 - » Chemical Monitoring;
 - » Biological Monitoring;
 - » Historical and Cultural Features Monitoring;
 - » Summary of environmental Monitoring Plan;
 - » Reporting;
 - » Emergency Management Plan; and,
 - » Cost of Environmental Rehabilitation and Monitoring.
- Summary and Conclusion; and,
- Annexes including the References, the Biographies of Report Authors, the Relevant Regulatory Documents, the Maps and Illustrations, and other relevant documents as needed.

6.3 Suggested Plan for Environmental Impact Reduction

The responsibility for implementation of the early works and construction phase mitigation measures rests with the CONTRACTOR whilst the responsibility for implementation of the operational phase mitigation measures rests with the OPERATOR. The mitigation and management measures for the decommissioning phase will be implemented by the appointed CONTRACTOR at the time.

This section presents a summary of the residual impact significance following the application of mitigation measures for construction, operations and decommissioning phases, along with all mitigation measures as presented in Table 6-1 to Table 6-13. These tables reflect the anticipated level of impact remaining after mitigations has been applied.

It should be noted that the Project is currently at the pre-development phase of its lifecycle, thus, the technical information presented in this ESIA report is based on the preliminary design. In addition, all Project specification values and calculations in this chapter are approximate, based on data available at the time of drafting the ESIA, and are considered suitable for the pre-development phase of the Project. Future amendments to the technical specifications might be made as a result of additional detailed studies and site optimisation carried out by the

appointed developer. These future amendments are not likely to result in material changes to the ESIA. However, if future changes are required, that do lead to material impacts, this will be communicated to the NCEC through official channels at that time.

6.3.1 Natural Vegetation Cover and Biodiversity

The proposed mitigation measures to control or minimise the identified potential impacts on terrestrial ecology and biodiversity during the construction, operations and decommissioning phases are provided in the sections below. However, it should be noted that additional mitigation measures and control plans may be added during the Environmental Management Plan (EMP) stage where a more detailed construction methodology and operation plan are anticipated to be available in addition to any specific measures relating to decommissioning.

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation	Significance after Mitigation (Residual Significance)
Construction Phase					
TEB01	Natural Habitat	Loss or change of habitat within the development area	Minor	Ensure all clearing activity is confined to site boundary and the required Project footprints only. Relevant approvals will need to be obtained prior to any capture and relocation of species.	Minor
TEB02	Flora and fauna	Loss of flora and fauna due to construction activities	Minor	Contractors during construction shall ensure that environmental officer/s shall undertake daily site inspection of all construction activities to ensure that works and vehicle movements are limited to the designated working footprints.	Minor
TEB03	Terrestrial vertebrates	Disturbance of terrestrial vertebrates due to construction activities including noise	Minor	- Slow start up procedures, especially during site clearance, to allow habituation of avifauna as well as dispersal of non-volant mammals and reptiles to adjacent natural habitats; - Control night-time construction activities to ensure minimised disturbance; - Operate machinery within manufacturer guidelines to avoid excessive noise and implement a regular maintenance programme for construction machineries and equipment; and, - Avoid the use of audible warning systems during nighttime, unless this is required for safety purposes.	Minor
TEB08	Flora and fauna	Potential, accidental introduction and proliferation of IAS	Minor	- The contractor will ensure that vehicles, modular offices, and construction material packaging are inspected and free of hitching invasive species (i.e., Black Rat (<i>Rattus rattus</i>)) prior to mobilisation or delivery onto the Project area; - The appointed Engineering, Procurement and Construction Contractor shall ensure that a WMP is prepared. The WMP shall include food waste management to ensure there will no available food resources for feral species to venture inside the construction area or areas near the temporary waste storage facility or workers mess hall and accommodation; - HSE Department shall ensure compliance to the approved WMP; and, - Daily inspection of food waste management at designated rest and eating area for workforce.	Minor
Operation Phase					
TEB04	Terrestrial vertebrates	Behavioural change of wildlife as a result of increased human activity	Minor	Limit or prevent workers from venturing onto adjacent or nearby natural habitats located in proximity to the Project area.	Minor
TEB05	Terrestrial vertebrates	Injury or mortality of terrestrial vertebrates due to collision with vehicles	Minor	- Identify areas on the access road where wildlife encounters are frequent and potential for collisions with small and medium bodied vertebrates are high; - Undertake regular field inspections of collision hotspot areas; - Install signages warning driver of potential encounters and collision with wildlife; - Enforce speed limits (e.g., 40 kph for HGV and 60 kph for LGV) at access roads; and, - Include local laws regarding wildlife protection in the KSA and wildlife collision risks during site induction and regular Toolbox Talks and meetings.	Minor
TEB08	Flora and fauna	Potential, accidental introduction and proliferation of IAS	Minor	- Ensure the development and implementation of control plans that will prevent and control the introduction and proliferation of terrestrial alien species in the Project area; and, - Ensure regular collection of food wastes to prevent pests from establishing populations.	Minor
Decommissioning Phase					



Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation	Significance after Mitigation (Residual Significance)
TEB06	Flora	Vegetative metabolic distress	Minor	Effective dust control measures including watering dry and exposed surfaces and enforcing speed limits on the roadways in and nearby the Project boundary will reduce the severity of this impact.	Minor
TEB07	Terrestrial vertebrates	Injury and mortality of wildlife	Minor	Periodically check for trapped wildlife, and opportunistically rescue animals trapped in pits and/or the trenches, until rehabilitation efforts are completed.	Minor
TEB08	Flora and fauna	Potential, accidental introduction and proliferation of IAS	Minor	- Ensure the development and implementation control plans that will prevent and control the introduction and proliferation of terrestrial alien species in the Project area; and, - Ensure regular collection of municipal and food wastes to prevent pests from establishing populations.	Minor

Table 6-1: Mitigation Measures for Impacts on Natural Vegetation Cover and Biodiversity



6.3.2 Ambient Air

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction and Decommissioning Phases					
AQ01 & AQ04	Construction Workers	Increased fugitive dust and PM ₁₀ emissions from general construction activities	Non-Significant	As per the IAQM guidance for each construction phase, namely earthworks, construction and trackout, the following mitigation measures for dust emissions are highly recommended [48]:	Non-Significant
AQ02 & AQ05	Road Users	Impaired visibility due to dust from general construction activities	Non-Significant	- Re-vegetate earthworks, exposed areas and soil stockpiles to stabilise surfaces as soon as practicable; - Remove vegetation cover in small sections where practicable; - Avoid sweeping large areas; - Cover vehicles entering and leaving the site to prevent spillage of materials during transport; - Keep a record of all inspections of the haul routes and any resulting actions; - Implement a wheel washing system with rumble grids where reasonably practicable; - Selection of modern equipment and operate as per the manufacturers' guidelines; - Ensure regular inspection and preventive maintenance of vehicles, generators, and construction machinery to minimise exhaust emissions, oil leaks, and unnecessary idling; - Install appropriate exhaust or filtration controls on stationary combustion sources (e.g., generators or compressors) to limit particulate and gaseous emissions; - Routine spraying of access roads using water bowsers; - Halting of construction activities during periods of high winds; and, - Enforce speed limits (e.g., 40 kph for HGV and 60 kph for LGV) at access roads.	Non-Significant
Operation Phase					
AQ03	Surrounding Area	Vulnerability of the Project to Climate Change	Non-Significant	No additional mitigation measures required.	Non-Significant
Unplanned Event					
AQ06	Surrounding Area	Release of smoke / fumes due to fires / thermal runaway	Minor	Utilisation of SCADA system to implement fire response plan effectively are adequate measures.	Minor

Table 6-2: Mitigation Measures for Impacts on Ambient Air



6.3.3 Noise and Vibrations

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
NBV01	Onsite human receptor	Exceedance of noise limits	Non-Significant	Based on the construction phase noise impact assessment, the Project noise contributions are unlikely to result in significant impacts. However, in order to minimise the potential impact from the construction phase of the project, key noise control measures have been provided. Best practice construction noise control measures, as they are applicable to the construction phase, are provided to minimise noise from overall constructions activities. - Avoid unnecessary revving of engines and switch off equipment when not required; - Keep internal access routes well maintained and avoid steep gradients; - Use rubber linings in, for example, chutes and dumpers to reduce impact noise; - Start-up plant and vehicles sequentially rather than all together; - The movement of plant equipment onto and around the site should have regard to the normal operating hours of the site or surrounding environment; - Audible reversing warning systems on mobile plant and vehicles should be of a type which, whilst ensuring that they give proper warning, have a minimum noise impact on persons outside sites. When reversing, mobile plant and vehicles should travel in a direction away from SRs whenever possible. Where practicable, alternative reversing warning systems should be employed to reduce the impact of noise outside sites; - Noise from equipment can often be reduced by modification or by the application of improved sound reduction methods, but this should only be carried out after consultation with the manufacturer (i.e., fitting a more effective exhaust silencer system or by designing an acoustic canopy to replace the normal engine cover); - It might be possible in certain circumstances to substitute diesel engines with electric motors, thereby resulting in noise reduction; - On-site generators supplying electricity for electric motors should be suitably enclosed and appropriately located; - Noise caused by resonance of body panels and cover plates can be reduced by stiffening with additional ribs or by increasing the damping effect with a surface coating of special resonance damping material. Rattling noises can be controlled by tightening loose parts and by fixing resilient materials between the surfaces in contact; this is generally a maintenance issue. Impact noise during steel construction can be a nuisance. Direct metal-to-metal contact should be minimised; - As far as reasonably practicable, sources of significant noise should be enclosed. The extent to which this can be done depends on the nature of the machine or process to be enclosed and their ventilation requirements; - Equipment should always be used in accordance with manufacturers' instructions. Where possible, loading and unloading should also be carried out away from such areas;	Non-Significant



Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
				▪ Machines such as cranes that might be in intermittent use should be shut down between work periods or should be throttled down to a minimum; ▪ Equipment from which the noise generated is known to be particularly directional should, wherever practicable, be orientated so that the noise is directed away from noise-sensitive areas; ▪ Acoustic covers to engines should be kept closed when the engines are in use and idling. If compressors are used, they should have effective acoustic enclosures and be designed to operate when their access panels are closed; ▪ Materials should be lowered whenever practicable and should not be dropped. The surfaces onto which the materials are being moved should be covered by resilient material. ▪ Provide regular and effective maintenance by trained personnel; ▪ Ensure routine inspection and maintenance of all construction equipment, vehicles, and machinery to minimise noise resulting from mechanical wear, loose fittings, or faulty components; ▪ Regular servicing (e.g., lubrication, tightening, and replacement of worn parts) will help maintain low operational noise levels of the construction vehicles / equipment; ▪ Conduct site inductions to cover the importance of noise control and available noise reduction measures; ▪ Establish and enforce site speed limits; and, ▪ Designate a grievance officer who is able to deal with concerns and establish a complaints response programme (this can form part of the grievance mechanism) to enable the identification and resolution of any noise related concerns at an early stage of the construction operations, as well as throughout the different phases of project development.	

Table 6-3: Mitigation Measures for Impacts of Noise and Vibration



6.3.4 Water Quality (Surface Water and Groundwater)

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
WQ01	Nearby infrastructure such as the permitted Haden PV Park, project area and low-lying areas	Potential run-off causing pollution and accumulation of flood waters in Project area or nearby low-lying areas during flooding.	Minor	- Compact disturbed soils and surface materials; - Ensure drainage channels are prepared prior to construction; and, - Ensure that temporary construction facilities are located at a safe distance from low-lying areas.	Non-Significant
Operation Phase					
WQ02	Surface water bodies	Contamination of surface water bodies from battery leaks or fluid spills and maintenance activities.	Non-Significant	- Elevate all BESS components 300 mm above Q100 flood level, or 500 mm in high-risk flood areas; - Place cleaning supplies in strategic locations and clearly labelling them throughout important areas of the site; - Store hazardous materials such as fuels appropriately; - Install appropriate secondary containment systems (bund areas with 110% volume) at fuel storage areas; - Install spill containment and drainage control systems; and, - Ensure routine inspection and maintenance of storage systems.	Non-Significant
Decommissioning Phase					
WQ03	Nearby infrastructure such as the permitted Haden PV Park, project area and low-lying areas	Potential run-off from decommissioning related activities causing pollution downstream during heavy rainfall events.	Minor	- Dismantling procedures for BESS must be adhered to; - Implement waste management procedures; - Ensure staff is trained to implement a spill prevention and response plan; and, - Ensure proper disposal of used batteries and other hazardous materials.	Non-Significant
Unplanned Events					
WQ04	Existing nearby infrastructure such as the permitted Haden PV Park, Project and surrounding area.	Contamination of flood pathways and / or drainage from fire suppression during emergency events (battery fire / thermal runaway)	Minor	- Ensure drainage channels are constructed for containing contaminated surface run-off (spills and fire suppressants) to a designated location; - Install leakproof bunding; - Implement an emergency response plan; - Ensure staff is trained to implement a spill prevention, containment and response plan; - Sealed enclosures with dehumidifiers; - Install condensation sensors to prevent moisture-induced faults; - Implement a routine inspection and maintenance schedule to check for cracks, corrosion, or leaks in bunds, tanks, and pipelines; and, - Refer to Section 6.1.6.5.1 for a detailed explanation on fire safety measures.	Non-Significant

Table 6-4: Mitigation Measures for Impacts on Water Quality



6.3.5 Quality of Soil and Sediment

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
SSQ01	Soil and Sediments	Disturbance of loose sandy soils from land clearing, grading and excavation may result in wind-driven erosion and short-term sediment transport.	Minor	- Restrict vegetation clearance to essential areas only; - Apply dust suppression methods such as water spraying on exposed surfaces; - Stabilise cleared or loose soil areas using mulch, cover mats, or geo-fabric; and, - Schedule earthworks to avoid periods of high wind or storms.	Non-Significant
SSQ02	Soil and Sediments	Accidental spills or leaks of fuel, lubricants, and chemicals from construction machinery may contaminate surface soil and alter its composition.	Minor	- Store hazardous materials in bunded areas away from drainage lines; - Provide spill kits and secondary containment near all fuel and lubricant storage points; - Train staff on safe material handling and spill response; and, - Implement regular inspection and maintenance of construction vehicles and equipment. - Install appropriate secondary containment systems (bunded areas with 110% volume) at fuel storage areas; - Install liners with impermeable material; and, - Install drainage control systems.	Non-Significant
SSQ03	Soil and Sediments	Inadequate handling of wastewater from sanitation and vehicle washing could lead to soil infiltration by pathogens or organic contaminants.	Minor	- Use mobile sanitation units with sealed containment and scheduled servicing; - Designate washdown areas with oil-water separators and impermeable flooring; - Prohibit vehicle washing in uncontained open areas; and, - Monitor wastewater containment systems for leaks or overflow.	Non-Significant
Operation Phase					
SSQ04	Soil and Sediments	Routine maintenance involving oil, coolant or chemical use could result in gradual localised soil contamination if spills are not well contained.	Minor	- Use drip trays and spill-proof containers during oil and chemical handling; - Conduct maintenance in designated, bunded areas; - Dispose of waste oils and chemicals at licensed facilities; - Install drainage controls; - Provide spill kits; - Implement a routine inspection and maintenance schedule to check for cracks, corrosion, or leaks in bunds, tanks, and pipelines; - Promptly repair any identified defects; and,	Non-Significant



Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
				Document and monitor all maintenance activities for compliance.	
SSQ05	Soil and Sediments	Leakage from poorly stored transformers, batteries, or oils may alter soil chemistry and pose risks to subsurface quality over time.	Minor	- Implement robust storage systems with bunds for transformers, batteries, and oils; - Conduct routine inspections for leaks and corrosion; - Maintain inventory and safety data sheets (SDS) for all stored substances; and, - Apply emergency containment procedures in the event of leaks.	Non-Significant
Decommissioning Phase					
SSQ06	Soil and Sediments	Small-scale fuel or lubricant spills during infrastructure removal activities may result in short-term soil degradation along transport routes.	Minor	- Install appropriate secondary containment systems (bunded areas with 110% volume) at fuel storage areas; - Conduct fuel transfers and storage in bunded or contained zones; - Restrict heavy vehicle access to stabilised tracks; - Use spill mats and absorbents during dismantling activities; and, - Remove all contaminated soil from spill zones following incidents.	Non-Significant
Unplanned Event					
SSQ07	Soil and Sediments	Emergency fire response may lead to firewater infiltration, potentially introducing heavy metals and toxic substances into permeable soil.	Minor	- Develop and drill emergency response procedures for firewater runoff (refer to section 6.1.6.5.1); - Construct diversion channels / install spill containment and drainage system to prevent contaminated runoff from entering clean soil zones; and, - Safely collect, test and dispose of firewater via licensed hazardous waste contractors.	Non-Significant

Table 6-5: Mitigation Measures for Impacts on Quality of Soil and Sediments



6.3.6 Health and Safety (Occupational and Public)

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
HS01	Construction workforce	Risk of injuries, heat stress, and exposure to dust, chemicals, or machinery during construction.	Minor	- Implement a site-specific Construction Health and Safety Management Plan (CHSMP); - Conduct daily toolbox talks and safety inductions; - Provide PPE and hydration stations; and, - Enforce dust control and machinery safety protocols.	Non-Significant
Decommissioning Phase					
HS03	Decommissioning workforce	Injuries from dismantling activities, dust exposure, and residual chemical handling.	Minor	- Develop a Decommissioning Health and Safety Plan; - Provide worker training on handling hazardous materials; - Use proper dismantling equipment and dust suppression measures; and, - Monitor and label residuals before disposal.	Non-Significant
Unplanned Event					
HS04	Site personnel and responders	Health emergencies or injury due to fires, spills, or thermal runaway events.	Minor	- Maintain an ERP and conduct regular drills; - Equip site with fire extinguishers, spill kits, and first-aid facilities; - Install fire detection and suppression systems; and, - Train staff on incident reporting and BESS safety; and, - Refer to Section 6.1.6.5.1 for a detailed explanation on fire safety measures.	Non-Significant

Table 6-6: Mitigation Measures for Impacts on Health and Safety (Occupational and Public)



6.3.7 Natural Landscapes and Visual Comfort

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
LVC01	Visual receptors	Temporary visual disruption from construction activities	Non-Significant	- Limit night-time activities to avoid light spill; - Minimise vegetation clearance to what is necessary; - Site laydown areas to be away from roads or exposed areas.	Non-Significant
Operation Phase					
LVC02	Visual receptors	Presence of permanent infrastructure	Non-Significant	- Use low-profile equipment where feasible; - Neutral-coloured or non-reflective finishes on enclosures and fencing; and, - Maintain a tidy site layout.	Non-significant
Decommissioning Phase					
LV03	Visual receptors	Temporary visual disturbance from dismantling works and vehicle activity during decommissioning.	Non-Significant	- Schedule removal activities to avoid sensitive viewing times; - Screen laydown or dismantled areas where feasible; and, - Restore site promptly after works.	Non-significant

Table 6-7: Mitigation Measures for Impacts on Natural Landscapes and Visual Comfort



6.3.8 Land Use

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
LU01	Undeveloped land within permitted energy zone	Temporary disruption of land during site preparation and infrastructure installation	Minor	- Limit site clearance to essential construction areas only; - Clearly mark disturbance boundaries; and, - Rehabilitate temporary use areas after construction.	Non-Significant
	Informal land users (e.g. occasional grazing or movement)	Restricted access to open land during construction activities	Minor	- Provide clear signage and fencing to define restricted areas; - Communicate temporary access; and, - Restore informal access routes post-construction where safe.	Non-Significant
Decommissioning Phase					
LU03	Previously developed land within permitted Haden PV Park boundary	Temporary disturbance from infrastructure removal causing surface disruption and limited access	Minor	- Schedule removal activities to minimise disturbance; - Stabilise and regrade disturbed areas; and, - Restore land to original or agreed condition.	Non-Significant

Table 6-8: Mitigation Measures for Impacts on Land Use



6.3.9 Waste Generation

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
WG01	Project area and on-site workers	Generation of construction and domestic waste including improper segregation or storage of hazardous and non-hazardous waste	Minor	- Segregate hazardous and non-hazardous waste at source; - Provide clearly labelled, weatherproof storage containers; and, - Ensure regular on-site waste collection and off-site disposal via licensed contractors.	Non-Significant
WG02	Soil and on-site environment	Liquid waste from sanitation and domestic sources resulting in potential leaching and localised contamination.	Minor	- Install adequate temporary sanitary facilities; - Construct leakproof bunds; - Include waste handling procedures in the Construction Environmental Management Plan (CEMP); - Prevent leaching by using sealed units and bunded storage; - Promptly repair any identified defects; and, - Implement a routine inspection and maintenance schedule to check for cracks, corrosion, or leaks in bunds, tanks, and pipelines.	Non-Significant
WG03	Soil and construction workers	Accidental spills or mismanagement of hazardous liquids such as paint, oil, and fuel leading to soil contamination and health risk.	Minor	- Install appropriate secondary containment systems (bunded areas with 110% volume) at fuel storage areas; - Store hazardous liquids in bunded, weather-protected areas in line with a Hazardous Materials Management Plan; - Train workers on handling and emergency spill procedures; and, - Maintain spill kits and response plans on-site.	Non-Significant
Operation Phase					
WG04	Project site and personnel	Solid waste generation from routine maintenance, including office waste and cleaning supplies.	Minor	- Schedule routine waste removal and housekeeping; - Provide waste receptacles at key maintenance and admin locations; and, - Avoid on-site accumulation through periodic inspections.	Non-Significant
WG05	Soil and site drainage systems	Liquid waste from sanitary use, transformer oil handling, and battery servicing with potential for leaching.	Minor	- Include transformer oil and liquid waste handling in the Hazardous Materials Management Plan and Stormwater Management Plan; - Implement drainage controls and stormwater separation; and, - Train staff on proper liquid handling procedures.	Non-Significant
WG06	Project site and licensed hazardous waste providers	Generation of hazardous waste from spent batteries requiring replacement, handling and disposal; and risk of contamination if not managed per regulatory and best practice standards.	Minor	- Establish secure on-site battery storage areas with fire-resistant enclosures; - Implement strict chain-of-custody procedures for battery removal and transport; - Use licensed hazardous waste contractors for battery collection and disposal; - Train staff in safe battery handling, spill containment and emergency response; and, - Ensure all waste streams are labelled and tracked for auditing compliance.	Non-Significant



Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Decommissioning Phase					
WG07	Project site and waste handlers	Solid waste from dismantling infrastructure (e.g. PCS units, batteries, cables) including hazardous residues.	Minor	- Prepare a decommissioning waste management plan; - Segregate and classify demolition waste; and, - Ensure prompt disposal through licensed facilities.	Non-Significant
WG08	Soil and immediate surroundings	Liquid waste from equipment washing and chemical use during decommissioning with potential for contamination.	Minor	- Use bunded areas and impermeable surfaces for liquid waste activities; - Implement spill prevention and clean-up procedures; - Implement routine inspection and preventive maintenance, - Repair defects promptly and, - Conduct soil testing if contamination is suspected.	Non-Significant
WG09	Project site	Management and disposal of spent batteries and hazardous components at end-of-life.	Minor	- Prepare a comprehensive decommissioning waste and battery disposal plan; - Store spent batteries in secure, ventilated, and fire-rated containers; - Ensure waste storage areas are bunded or contained with impermeable flooring to prevent leaks or contamination of soil and groundwater; - Select corrosion-resistant and chemically compatible materials for waste storage containers and surfaces to prevent reaction or deterioration; - Conduct routine inspection and maintenance of all waste storage areas, containers, and bunds to detect and address any leaks, corrosion, or damage promptly; - Prioritise recycling or refurbishment pathways through licensed facilities; - Maintain full documentation for all removed battery units and destinations; and, - Comply with national hazardous waste regulations and international conventions.	Non-Significant
Unplanned Events					
WG10	Project site	Accidental generation of hazardous waste due to battery fires, chemical spills, or thermal runaway incidents.	Minor	- Maintain emergency response plan for fire (refer to section 6.1.6.5.1), spills, and system failure; - Store reactive materials safely with secondary containment; and, - Ensure trained personnel and rapid containment measures.	Non-Significant

Table 6-9: Mitigation Measures for Impacts on Waste Generation



6.3.10 Economic and Social Aspects

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
ES01	Local workforce and regional service providers	Short-term employment and procurement benefits.	Minor	Ensure transparent recruitment practices and advertise opportunities in local regions.	Non-Significant
ES02	Informal land users (e.g. nomadic herders)	Temporary restrictions on access to informal users.	Minor	- Provide advance notification to nearby communities and herders through local authorities; - Install signage and fencing at access points; and, - Reinstate informal access routes where safe post-construction.	Non-Significant
Operation Phase					
ES03	Local economy and project area	Minimal long-term economic influence and employment during the automated operational phase.	Minor	- Communicate long-term project benefits to regional stakeholders; and, - Offer periodic maintenance subcontracting opportunities to local service providers, where feasible.	Non-Significant
ES04	Informal land users and national development context	Restricted access to site and long-term land use change.	Minor	- Clearly communicate access restrictions and land use changes to affected parties; and, - Integrate national renewable energy messaging into local engagement materials.	Non-Significant
Decommissioning Phase					
ES05	Local workforce and regional suppliers	Short-term job creation and procurement benefits during decommissioning.	Minor	- Prioritise local contractors and labour for dismantling and site closure activities; and, - Engage local stakeholders early regarding job opportunities during decommissioning.	Non-Significant
ES06	Community and social structures	Minimal disruption to communities following decommissioning.	Minor	- Notify local authorities and communities of the decommissioning schedule in advance; and, - Include social closure communication as part of the Decommissioning Plan.	Non-Significant
Unplanned Event					
ES07	Public or emergency service perception	Public safety concerns during emergency events (e.g. fires, accidents), with no significant socio-economic disruption expected.	Minor	- Maintain an active ERP with community notification protocols; and, - Conduct annual emergency drills and ensure emergency contact info is available to the public.	Non-Significant

Table 6-10: Mitigation Measures for Impacts on Economic and Social Aspects

Impact ID	Receptor	Impact	Significance before Enhancement	Enhancement Measures	Significance after Enhancement
Construction and Decommissioning Phases					
ES01	Local workforce and suppliers	Short-term job creation and procurement benefits during construction and decommissioning phases.	Minor	- Include local hiring targets and supplier preferences in procurement documents; - Partner with local training centres or municipalities to build worker readiness; and,	Moderate



Impact ID	Receptor	Impact	Significance before Enhancement	Enhancement Measures	Significance after Enhancement
				Communicate opportunities via local notice boards or online platforms in advance of mobilisation.	
Operation Phase					
ES02	National energy sector	Contribution to long-term national renewable energy targets through sustained BESS operation.	Minor	- Promote the Project's contribution to national energy goals through stakeholder engagement, reports, or public platforms; and, - Share performance metrics or energy storage contributions annually with relevant ministries to reinforce policy alignment.	Moderate

Table 6-11: Enhancement Measures for Opportunities on Economic and Social Aspects



6.3.11 Ruins and Cultural Heritage

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
RCH01	Subsurface archaeological heritage	Potential disturbance of undocumented cultural heritage or artefacts during excavation or earthworks.	Minor	- Implement a chance finds procedure; - Train site personnel to recognise and report heritage materials; and - Stop work immediately if finds are encountered and notify authorities.	Non-Significant

Table 6-12: Mitigation Measures for Impacts on Ruins and Cultural Heritage



6.3.12 Human Rights

Impact ID	Receptor	Impact	Significance before Mitigation	Mitigation Measures	Significance after Mitigation (Residual Significance)
Construction Phase					
HS01	Construction workforce	Potential exposure to improper labour practices, including excessive working hours, delayed or unfair wages, poor living or working conditions, lack of freedom of association, and inadequate access to grievance mechanisms, particularly affecting migrant workers.	Minor	- Develop and implement a WMP that addresses fair recruitment, working hours, wages, accommodation, and worker welfare standards; - Enforce Contractor and subcontractor compliance with national labour laws and international standards; - Conduct regular audits of labour practices and living conditions; - Ensure a grievance mechanism is available, confidential, and trusted by workers, with awareness sessions provided; and, - Provide induction and ongoing training for workers on their rights and grievance procedures.	Non-Significant
HS02	Nearby informal land users (e.g. Bedouins)	Possible disturbance and reduced access to traditional land due to workforce influx and associated construction activities, which may affect mobility, cultural practices, or grazing patterns.	Minor	- Engage with informal land users (e.g., Bedouins) during pre-construction and construction phases to communicate construction timelines, access routes, and anticipated changes; - Avoid or minimise physical obstruction of traditional access paths or grazing land; - Maintain clear signage and access management to reduce disruption; and, - Establish a stakeholder grievance mechanism to address any complaints or concerns from affected users.	Non-Significant
Operational Phase					
HS03	Operational workforce	Limited but present risk of unfair treatment, discrimination, or denial of grievance channels for permanent or contracted personnel performing maintenance and monitoring duties.	Minor	- Ensure all operational staff and contractors are governed by transparent employment policies that prohibit discrimination and promote fair treatment; - Maintain access to a functioning and responsive grievance mechanism; and, - Conduct periodic worker feedback surveys or informal engagement to monitor conditions.	Non-Significant
Decommissioning Phase					
HS04	Decommissioning workforce and local users	Temporary risks related to worker welfare during dismantling activities, including fair pay, occupational safety, and working hours. Additionally, minor disturbance to nearby land users may arise from short-term site traffic and workforce presence.	Minor	- Extend the WMP and grievance procedures to the decommissioning phase; - Provide training to temporary workers on occupational health and safety, fair labour standards, and their rights; - Monitor contractor performance and ensure welfare provisions such as water, shade, and rest areas are in place; and, - Inform local users of the schedule and scope of decommissioning activities to reduce surprises or disruption.	Non-Significant



Table 6-13: Mitigation Measures for Impacts on Human Rights



6.4 Suggested Environmental Control and Management Plan

6.4.1 Preamble

This section describes the Environmental Monitoring Plan to enable effective monitoring and supervision of the mitigation measures to be implemented to support the construction, commissioning and operations phases of the Project. This monitoring plan will be updated as required during the Project phases by the Developer's appointed Contractors.

The objective of the Environmental Monitoring Plan is to identify environmental monitoring programs that will be implemented to manage the predicted impacts and confirm performance of the mitigation measures.

6.4.2 Regulatory Compliance

The Project shall comply with the requirements of the regulatory authority NCEC as detailed in Section 2 of this report and Annexure B of this report. These requirements will include those specified for emissions, discharges and wastes (covered in this ESIA report and its annexes / technical studies). Furthermore, the IFC EHS Guidelines and World Bank Group EHS Guidelines shall be adhered to.

The status of compliance to these requirements shall be reviewed periodically.

6.4.3 Monitoring Requirements

The ESIA process has identified several monitoring requirements which will be required to be implemented during the construction / decommissioning and operations phases, and these are set out in Table 6-14 and Table 6-15, respectively.

6.4.3.1 Monitoring Requirements – Construction and Decommissioning Phase

No	Monitoring Parameter Aspect	Monitoring	Monitoring Method	Monitoring Frequency
1	Natural Vegetation Cover and Biodiversity	Visual inspection and internal audit to ensure compliance with the mitigation measures provided in the ESIA.	Site walkover.	Daily for visual inspection.
2	Ambient Air Quality	- Implementation of dust control measures where dust generation is significant; and, - Site walkovers should be undertaken by the HSE Manager.	- Visual inspections of site; and, - Inspection log, monthly reporting.	Daily for site walkovers
3	Noise and Vibration	- On-going observations by contractor Site Manager as part of routine checks; and, - Noise monitoring surveys in the event of community complaints.	On-going auditory checks when on-site and as part of regular site walk over	- Daily; and, - Within two (2) weeks of receipt of complaints and then develop plan for monitoring based on outcomes of the survey.
4	Water Quality (Surface water, Ground water)	Surface water runoff and sedimentation.	Site inspections	As required.
		Groundwater quality and potential contamination indicators.	- Inspect containment systems, and sediment barriers to prevent contamination; - Check chemical and fuel storage areas for secondary containment compliance; and, - Monitor soil conditions near refuelling areas for signs of seepage.	- Weekly, and immediately following heavy rainfall; - Monthly; and, - Weekly.
		Presence of hydrocarbons and other pollutants.	Inspect and document hydrocarbon or chemical spill management, including spill kit availability and usage.	After each reported spill, with monthly compliance checks.
5	Quality of Soil and Sediment	Soil erosion or unstable slopes.	- Inspect excavation activities to ensure they are limited to designated areas and slopes are stabilized; - Monitor exposed soils for re-vegetation progress and erosion signs; and, - Check storage and covering of excavated soil to prevent erosion.	- Weekly during active construction and decommissioning and after significant rainfall or wind events; and, - Monthly and after major weather events.
		Soil compaction in work zones and access roads.	Inspect vehicle and equipment paths to confirm adherence to designated routes	- Weekly - Quarterly
		Soil contamination at equipment and storage areas.	- Conduct visual inspections of spill management practices and ensure spill kits are available at all relevant locations; - Inspect cement mixing areas for impermeable liners or barriers; and, - Verify disposal records for contaminated soils and construction waste at approved landfills.	- Weekly and after any spill incidents - Weekly - Monthly
6	Health and Safety (Occupational and Public)	Records of the following: - HSE incidents; - Training on PPE; - Induction training documentation; - Records of the grievances reported by both onsite workers and informal land users (if any); and, - Worker accommodation standards.	- Record-keeping; - Incident reports to be written as applicable; and, - Record of audits.	- Weekly for HSE incidents, PPE training, Induction training and grievances; and, - Quarterly for worker accommodation audits.
7	Natural Landscapes and Visual Comfort	- Encroachment beyond designated work areas; and, - Visibility and dust impacts on surrounding landscape.	- Visual inspections; and, - Incident reports to be written as applicable.	Weekly Inspections.
8	Land Use	Interactions with local land users.	- Maintain records of community notifications and feedback. - Conduct weekly inspections to ensure construction zones are clearly marked.	Weekly during construction and decommissioning activities.

No	Monitoring Parameter Aspect	Monitoring	Monitoring Method	Monitoring Frequency
		Traffic and dust management.	Track vehicle movements and road conditions.	Daily during construction and decommissioning
		Operation of the grievance mechanism.	- Log and analyse all grievances received. - Track response times and outcomes.	Monthly review of grievances and resolutions.
9	Waste Generation	Onsite checks.	Engineering, Procurement and Construction Contractor shall develop a program to ensure that waste management arrangements remain effective to the scale, scope, and pace of their works.	Daily site inspections
		Off Site checks.	Engineering, Procurement and Construction Contractor shall develop a program to ensure that waste generated on site is going to approved disposal/recycling facilities and that their Waste Management Service Provider is adhering to applicable legal requirements in their delivery of service to the Engineering, Procurement and Construction Contractor.	Engineering, Procurement and Construction Contractor Internal EMS Audits
		Waste segregation and disposal monitoring.	Audit waste storage areas weekly for proper segregation.	Engineering, Procurement and Construction Contractor Supplier Audits
		Hazardous waste management.	Verify disposal receipts from licensed facilities monthly.	Scheduled inspections of Waste Management Service Providers' premises
		- Waste management of spent batteries and components (Decommissioning Phase); and, - Chain-of-custody documentation for off-site transport.	- Cross-check battery/component inventory against removal records; - Conduct audits on storage conditions and packaging for transport compliance; - Verify licensing and permits of waste contractors; - Review chain-of-custody documentation; and, - Confirm material routing to licensed recycling or disposal facilities.	- Prior to decommissioning; - Weekly during decommissioning; and, - Upon completion of waste removal activities
10	Economic and Social Aspects	Local employment and training participation.	Review employment data monthly and compare with project targets.	Monthly during the construction and decommissioning phase.
		Public consultation and grievance mechanism.	Record and address grievances promptly, maintaining a log of issues and resolutions.	Weekly during active construction.
		Traffic and dust management.	- Record dust suppression activities and inspect roads for safety. - Audit vehicle routes and schedules weekly to ensure compliance.	Daily for dust management; weekly for traffic compliance.
		Noise exposure at community locations.	- Measure noise levels weekly at construction sites and nearby communities. - Review community feedback on noise disturbances monthly.	Weekly.
		Worker health and sanitation.	- Maintain health screening logs and sanitation schedules. - Record attendance at awareness sessions and assess their effectiveness through surveys.	Biweekly health screenings; monthly awareness sessions.
11	Archaeology and Cultural Heritage	Chance Finds Procedure: Discovery of heritage or archaeological materials during excavation.	Maintain logs of chance finds and their outcomes	Ongoing as ground-disturbing activities occur.
		Training and Awareness: Worker understanding of the Chance Finds Procedure.	- Track attendance at training sessions; and, - Evaluate knowledge retention through periodic worker assessments.	Before construction begins and every six months during construction and decommissioning.

Table 6-14: Monitoring Requirements for the Construction and Decommissioning Phases



6.4.3.2 Monitoring Requirements – Operation Phase

No	Monitoring Parameter / Aspect	Monitoring	Monitoring Method	Monitoring Frequency
1	Natural Vegetation Cover and Biodiversity	- Identification and monitoring of wildlife collision hot spots along the access road; and, - Visual inspection and internal audit to ensure compliance with the mitigation measures to prevent the potential impacts on native flora and fauna that may colonise or propagate through the Project area and surroundings.	- Driven transect; and, - Facility walkover.	Biweekly (two (2) times per month) for internal compliance audit.
2	Air Quality	- Implementation of dust control measures where dust generation is significant; and, - Site walkovers should be undertaken by the HSE Manager.	- Visual inspections of site; and, - Inspection log, monthly reporting.	- Daily for site walkovers; and, - Monthly reporting.
3	Noise	Worker Grievance Mechanism.	Record Keeping	Continuous
5	Water Quality (surface water, ground water)	Sustainable Water Supply Monitoring.	Perform water audits to evaluate efficiency and conservation measures.	Twice a year
6	Quality of Soil and Sediments	Soil erosion .	- Inspect maintenance activities to ensure soil disturbance is minimized and revegetation is progressing in disturbed areas. - Check backfilled areas for stabilization and signs of erosion.	After major weather events.
		Soil contamination.	- Inspect secondary containment systems in fuel and chemical storage areas for leaks or damage. - Monitor runoff pathways and verify that seepage is contained within designated areas. - Ensure waste materials are stored and disposed of as per the waste mitigation plan. - Conduct training sessions for staff on emergency spill protocols outlined in the EPRP.	- Monthly and after spill incidents. - Quarterly - Monthly - Annually
7	Health and Safety	The monitoring measures presented for the construction phase will be followed.	The monitoring measures presented for the construction phase will be followed.	As per construction phase.
8	Landscape and Visual Comfort	Disturbance from lighting.	- The operator shall develop (or evaluate and adjust existing) lighting plans to position, tilt, and shade lights to direct light only where it is needed and to prevent overspill from the site or upwards. - The operator shall minimise visibility of residual light from adjoining natural or populated areas by using fencing or landscaping, with particular reference to nesting areas. - The operator shall use energy-efficient bulbs and lights in all lighting facilities used throughout the construction site.	Continuous
9	Land Use	Community engagement and job opportunities: Prioritise local hiring and communicate employment opportunities transparently.	- Document hiring statistics, emphasizing local employment. - Survey community satisfaction annually regarding economic benefits.	Quarterly community engagement sessions.
		Traffic and noise management: Maintain traffic safety protocols and monitor operational noise levels.	- Use decibel meters to confirm compliance with noise regulations. - Record vehicle schedules and ensure adherence to approved routes.	Biannual noise level checks and quarterly traffic audits.
10	Waste Generation	Waste reduction initiatives: Promotion of recycling and minimize waste generation during operations.	- Track volumes of recyclable materials. - Conduct quarterly waste audits to identify improvement areas.	Monthly reviews of waste reduction strategies.
		Maintenance waste management: Safe management of maintenance waste, such as used equipment or oils.	- Document waste quantities and disposal methods. - Inspect maintenance storage areas monthly for compliance.	As generated, with monthly checks.
		Waste management of spent batteries and components; and,	Cross-check battery/component inventory against removal records;	Prior to decommissioning;

No	Monitoring Parameter / Aspect	Monitoring	Monitoring Method	Monitoring Frequency
		Chain-of-custody documentation for off-site transport.	- Conduct audits on storage conditions and packaging for transport compliance; - Verify licensing and permits of waste contractors; - Review chain-of-custody documentation; and, - Confirm material routing to licensed recycling or disposal facilities.	- Weekly during decommissioning; and, - Upon completion of waste removal activities
11	Economic and Social Aspects	Public consultation and grievance mechanism.	- Log grievances and resolutions quarterly. - Assess community satisfaction through biannual surveys.	Quarterly
		Local economic benefits.	- Track local procurement statistics and compare with targets. - Maintain records of engagement with local chambers of commerce.	Quarterly
		Disease transmission control.	- Maintain logs of health screenings and sanitation schedules. - Conduct monthly inspections of hygiene facilities.	Monthly

Table 6-15: Monitoring Requirements for the Operation Phase



7 CONCLUSION

7.1 Summary of Methods of Treating, Mitigating, Improving or Controlling the Negative Impact on the Environment or Public Health, and Methods of Strengthening the Positive Impact

A summary of identified impacts post mitigation including the proposed mitigation measures and monitoring control is provided in Chapter 6.

A Construction, Environmental and Social Management Plan (CESMP) shall be developed between the Developer and Engineering, Procurement, and Construction Contractor.

The purpose of a CESMP is to ensure that social and environmental impacts, risks and liabilities identified during the ESIA process are effectively managed during the early works and construction phase of the proposed Project.

The key objectives of the CESMP are to:

- Formalise and disclose the programme for environmental and social management; and,
- Provide a framework for the implementation of environmental and social management initiatives.

The CESMP describes the mitigation measures for all the identified potential impacts associated with the proposed Project during its construction phases. The CESMP outlines the monitoring and management measures to avoid and / or minimise such impacts through the allocation of management responsibility and suggestion of the required skills for implementation of these measures.

The CESMP shall ensure a continuous communication process between the Developer, Engineering, Procurement, and Construction Contractor, workers (including sub-contractors), the local community and other stakeholders. The Developer will have an obligation to ensure compliance with all relevant regulations and standards therein while executing all the Project-related activities for the proposed Project.

7.2 Summary of the Roles, Responsibilities, and Budget for the Implementation of the Environmental Management Plan

All stakeholders involved with the Project should recognise the need to minimise or negate negative environmental impacts. As such, all stakeholders are responsible for ensuring that negative environmental and social impacts caused by the Project are reduced or mitigated to acceptable levels through the implementation of the relevant mitigation measures and monitoring programmes.

An organisational diagram for this Project is provided in Figure 7-1, which highlights the key role-players in the CESMP. Detailed environmental requirements, mitigation measures, and related roles and responsibilities of Contractors will be included in the Contractor's HSE Plan, which should be approved (and environmental commitments monitored) by the Developer.



Figure 7-1: CESMP Organisational Chart

Role	Responsibility
Developer Project Director	Responsible for: - Ensuring resources are provided to implement the CESMP; - Ensuring the CESMP is implemented according to the requirements detailed within it; - Ensuring the CESMP is reviewed and updated annually or more frequently, if required; - Liaising with the Developer regarding any potential changes to the works and any updates to the CESMP; and, - Ensuring environmental incidents are reported and investigated in accordance with Chapter 6.
Environmental Project Manager	Responsible for: - Monitoring Contractor environmental performance; - Liaising with the Developer on any potential changes to the works; - Reporting all environmental and social issues and incidents to the Developer; and,

Role	Responsibility
	Ensuring environmental incidents are reported and investigated in accordance with Chapter 6.
Contractor Project Director	Responsible for: - Ensuring resources are provided to implement the CESMP; - Reporting all environmental and social issues and incidents to the Environmental Project Manager; and, - Ensuring that all environmental incidents are reported and investigated in accordance with Chapter 6.
Contractor Construction Manager	Responsible for: - Ensuring compliance with legislation and the requirements of the CESMP; - Identifying any potential changes to the works and liaising with the Contractor Project Director and the Environmental Project Manager; - Ensuring environmental records relevant to the works are generated and maintained; and, - Ensuring all environmental incidents and non-conformances are recorded, reported, investigated and corrective actions tracked until they are closed.
Contractor Environment Manager	Responsible for: - Ensuring compliance with legislation and the requirements of the CESMP; - Liaising with Managers / Supervisors on daily management of environmental risks and issues; - Ensuring daily inspections and audits are undertaken in accordance with Chapter 6 of this ESIA; - Ensuring sufficient resources of suitable qualification and experience to implement the requirements in the CESMP; - Ensuring personnel are made aware of their requirements under the CESMP; - Coordinating environmental training and inductions; - Coordinating and leading any environmental auditing required by the CESMP; - Ensuring environmental records relevant to the works are generated and maintained; - Ensuring corrective actions are closed out; and, - Overall environmental and social reporting, as necessary.
All Personnel	Responsible for: - Undertaking activities in an environmentally responsible manner and in accordance with relevant legislation, the CESMP and any relevant procedures; - Understanding the environmental risks and control measures that apply to their work; - Attending environmental training and inductions relevant to their role; and,

Role	Responsibility
	Immediately reporting all environmental issues and incidents to their supervisor.

Table 7-1: CESMP Key Personnel, Roles and Responsibilities

The budget for the implementation of the environmental management and monitoring plans will be the responsibility of the Engineering, Procurement, and Construction contractor.

7.2.1 Roles of the Different Authorities Concerned

All stakeholders involved with the Project should recognise the need to minimise or negate negative environmental impacts. As such, all stakeholders are responsible for ensuring that negative environmental and social impacts caused by the Project are reduced or mitigated to acceptable levels through the implementation of the relevant mitigation measures and monitoring programmes.

Environmental responsibilities for the different authorities are provided in Table 7-2.

Organisation	Description
MEWA	The MEWA, formerly the Ministry of Agriculture is responsible for water and environmental affairs. The ministry consists of eight agencies, namely the Environment, Water Affairs, Agriculture, Land and Surveys, Animal Resources; and Planning, Shared Services and Economic Affairs and Investment.
NCEC	The main institutional authority for the environmental affairs is the NCEC. The NCEC is a national entity that works with all parties to improve the environment through pollution monitoring, environmental assessment and strengthening environmental control and guidance in the region as well as being committed to enhancing the sustainability of the environment. In addition to the NCEC, the following National Centres have also been established and have their own policies and standards which need to be followed where applicable: - NCM; - NCW; - NCVC; and, - MWAN.
Ministry of Energy	The Ministry of Energy is one of the governmental bodies of Saudi Arabia and part of the Cabinet. The Ministry has the function of developing and implementing policies concerning petroleum and related products.
Ministry of Human Resources and Social Development	The Ministry of Human Resources and Social Development was established in 2019 after merging the Ministry of Labour and Social Development with Ministry of Civil Service. The Ministry is responsible for providing the community with development, support, and protection. The Ministry is also in charge of labour affairs and its related issues and policies.
Ministry of Municipalities and Housing (MoMAH)	MoMAH was established in 1975 and is responsible for the supervision and regulation of municipalities in the Kingdom. The Ministry is the central governmental organization entrusted with the oversight and regulation of municipalities across the country's cities, towns, and villages.

Organisation	Description
Ministry of Commerce and Investment	The Ministry of Commerce and Investment is responsible for managing the commerce and investment sectors. The Ministry is required to develop and implement effective and efficient policies and mechanisms, which will contribute to achieving sustainable economic development. This will enhance growth while protecting the interests of beneficiaries.
Saudi Geological Survey	The Saudi Geological Survey provides advisory services to the government of the KSA on geological matters. It has been authorised to study geological aspects of environmental issues and to determine ways to protect and mitigate the harmful effects of mining activities.
Ministry of Health	The Ministry of Health is the ministry responsible for the health of the citizens of Saudi Arabia. Recently, the Ministry has played an influential role in advising the Saudi government on social matters that could assist with the health of the Saudi people.

Table 7-2: Roles and Environmental Responsibilities



8 ANNEXURES

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8.2 Biographies of the Report Authors

8.2.1 WKC NCEC Registration Certificate and CVs

ILF has appointed WKC, an NCEC-approved Environmental Consultancy, to undertake the ESIA Study for this Project.

WKC's NCEC Registration Certificate and key team CVs have been attached as **Annexure A** to the ESIA Report.

8.3 Technical Documents of the Project

8.3.1 National and IFC Environmental Standards

Annexure B compiles the environmental standards applicable to the Project, including those issued by the MEWA and the NCEC. It also includes international benchmarks from the IFC and World Bank EHS Guidelines, covering air quality, noise, soil, water, biodiversity, and waste.

8.3.2 Element's NCEC Registration Certificate

Annexure C presents Element Arabia's NCEC registration certificate.

Element Arabia is authorised for conducting ambient air quality and noise surveys in KSA.

8.3.3 BESS Specifications and Layout

Annexure D provides the technical specifications and layout drawings of the BESS, including battery chemistries assessed (LFP and NMC), and associated infrastructure.

8.3.4 Preliminary Site Assessment Report

Annexure E contains the site visit report conducted in 2025. The report documents preliminary baseline environmental conditions of the Project site, including land use, topography, ecology, air and noise observations, and potential constraints.

8.3.5 Air Quality Monitoring Report

Annexure F presents the results of the ambient air quality monitoring undertaken at the Project site. The report includes sampling methodology, pollutant concentrations, instrument specifications, and results.

8.3.6 Noise Monitoring Report

Annexure G includes the findings of the baseline noise survey. It outlines the sampling locations, equipment used, and measured sound pressure levels, along with results.

8.3.7 Terrestrial Ecology Baseline Survey Report

Annexure H contains the Terrestrial Ecology Baseline Survey (TEBS) report. It summarises field observations, species identified, habitat classifications, and key ecological sensitivities at the Project site.

8.3.8 Soil Sampling Analysis Report

Annexure I contains the Soil Sampling Analysis report.

8.3.9 Vegetation and Tree Cluster Report

Annexure J contains the Vegetation and Tree Cluster report.

8.4 Maps of the Activity Site

All Project site maps have been included in the Scoping Report; refer to the List of Figures.

8.5 Public Participation Documents

In terms of land ownership, the land is currently controlled by the MoMAH and the Developer will undertake the necessary procedures for the transfer and reallocation of land required for the development of the Project and associated infrastructure.

Note, stakeholder engagement and disclosure activities for the Project are being undertaken by the Developer in accordance with applicable national regulatory requirements and in line with local cultural norms. This approach ensures that relevant stakeholders are informed and consulted in a manner consistent with the objectives of IFC PS 1.

