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ESIA REPORT

LEBANON WIND POWER WIND FARM, LEBANON

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1. INTRODUCTION

Lebanon Wind Power SAL (hereafter referred to as the Developer), a Lebanese investment company, together with Tefirom İnşaat Enerji Sanayive Ticaret A.Ş (Tefirom), a Turkish construction, engineering and contracting firm with experience in the field of wind energy, is seeking an environmental license for the construction and operation of the Lebanon Wind Power Wind Farm (the Project). The area to be developed is located in Jabal Akroum, Akkar on Lebanon's northeastern border with Syria.

The Project comprises the construction and operation of a wind farm to provide a maximum licensed capacity of 68.3 megawatts (MW). A potential for a 10% expansion as stipulated in the Power Purchase Agreement (PPA) arranged between LWP and the Government of Lebanon (GOL), which will be delivered to the public grid.

The purpose of this Environmental and Social Impact Assessment (ESIA) is to assess environmental and social impacts generated by the Project in line with the good international practice, as per International Finance Corporation (IFC) standards and European Investment Bank (EIB) Environmental and Social Standards.

This report is accompanied with three stand-alone documents: a Stakeholder Engagement Plan (SEP), an Environmental and Social Management Plan (ESMP) and a non-technical summary (NTS), which together constititute a full set of documents necessary for the international lenders to take a decision on Project financing.

1.1. Project Background

In Lebanon, the average available production capacity in 2009 was 1,500 megawatts (MW) while the average demand was around 2,000-2,100MW. The total energy demand was 15,000GWh although the total produced energy was 11,522GWh; thus, the electric energy deficit in Lebanon in 2009 was estimated at 3,478 GWh. At the 2009 Copenhagen Climate Conference, the Government of Lebanon (GOL) pledged to meet 12% of its energy consumption from renewable energy sources by 2020. Several strategies and Action Plans were put forth by different ministries to achieve this target, most importantly the Ministry of Energy and Water (MOEW) 2010 Policy Paper for the Electricity Sector (PPES),[1] committing to "*launching, supporting and reinforcing all public, private and individual initiatives to adopt the utilization of renewable energies to reach 12% of electric and thermal supply*".

Based on the contents of the PPES, the Lebanese Center for Energy Conservation (LCEC) developed the first National Energy Efficiency Action Plan for Lebanon for the period 2011-2015. It included fourteen initiatives to address energy efficiency and renewable energy, including Initiative 6: Electricity Generation from Wind Power. The subsequent *Wind Atlas of Lebanon* (UNDP-CEDRO, 2011) provided a mesoscale and microscale modelling for the entire country to produce a wind map at heights of 50m and 80m above ground level and at a resolution of 100m (GL Garrad Hassan, 2011). The Wind Atlas demonstrated a potential of 1,500MW of wind energy in the country, with the possibility to install 400 to 500MW by 2020.

[1] http://www.databank.com.lb/docs/Policy%20paper%20for%20the%20electricity%20sector%202010.pdf

Developers responded to a 2013 Request for Proposal (RFP) for developing the first utility-scale wind farm in Lebanon. Shortly thereafter, a higher electricity deficit of 5,524GWH was indicated in 2014, despite the start of power generation through rental floating power plants.[2] This situation resulted in end users being forced to rely on diesel generators to overcome the electricity shortages. As of 2016, the peak power demand reached 3,594MW while the effective power production by Electricité du Liban (EDL) only reached 2,108MW,[3] leading to 21 hours of electricity supply in Beirut, and 14 hours outside of the capital.

In response, Lebanon signed its first-ever Power Purchase Agreements (PPAs) to purchase wind energy from three separate consortiums that will build and operate wind farms in Akkar, in the north of the country. The MOEW's signing of the agreements represent Lebanon's first PPA with the private sector in electricity generation as part of efforts to close an estimated 1GW gap between current electrical supply and demand in the country.

To this extent, Lebanon Wind Power SAL (the Developer) was qualified and signed a PPA in February 2018 to construct and operate the Lebanon Wind Power Wind Farm (the Project) to provide a maximum licensed capacity of 68.3MW, with a stipulated potential for 10% expansion, which will be delivered to the public grid.

1.2. Project Location and Setting

The Project is located on an uninhabited mountain ridge of Jroud Akkar in the Akkar District and Akkar Governates, where the mean wind speed is 6-8m/s, as outlined in red in **Figure 1-1**.

The Akkar Governate (shown as "1" in **Figure 1-1**) is the northernmost governate of Lebanon and covers an area of 788 km^2 (304 mi^2). It is bounded by the Mediterranean Sea to the west, North Governate to the south and Baalbek-Hermel Governate to the southeast (shown as "2a" and "3a", respectively, in **Figure 1-1)**, and the Syrian governates of Tartus and Homs to the north and northeast.

Akkar can be divided into 7 parts: Qaitea, Jouma, Dreib, Jabal Akroum, Wadi Khaled, Cheft and As-Sahel. The largest cities in Akkar are Halba, Bire Akkar and Qoubaiyat. The Project site is located within Jabal Akroum. The Project area is approximately 2.6km^2 with an actual installation area of around 58,000m^2. The Project site is located on lands that shall be leased from the Municipality of Fnaidek and leased and or purchased from the Karm Chbat Forest Nature Reserve.

The layout of the Project is shown in **Figure 1-2**. The Project will comprise the construction of up to 16 wind turbines which range in power rating from 4.2MW to 5.3MW. Regardless of the Original Equipment Manufacturer (OEM)/Engineering, Procurement, and Construction (EPC) Contractor selected, the turbines will be installed among the 17 locations shown in **Figure 1-2**. Note: potential turbine locations LWP 01 through LWP 06 were removed as part of the ESIA process to mitigate Project impacts (refer to **Section 3 Project Alternatives**).

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[2] Bouri, E., El Assad, J. 2016. The Lebanese Electricity Woes: An Estimation of the Economical Costs of Power Interruptions. Energies, 9, 583; doi:10.3390/en9080583.

[3] Ashari, T (2018) *Lights Out as Demand Surges for Electricity*. The Daily Star Published on 10 July 2018. Retrieved from: http://www.dailystar.com.lb.

Figure 1-1 Project Location

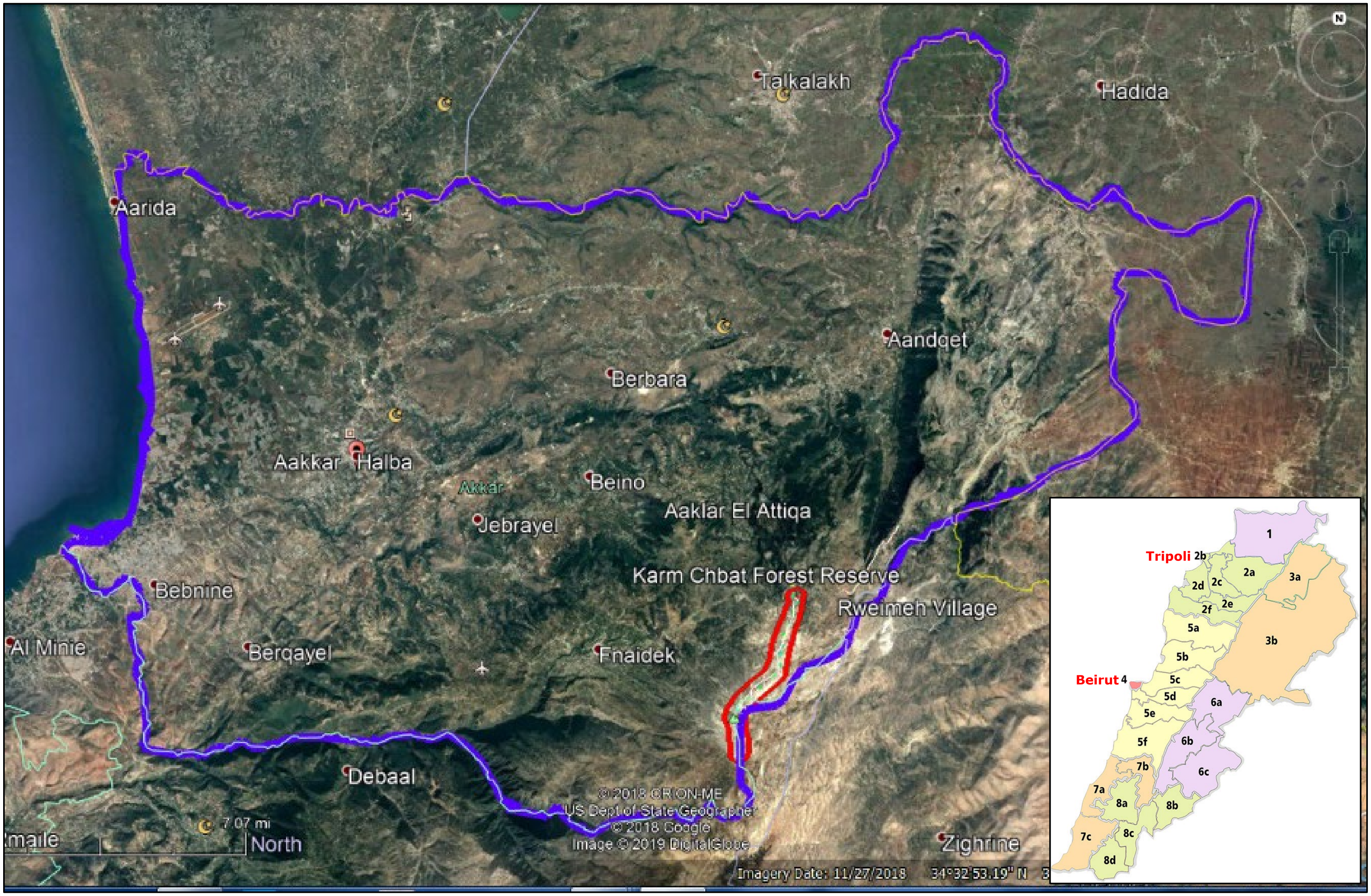
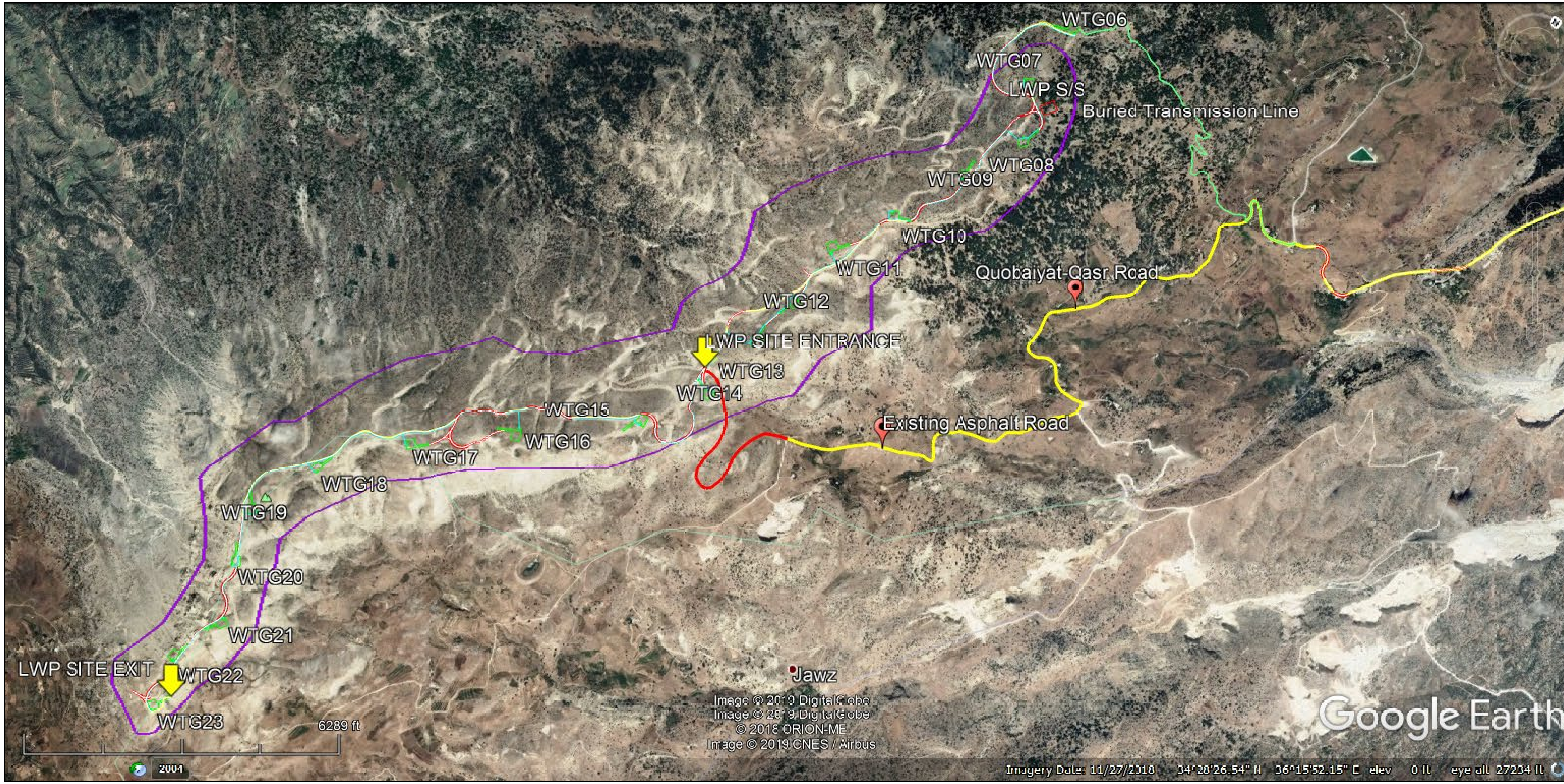


Figure 1-2 Project Layout



1.3. The Environmental and Social Impact Assessment Report

The environmental clearance for this Project is governed by the Ministry of Environment (MOE) as stipulated in Law 444 of 2002 for the Protection of the Environment[4] and the MOE Decree No. 8633 of 2012, Fundamentals for Environmental Impact Assessment[5]; the Project falls under Annex 1 requiring a full Environmental Impact Assessment.

The Developer will be seeking financing for the Project from prospective lenders, including International Finance Institutions (IFIs). Therefore, the Developer wishes to design and manage the Project in accordance with this Environmental and Social Impact Assessment (ESIA) Report which will be submitted to the MOE and the relevant IFIs and has therefore been prepared in accordance with good international industry practice and standards. For the purpose of the ESIA, this has therefore been developed in accordance with the following:

1. A Scoping Report submitted by the Developer on 5 June 2018 and approved by the MOE in their scoping response dated 14 June 2018 (Registration No. 3180/B 2018).
2. International Finance Corporation (IFC) Performance Standards (PSs)[6]
3. Relevant IFC Environmental Health and Safety (EHS) Guidelines.[7]
4. European Investment Bank (EIB) Environmental and Social Standards (ESSs).[8]

1.4. Document Structure

Table 1-1 provides an overview of the sections within this ESIA document.

Table 1-1 Summary of ESIA Report Contents

Section	Contents
Section 2 – Project Description	Provides a detailed description of the Project in relation to its location, the key project components and an overview of the proposed activities that are to take place during the various Project phases.
Section 3 – Project Alternatives	Provides an analysis of certain alternatives to the Project development in relation to: (i) the Project site selection alternatives, (ii) the Project design, (iii) the chosen technology; and investigates (iv) the 'no action alternative'.
Section 4 – Regulatory and Policy Framework	Provides an overview of the environmental clearance process for the Project as governed by the MOE.

[4] Lebanese Official Gazette: Law 444, dated 08/08/2002.
[5] Environmental Impact Assessment Decree - MOE Decree 8633 of 2012.
[6] World Bank. 2017. IFC Performance Standards on Environmental and Social Sustainability. IFC E&S. Washington, D.C.: World Bank Group.
[7] IFC, 2007. Environmental, Health and Safety General Guidelines, World Bank Group; IFC, 2007. Environmental, Health and Safety Guidelines, for Toll Roads, World Bank Group; IFC, 2007. Environmental, Health and Safety Guidelines, for Electric Power Transmission and Distribution, World Bank Group; IFC, 2015. Environmental, Health and Safety Guidelines, Wind Energy, World Bank Group.
[8] Environment, Climate and Social Office Projects Directorate, Version 10.0 of 08/10/2018.

Section	Contents
Section 5 – ESIA Approach and Methodology	Presents the methodology and approach that was adopted for the ESIA study. This is followed by presentation of gaps in baseline data and/or nature and extent of current knowledge, and environmental commitments for future data collection.
Section 6 – Stakeholder Consultation and Engagement	Discusses the stakeholder consultation and engagement which were undertaken as part of the ESIA process and provides an overview of the findings. In addition, this section also discusses the future stakeholder engagement and consultation plans.
Section 7 – Overview of Strategic Environmental and Economic Impacts	Provides an overview of the significant positive environmental and economic impacts that will result from the Project development on the strategic and national level. Also highlights the site specific negative environmental and social impacts anticipated from the Project throughout its various phases – each of which is discussed in detail in the subsequent sections.
Section 8 – Section 20 Baseline Environment and Impact Assessment	Presents the environmental and social attributes studied throughout the ESIA. This includes: Climate and Climate Change (Section 8), Geology (Section 9), Geophysical Ground and Seismicity (Section 10), Hydrology (Section 11), Air Quality (Section 12), Transport (Section 13), Biodiversity (Section 14), Bats (Section 15), Ornithology (Section 16), Socio-Economic Conditions --- to include Land Use --- (Section 17), Community Health, Safety and Security --- to include Noise, Shadow Flicker, Visual Amenity and Traffic --- (Section 18), Landscape (Section 19) Archeology and Cultural Heritage (Section 20) and Occupational Health and Safety (Section 21). For each attribute, the baseline conditions within the Project site and its surroundings is assessed. Each section then moves on to identify and assess the potential impacts from the Project on each attribute.
Section 21 – Assessment of Cumulative Impacts	Investigates the cumulative impacts which could result from other known existing and/or planned developments in the area and currently available information on such planned developments.
Section 22 – Summary of Impacts and Mitigation	Provides a summary of all the identified impacts discussed throughout the previous sections which are anticipated throughout the various phases of the Project to include planning and construction phase, operation phase, and decommissioning phase. For each impact provides a set of mitigation measures have been identified to eliminate or reduce the impacts to acceptable levels. References the stand-alone ESMP framework.
Section 24 – References	Summarized the references within the ESIA document.
Section 25 - Annexes	Annexed documents referenced in the ESIA Report.

1.5. Project Proponent and Key Contributors

Different entities are involved in the planning and implementation of the Project. The responsibilities of each key entity which is of relevance to the ESIA are listed in the text below along with a general description of their roles.

- Lebanon Wind Power (the Developer): serving as owner and lead developer of the Project.
- Sustainable Environmental Solutions SAL (SES): was commissioned by the Developer to prepare the Environmental Impact Assessment (EIA) for the Project in order to apply for the necessary environmental permit in accordance with the requirements of the MOE and in Law 444 of 2002 for the Protection of the Environment and the MOE Decree No. 8633 of 2012, Fundamentals for Environmental Impact Assessment. This report is the EIA report submitted to the MOE.
- Ramboll US Corporation (Ramboll US): was commissioned by the Developer to prepare this Environmental and Social Impact Assessment (ESIA) for the Project in accordance with IFC Performance Standards, IFC's Environmental, Health and Safety (EHS) Guidelines and EIB Environmental and Social Standards.
- OEM/EPC Contractor: will be responsible for preparing the detailed design and layout of the Project; supply of the material, wind turbines, and equipment; and construction of the internal access roads, crane pads, foundations, operation building and the medium voltage and data interconnection between the individual wind turbines and the wind farm substation. The OEM/EPC Contractor has not yet been selected for this Project; however, Vestas Wind Systems A/S, Nordex Energy GmbH, Siemens-Gamesa and GE have been shortlisted and are preparing responses to a Request for Tender.
- Operation and Maintenance (O&M) Contractor (or referred to as the Project Operator): The O&M Contractor will be responsible for the daily operation of the Project and undertaking all monitoring and maintenance activities required for the turbines and other utilities. The O&M Contractor has not yet been selected for this Project; however, it will be the selected OEM/EPC Contractor, i.e. Vestas Wind Systems A/S, Nordex Energy GmbH, Siemens-Gamesa or GE.
- Ministry of Environment: The MOE is the lead government agency responsible for environmental permitting based on the submission of the EIA report by LWP. The MOE was established by Law 216/1993, amended by Law 690/2005, and then restructured by Decree 2275/2009. This decree defined the functions and responsibilities of each administrative unit including staff size and qualifications. According to Article 20 of Decree 2275/2009, the Service of Natural Resources at MOE is responsible for the protection of natural resources in the country including fauna and flora species, habitats, mountains, etc.

  According to Article 25 of Decree 2275/2009, the Service of Environmental Technology - Department of Integrated Environmental Systems at MOE is responsible for adopting clean and renewable energy sources as well as reducing the use of polluting energy sources in the country. Moreover, the Service of Environmental Technology, in line with several other services and departments at the MOE, is in charge for reviewing EIA studies. MOE is also responsible for meeting Lebanon's reporting obligations under the United Nations Framework Convention on Climate Change, particularly the National Communication on Climate Change (which includes emission data for the energy sector) prepared under its aegis. The Third National Communication, inventorying emissions for base-year 2005 and time-series covering the period from 1994 to 2010 was published and presented to the Government and national stakeholders in 2014. The Third National Communication gives an updated analysis of potential Green House Gas (GHG) mitigation measures as well as an updated assessment of potential impacts of climate change in Lebanon and adaptation measures.

- Ministry of Energy & Water: The MOEW is the lead government agency responsible for producing energy and for licensing renewable energy projects and programs, including Lebanon Wind Power. The MOEW was first established by Law 20/66 (dated 29/03/1966) amended several times and lastly (13 years ago) by Law 247 (dated 07/08/2000). Decree 5469 (dated 07/09/1966), that defined the functions and responsibilities of every Directorate (2 Directorates) at the Ministry and each administrative unit including staff size and qualifications was not amended and remains valid since 1966. Under the Directorate of Water and Electrical Resources (1st Directorate at MOEW), the Directorate of Electrical Resources studies and implements Electricity Projects in the Country. Supervising all activities related to water and electricity at the MOEW are performed by the Directorate of Investment (2nd Directorate at MOEW). The MOEW is the most active public body attempting to promote Energy Efficiency and Renewable Energy programs in Lebanon. To date, the most noteworthy achievement is the sponsoring of the Lebanese Center for Energy Conservation Program further discussed below as well as the development of the Policy Paper for the Electricity Sector.
- Electricité du Liban: EDL was established in 1964 (Decree 16878 dated 10/07/1964). With the exception of four private concessions (Zahle, Jbeil, Alay and Bhamdoun representing about 82,000 subscribers) and private/semi-private hydroelectric power plants (Nahr Ibrahim and Kadisha) as well as a public hydropower plant owned by the Litani River Authority, EDL has quasi total monopoly over electricity production, transmission and distribution in the country; it controls around 90% of the Lebanese electricity sector.
- Ministry of Interior and Municipalities: The Ministry of Interior and Municipalities (MOIM) has jurisdiction over Lebanon's estimated 994 municipalities organized according to Decree-Law 118 (dated 30/06/1977). The Akkar Caza counts 175 municipalities. Municipalities are local administrations charged with the day-to-day management of all public works located inside their jurisdiction (municipal boundaries). Specific responsibilities are wide and diverse including landscaping and beautification works, water and wastewater networks, street lighting, waste disposal, internal roads, recreational facilities, as well as urban planning in coordination with the Directorate General of Urban Planning (Article 49). Municipal Councils have also to approve all projects related to re-designing major roads in their municipal boundaries as well as any activity regulating the traffic in the municipal area (Article 51 of Decree-Law 118-1977 and Article 389 of Law 243-2012).
- Ministry of Public Works and Transport: In 2000, the Ministry of Transport was cancelled, and the two Directorates were affiliated to the Ministry of Public Works by Law 247 (dated 07/08/2000). The Ministry of Public Works became, then, the MOPWT which studies (technically and financially), evaluates and monitors the implementation and maintenance of public construction projects (buildings, road networks, etc.) and regulates land, sea and air transport. The MOPWT comprises three directorates including the General Directorate of Urban Planning, which is responsible for permitting all construction projects including the Project. The Ministry of Public Works was first

established in 1959 by Decree 2872 (dated 16/12/1959) and included four Directorates; two of them were later affiliated to the Ministry of Energy and Water (Law 20/66 – 1966). The Ministry of Transport was first established by Law 214 in 1993 and included two Directorates: 1) the Directorate General of Civil Aviation; and 2) the Directorate General of Land and Maritime Transport.

- Directorate General of Urban Planning: The Directorate General of Urban Planning (DGUP) falls under the authority of the MOPWT. Its mandate is to develop urban regulations and coordinate urban planning activities. Lebanon is divided into governorate ("mohafazah"), district ("caza") and municipalities. The DGUP also plays a key role in the construction permitting process through the regional Departments of Urban Planning in each caza.
- The Lebanese Center for Energy Conservation: Established in 2002, the Global Environment Facility funded the Lebanese Center for Energy Conservation Program (LCECP) which is currently hosted at the MOEW and managed by the UNDP. Registered under the name of the Lebanese Center for Energy Conservation (Attestation No. 172 dated 27/1/2011), the organization addresses end-use energy conservation and renewable energy at the national level by supporting the Government of Lebanon in developing and implementing national strategies that promote energy efficiency and renewable energy at the consumer level. The LCEC has implemented Renewable Energy (RE) and energy efficiency (EE) projects in Lebanon including the installation of domestic solar water heaters (DSWH) in south Lebanon, management of the DSWH project "One DSWH for every house" aiming at installing no less than 1 million m^2 of collectors by 2020, management of the 3 million compact fluorescent lamp (CFL) lamps project, etc. LCEC is financially and administratively independent and operates under the direct supervision of the MOEW.
- Community Energy Efficiency and Renewable Energy Demonstration Project: CEDRO is a partnership created in 2007 between the MOEW/Ministry of Finance (MOF)/Ministry of Economy & Trade (MOET)/Lebanon Recovery Fund (LRF)/Council for Development and Reconstruction (CDR)/UNDP, with a five-year mandate and a budget of $9.73 million funded by the LRF by means of a donation from Spain. Its aim is to promote energy efficiency and renewable energy in Lebanon through awareness, capacity building, market incentives for EE and RE installations, as well as country-wide research and development activities.

  CEDRO also initiated and financed several national milestone research documents related to RE including (1) the national bio-energy strategy that shed the light on available bioenergy resources in the country, and (2) the national Wind Atlas that establishes an understanding of the dominant wind regimes (onshore & offshore) in the country, essential to determine best areas to build wind farms in the country. CEDRO's January 2019 publication, Renewable Energy Sector in Lebanon, National Studies, concluded that:

  - Wind energy can potentially employ up to 2,753 people under the optimistic scenario in 2021, roughly half of them in direct jobs.
  - The largest number of jobs will be in the service sector and during the construction phase.
  - The transport of wind energy equipment will also create employment wherever infrastructure is needed, be it at the port or along the roads. Roads have to be widened and the area around the roads has to be cleared.

2. PROJECT DESCRIPTION

This section provides a detailed description of the Project in relation to its location, the key project components and an overview of the proposed activities that are to take place during the planning and construction, operation, and decommissioning phase.

2.1. Overview

The considered development consists of construction of a wind farm along with the auxiliary technical infrastructure in the Akkar Governorate in the northeast of Lebanon, approximately 182km northeast of the capital city of Beirut. The Developer holds a signed PPA to construct and operate the Project to provide a maximum licensed capacity of 68.3MW (plus 10%) to be delivered to the public grid.

One of three OEM/EPC Contractors are currently under consideration by the Developer for construction and operation of the wind farm, Vestas Wind Systems A/S, Siemens-Gamesa and GE. Depending on the OEM/EPC Contractor selected, the wind farm will comprise up to 16 wind turbine generators (WTGs) with rated outputs ranging between 4.2MW and 5.3MW, as presented in **Table 2-1**.

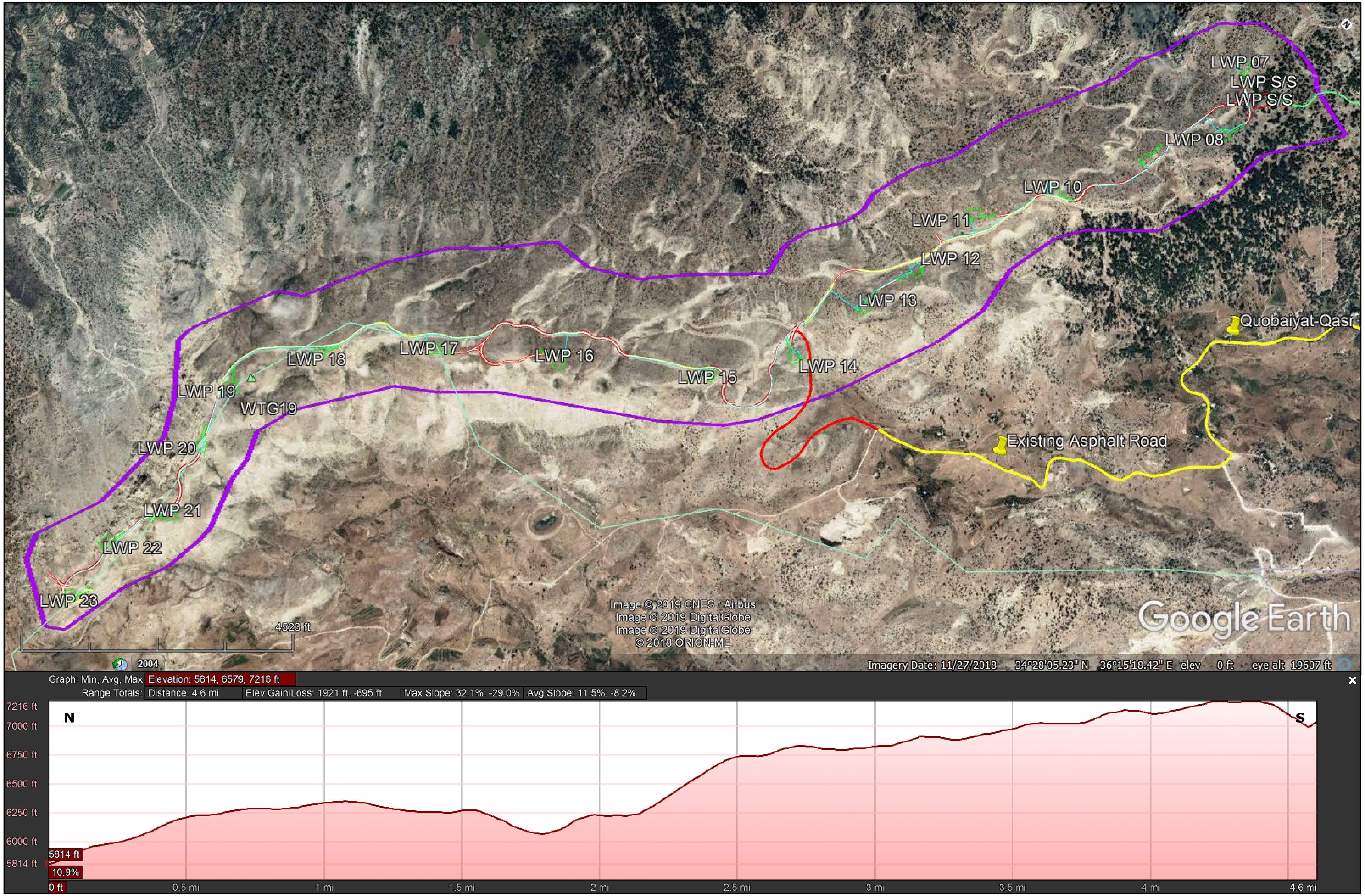
Table 2-1 Potential OEMs, Turbine Power Ratings and Turbine Locations

OEM/EPC Contractor	Turbine Power Rating	No. of Turbines	Power Generated by Turbines	Total Power Generated
VESTAS	4.2MW	16	67.2MW	67.2MW
Siemens	5.0MW	13	65.0MW	65.0MW
GE	5.0MW	2	10.0MW	68.3MW
	5.3MW	11	58.3MW	

The entire investment will include the following components:

- A maximum of 16 WTGs.
- Underground cable networks (electric and fiber-optic control and communication cables).
- External and internal access roads.
- Power substation and temporary and permanent maintenance buildings.
- Parking/laydown/assembly areas.
- Community Relations Office (CRO) building to be located in Kfartoun.
- Underground electric transmission line connecting the Project substation to the substation at the Sustainable Akkar wind farm.

Figure 2-1 Elevation Profile of the Project



2.2. Project Location

The Project is located on a mountain ridge of Jroud Akkar at an altitude ranging between 1,200m (3,840 feet) above sea level (asl) in the north of the Project and 2,190m (7,008 feet) asl in its south, as shown in **Figure 2-1**. The Project site can currently be accessed by Quobaiyat-Qasr Road which connects to Rweimeh Village and Kfartoun to the northeast, and beyond to Mqaible. The largest cities in the Akkar Governate are Halba, Bire Akkar and Qoubaiyat. The Project is located in Fnaidek, Karm Chbat Nature Reserve and Rweimeh Village. **Figure 2-2** presents the location of the Project in proximity to villages, noting there are none to the south. The distance to village centers nearest the Project are as summarized in **Table 2-2**.

Table 2-2 Distance to Village Centers Nearest the Project

To the East/Northeast	To the West	To the North/Northwest
Jawz – 1.5km.	Fnaidek – 5km.	Aaklar Al Attiqa – 3.3km
Souaisse – 4.6km.	Tacheaa – 6.7km	Rweimeh Village – 4.5km.
Jouar El Hachich – 5.5km	Mech Mech – 6.5km	Ain Yaacoub – 6.4km

In addition to the main villages, individual houses located near the Project are shown in **Figure 2-3,** with the nearest houses within 3km assessed for noise, shadow flicker and visual impacts (Note: yellow dots are uninhabited houses). The houses north and east of the Project are considered part of Rweimeh Village, the houses to the west are considered part of Fnaidek, and the houses to the northwest are considered part of Aaklar Al Attiqa.

2.3. Project Components

The Project comprises the construction and operation of up to 16 horizontal axis wind turbines to provide a maximum licensed power capacity of 68.3MW (plus 10%) to be delivered to the public grid. **Table 2-3** provides a summary of the Project components by OEM/EPC Contractor (it is noted that Nordex has withdrawn from further consideration). The locations of all Project components are shown in **Figure 2-4**. Conceptual diagrams of the substation and operations buildings (with elevations) have not been prepared as they are an element of the detailed design.

2.3.1. Wind Turbines

Generally, a wind turbine consists of a foundation, tower, nacelle, rotor blades, a rotor hub, and a transformer. The foundation is used to bolt the tower in place. The tower contains the electrical conduits, supports the nacelle, and provides access to the nacelle for maintenance. Typically, three (3) blades are connected to the hub which then connects with the nacelle; the box-like component that sits atop the tower and which most importantly contains the gear box (which steps up the revolutions per minute to a speed suitable for the electrical generator) and the generator (which converts the kinetic energy into electricity).

Each turbine and associated platform will occupy a maximum surface area of 3,500m^2. Foundation platforms will be constructed to bolt the tower of the turbine in place.

Figure 2-2 Project Site Location Relative to Villages

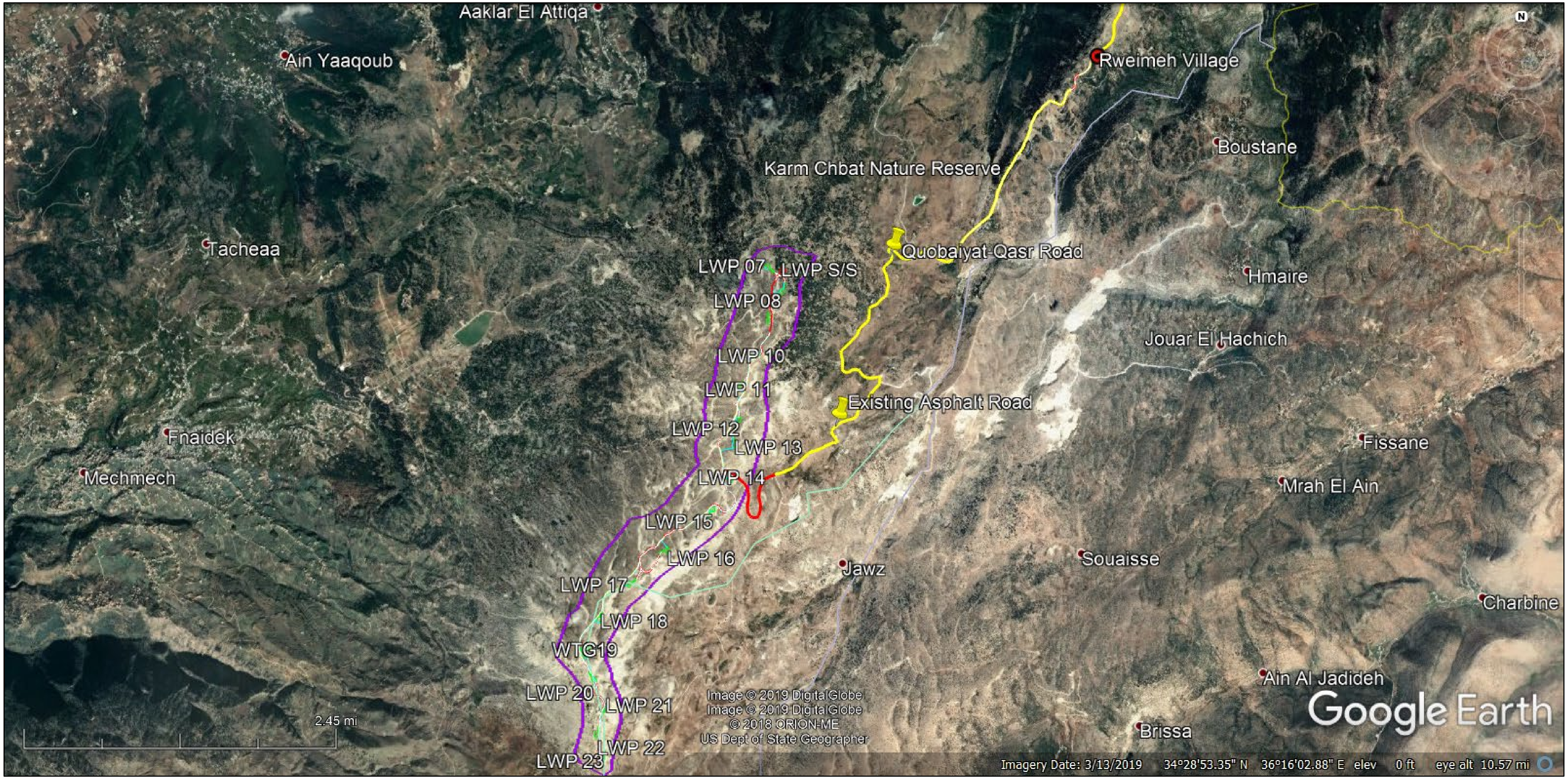


Figure 2-3 Individual Houses Near the Project

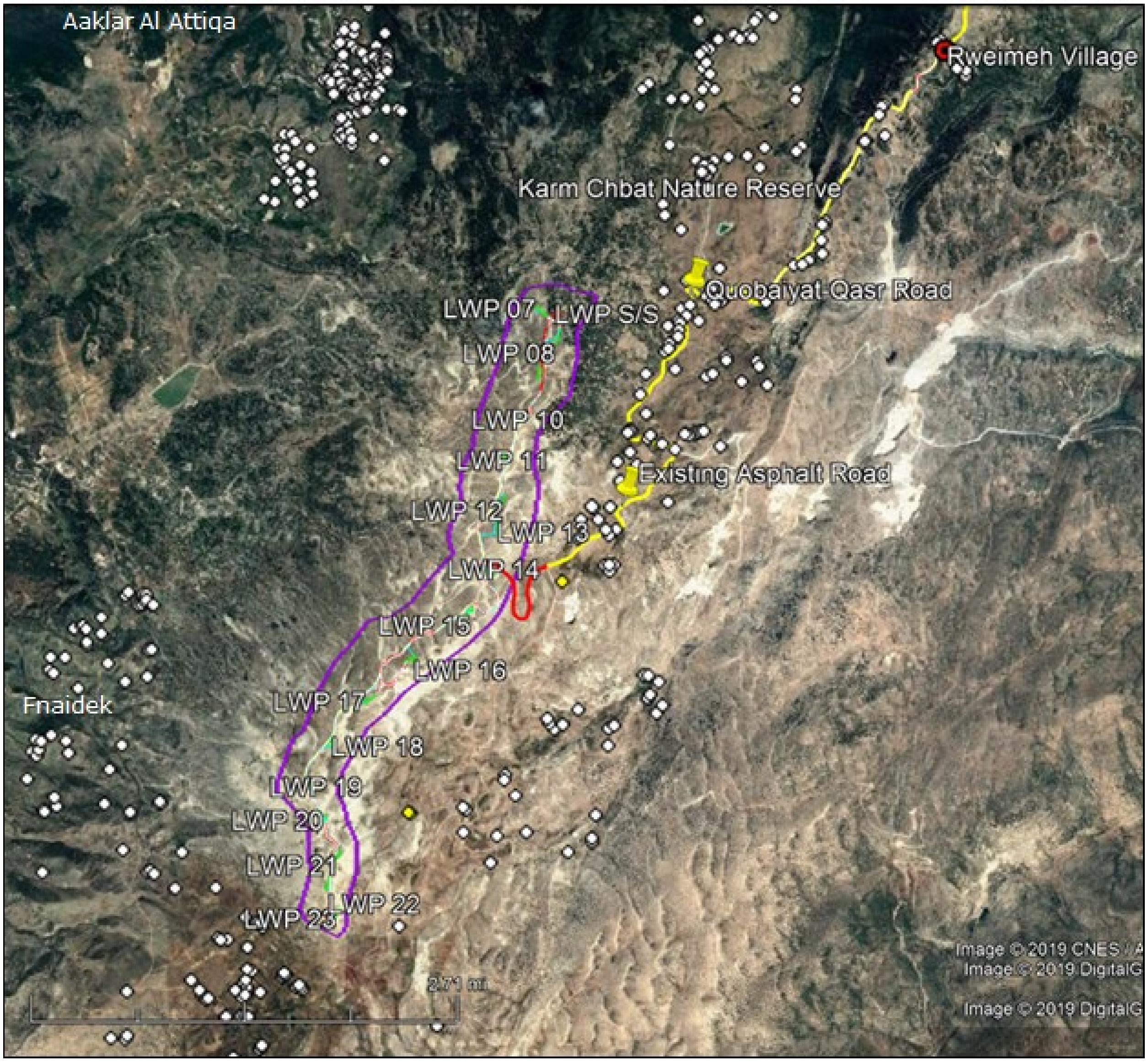
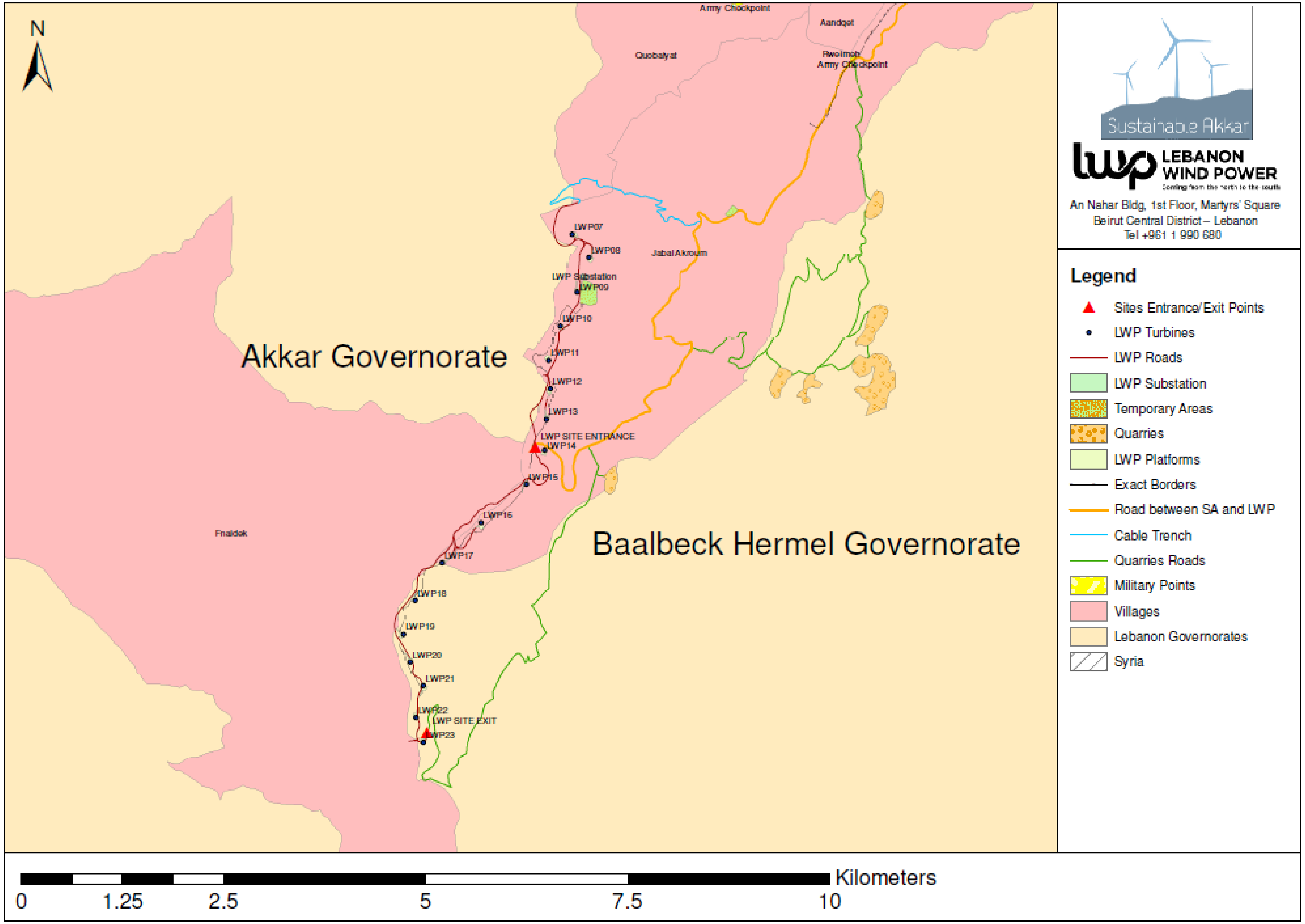


Table 2-3 Project Components

Design	Vestas Wind Systems A/S	Siemens-Gamesa	GE
Project Generation Capacity (MW)	67.2MW	65.0MW	68.3MW
Technology Type	Wind Power	Wind Power	Wind Power
Number of Wind Turbines	16	13	11 and 2
Nominal power	4.2MW	5.0MW	5.3MW and 5.0MW
Type	3-blade rotor and a hub	3 blade rotor and hub	3 blade rotor and hub
Hub height	105m	107.5m	101m (steel)
Number of tower sections	4	5	4 or 5
Rotor diameter	150m	145m	158.0m
Swept area	17,671m^2	16,513m^2	19,607m^2
Rotor shaft inclination angle (Tilt angle)	6º	4º	4º
Blade cone angle (Hub coning)	5.5º	6°	5º
Rotor blade material	Fiberglass reinforced epoxy, carbon fibers and solid metal tip (SMT)	Organic matrix composite with fiberglass reinforcement	Glass fiber reinforced polyester + Carbon fiber spar
Total blade length	73.7m	71.0m	77.4m
Tip height	180m	180m	180m
Maximum height above MSL	2,000m; above 2,000 msl is specifically available with some project-specific customized solutions	No strict limit. Should comply with Design Climatic conditions (see GD376219, page 17)	Maximum 1,000m with the maximum standard operational temperature of +40 °C. Above 1,000m, the maximum operational temperature is reduced per DIN IEC 60034 1
Certificate	In accordance with IEC 61400-22 and DIBt 2012	List of Certificates, (see GD376219, page 20) – Design certificate attached.	IEC 61400-22 in combination with IEC 61400-1.
Nominal power starting at wind speeds of (at air density of 1.225 kg/m^3)	12 m/s (at air density of 1.225 kg/m^3)	14m/s	12.5m/s
Nominal speed	4.9-12.0 min^{-1}		9.7 rpm
Cut-in wind speed	3 m/s	3 m/s	3m/s
Cut-out wind speed	24.5 m/s	27m/s	25m/s
Cut-back-in wind speed	22.5 m/s		22m/s
Calculated service life (Design Life)	At least 20 years	20 years	20 years standard
Design temperature; (Extreme Design Parameters)	Standard -20 ºC to +45 ºC; (-40 ºC to +50 ºC)		-20°C - +50°C
Infrastructure and Utilities		This includes: (i) two new asphalt road segments; (ii) internal road network; (iii) substation; (iv) underground transmission line; (v) offices and (vi) associated facilities.	

Figure 2-4 Project Components



The OEM/EPC Contractor will be constructing platforms (one for each turbine). A crane pad next to each wind turbine to accommodate cranes for the installation of the wind turbines and for maintenance activities during operation. The crane pads will be suitable to support loads required for the erection, assembly an operation and maintenance of the turbines.

The layouts of the land plots occupied by the turbine platforms and substation are as provided in **Figure 2-1** and the diagrams presented in **Appendix A**. Each turbine will be equipped with a transformer that converts/steps up the output from the turbine to a higher voltage to meet a specific utility voltage distribution level that is appropriate for connection with a substation. Regardless of the OEM/EPC Contractor selected, the turbines will be installed among the locations shown. It is noted that potential turbine locations LWP 01 through LWP 06 were removed as part of the ESIA process to mitigate Project impacts (refer to **Section 3**).

The wind farm design considered wind resources in the specific Project site, spacing between the turbines to minimize wake effects which could lead to a decreased wind energy production, accessibility to the turbines, etc., as well as environmental considerations as presented throughout this ESIA. In line with the recommendations of the Convention on Civil Aviation (ICAO, 2016) and local Lebanese regulations, the wind turbines will be installed as follows:

Turbine Distances:

- Peripheral wind turbines: wind turbines on the periphery of the cluster or the line formation. In case of a cluster or a grid: on corners and additional turbines on the perimeter in order to keep a maximum distance of 900m.
- Other wind turbines: no separations or gap to an equipped turbine of more than 900m exist for the integrity of the group appearance to be maintained.

Paint Markings:

- The blades of the selected wind turbines will be equipped with a painted blade marking in form of two red/orange stripes and one white stripe starting from the blade tip: 6m red or orange, 6m white and 6m red or orange.
- If the height of the wind turbine exceeds 150m, a red/orange strip of 3m shall be placed on the tower at a height between 35m and 45m above ground in a way to avoid covering the stripe with the blades of the wind turbine. The wind turbines shall be painted white.
- If a turbine within the wind farm (non-peripheral) projects at a height of more than 30m from the next equipped turbine (due to topography), it must be equipped with aviation warnings.
- Measurement masts within the wind farm area should be considered as obstacles (like the wind turbines) and be equipped as required above.
- As a result, not all the wind turbines in the wind farm will be equipped with aviation warnings.

Obstruction Lights:

- All obstruction lights in the wind farm should be synchronized to flash simultaneously.
- Obstruction lights must be equipped with an uninterruptable power supply system with at least 12 hours of autonomy.
- Lights shall be placed on the nacelle and be visible from all directions in the horizontal plane.
- If the wind turbines height exceeds 150m, an intermediate level at half the nacelle height of at least three low-intensity Type E lights, should be installed.

- If the wind turbines height exceeds 150m, in addition to the medium-intensity light installed on the nacelle, a second light serving as an alternate should be provided in case of failure of the operating light. The lights should be installed to assure that the output of either light is not blocked by the other.

Obstruction Light Types and Intensity:

- Daytime: Medium intensity, Type A aviation white flashing light, minimum intensity 20,000 candela.
- Nighttime: Medium intensity, Type B aviation red flashing lights, minimum intensity 2000 candela.

Once the OEM/EPC Contractor has been selected, and the final number, layout and height of the wind turbines is fixed, the Developer will submit the final plan to the Civil Aviation Authority for approval.

2.3.2. Transmission Lines and Power Substation

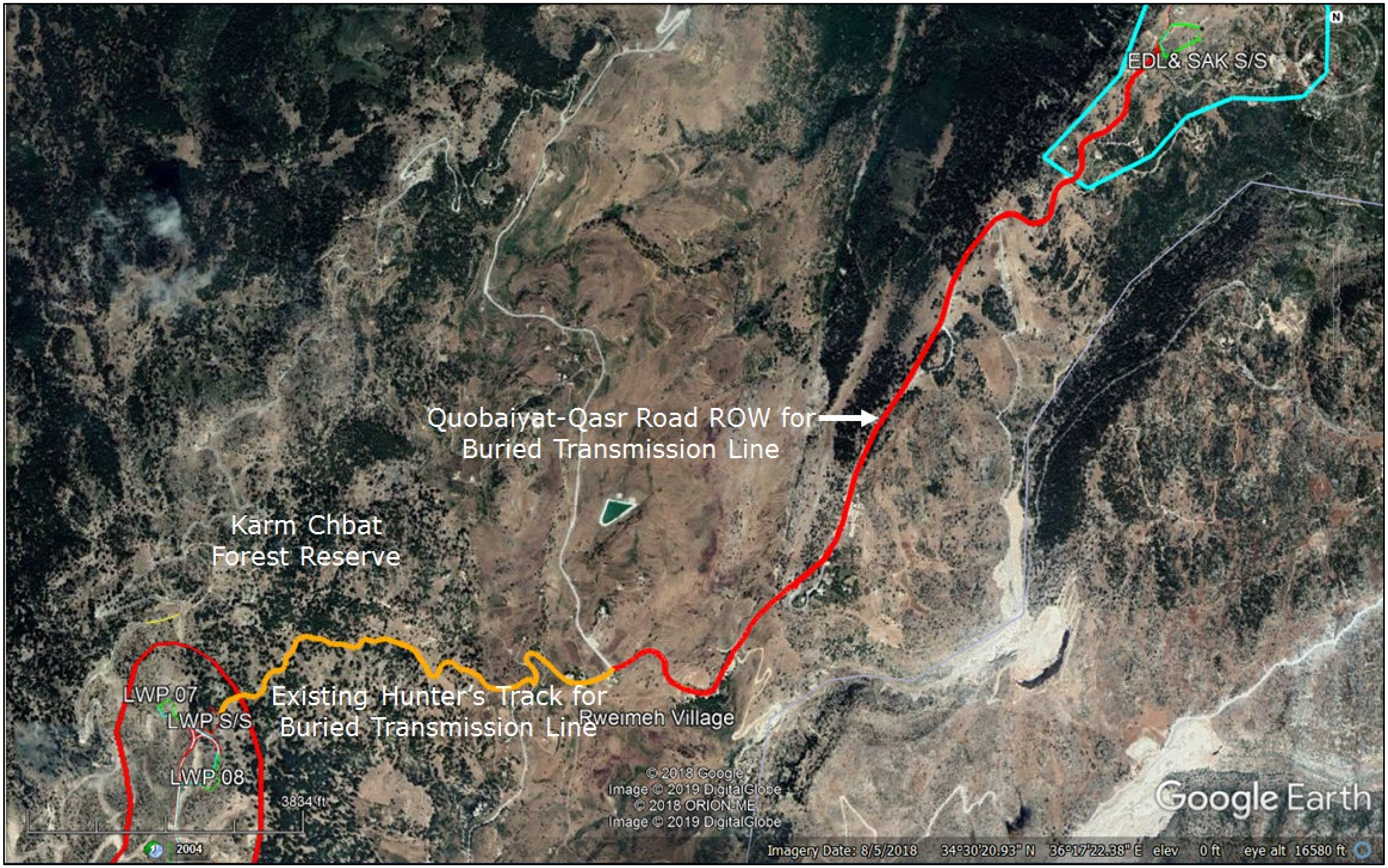
The wind turbines will be connected at the switchgear panels through a 36kV medium voltage (MV) cross linked polyethylene (XLPE) cabling system to a substation located within the Project site. The connection between the turbines and the substation will be made using underground transmission cables buried in ground by trenches. A new sub-station will be installed at the Project site, between Turbines LWP 07 and LWP 08. The Project substation will be connected by a 30cm diameter transmission line to the neighboring Sustainable Akkar Wind Farm Project substation to be located within its boundary.

The transmission line will be buried within an existing ~3.25m wide track through the Karm Chbat Forest Reserve, previously created by recreational hunters and navigating around vegetation and under tree canopies, until reaching the existing, asphalt 2-lane Quobaiyat-Qasr Road. The transmission line will then follow the Quobaiyat-Qasr Road right-of-way (ROW) for 7km until entering the Sustainable Akkar wind farm and connecting to the shared Sustainable Akkar/EDL substation (as shown in **Figure 2-5**), before the generated electricity being injected into the EDL transmission line.

Two possible design options are possible, consisting of either a 33 to 66KV or a 33 to 220KV substation. The electrical diagrams of the wind farm are shown in **Appendix B**, and include the following components:

- A 36kV MV XLPE cabling system connecting the MV switchgear panels at the wind turbines with the 36kV switchgear in the Control Buildings.
- An MV 36kV indoor switchgear in Control Building of wind farm.
- MV/High Voltage (HV) transformer: A 36/220kV step-up power transformer.
- Earthing: One complete earthing system comprising all earthing conductors, earthing rods, equipment connectors, welding fittings, etc. for the complete Facility.
- Fiber optic cables: between the wind turbines and the wind farm SCADA system and the closed-circuit television (CCTV) system to be installed in the Operation Building.
- Operation buildings and auxiliary facilities including among others one 36/0.4 kV auxiliary service transformer and one 0.4 kV emergency diesel generator, a complete CCTV system, and complete fire detection and alarm systems.

Figure 2-5 Alignment of Buried Transmission Line



2.3.3. Operation Buildings

Two separate operation buildings shall be constructed, one building to be used by the OEM/EPC Contractor and their contractors, and the other to be used by the grid operator, EDL. The layout of the control buildings is included in the layouts of the substation provided in **Appendix B**. The operation buildings will include the following:

- A storage space for spare parts, lifting equipment, placement of batteries, tools and spare oil.
- A control room for communication equipment, medium voltage switchgear room, working station for the monitoring of the Project.
- A meeting room and facilities for maintenance personnel as deemed necessary, but as a minimum will include a kitchen, changing room, lounge or living room, toilets and showers.

2.3.4. Community Relations Office

As part of the Project development, a member of the local community has been hired as the first of three Community Relations Officers (CRO)s. During the pre-construction phase, a Community Relations Office will be established in Kfartoun using leased office space (to be shared with the Sustainable Akkar wind farm project; specific location to be determined).

The Community Relations Office will remain open through the construction, operation and decommissioning phases of the Project. The purpose of the Community Relations Office will be as follows:

- Establish a skills training program for members of the local communities.
- Maximize the hiring of local workers.
- Maximize the local procurement of construction materials and other goods and services.
- Establish a location for the receipt of community grievances and to provide Project information.

2.3.5. Meteorological Masts

Three meteorological masts, MM1, MM2 and MM3 (Enisolar 80m and 60m models), are currently installed at the locations shown in **Figure 2-6**. Each mast includes first class advanced top and low anemometers, wind vanes, a humidity and temperature sensor, an air pressure transducer, a data logger box, an aviation light and a top lighting rod. The data recorded by the mast is automatically sent twice daily to the Developer via internet. The currently installed meteorological masts will be removed at the start of wind turbine erection activities and will be replaced with new masts to be installed by the selected OEM/EPC Contractor.

2.3.6. Road Development

The overall route planned for the transport of the WTG components to the Project is shown in **Figure 2-7**. The wind turbine components will be transported from the Tripoli seaport to the Project site using a combination of existing asphalt roads (shown in blue), new asphalt road segments (shown in red), and existing and new tracks internal to the proposed Hawa Akkar, Sustainable Akkar and Lebanon Wind Power wind farm sites (also shown in red). The transport route can be described as follows:

Figure 2-6 Existing Metmast Locations

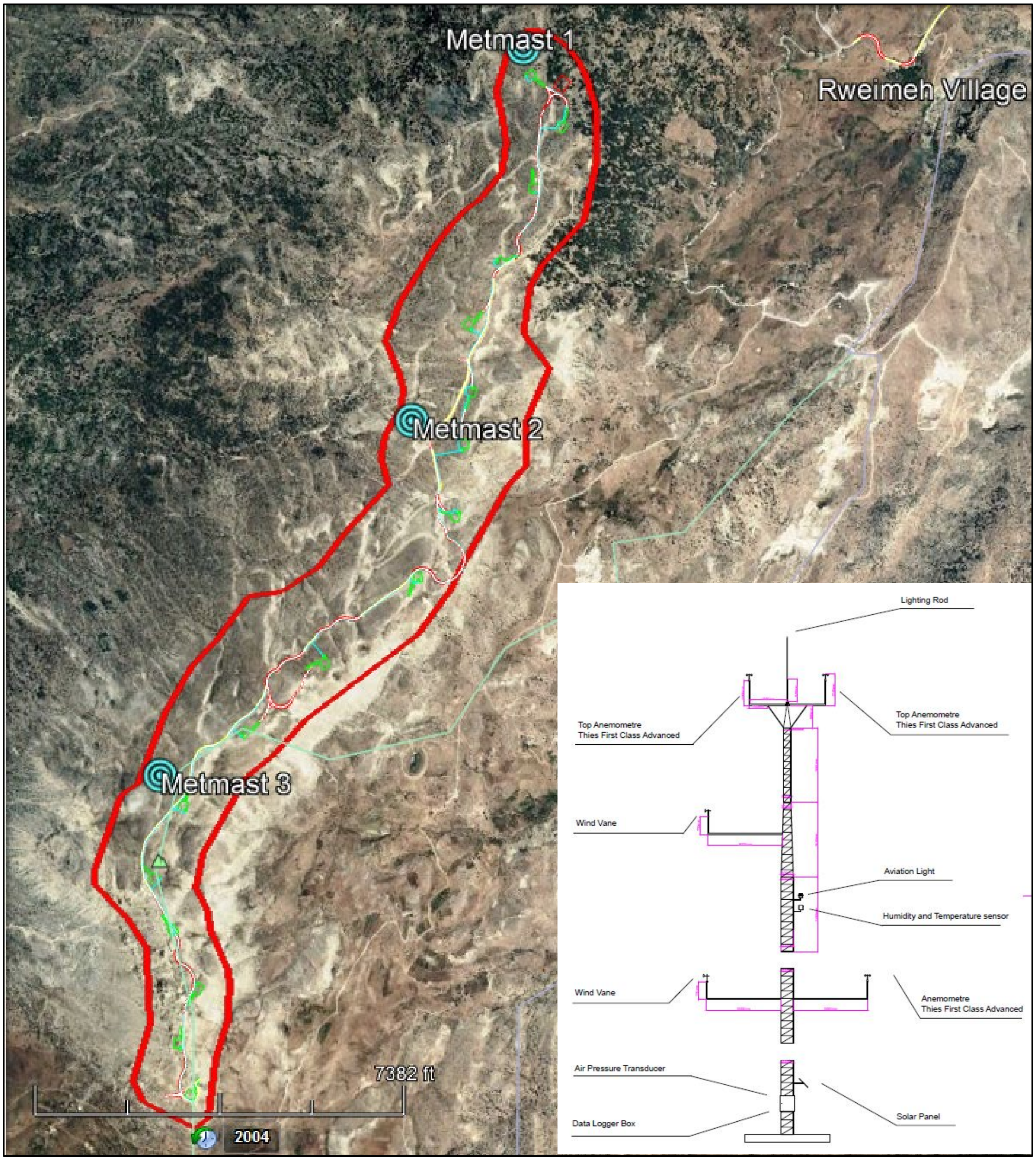
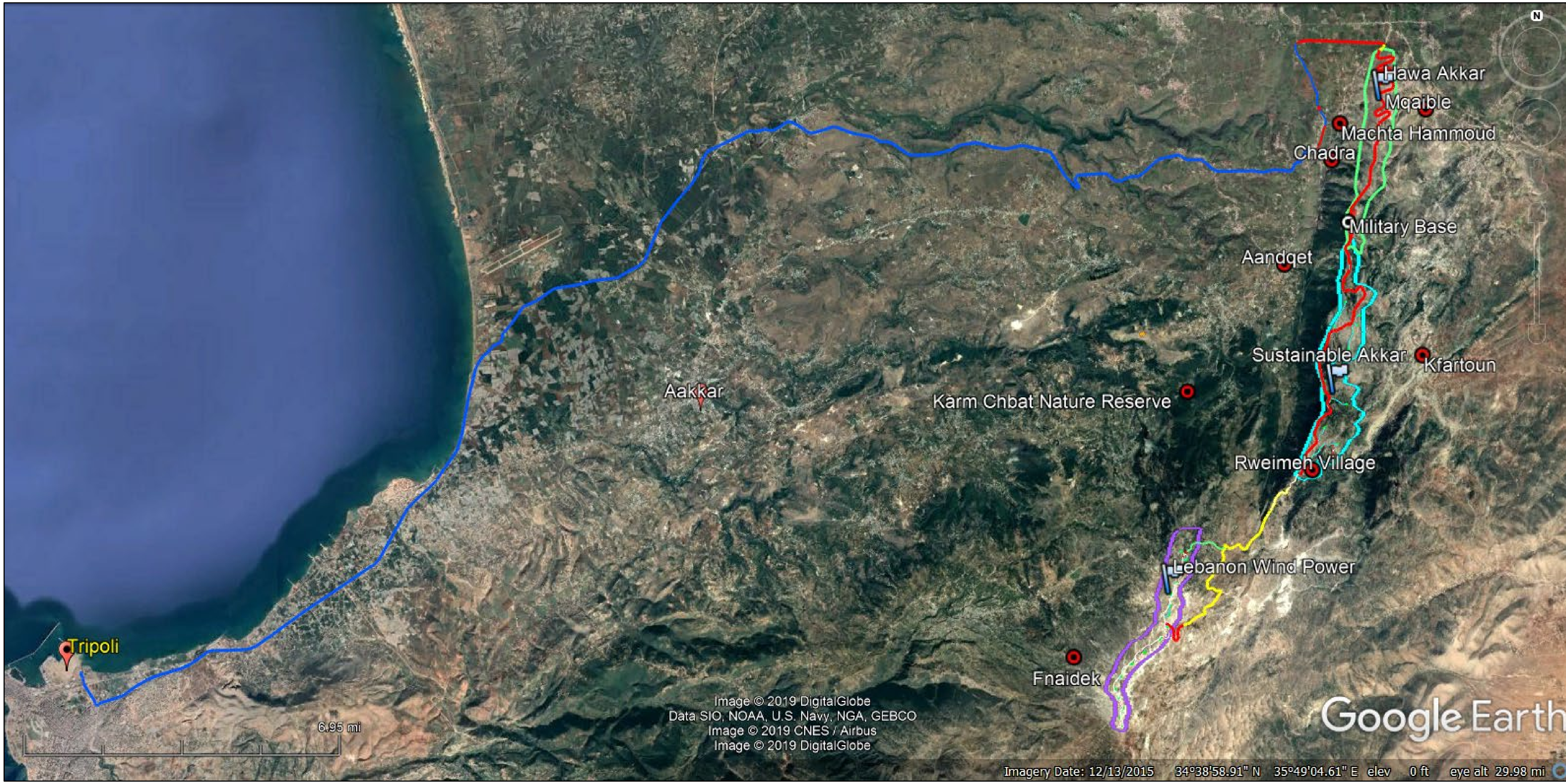


Figure 2-7 Transport Route from the Tripoli Seaport to the Project



1. Tripoli Seaport to Outside Chadra: The existing 2-, 4- and 6-lane asphalt road between the Tripoli
2. Seaport to outside Chadra will be used.
3. Outside Chadra to the entrance of the Hawa Akkar Wind Farm: New sections of road will be constructed as follows:
   - In order to avoid impacts to Chadra, Machta Hassan and Machta Hammoud, a new 0.65km section of asphalt road will be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 2-8**). The new road section will connect with the existing asphalt road outside of Machta Hammoud.
   - A new 0.15km section of asphalt road will be constructed (shown as #2 in **Figure 2-8**) between two existing sections of asphalt road in order to avoid hairpin turns near homes.
   - A new 3.0km section of gravel road will be constructed within the existing railroad right of way (ROW) managed by Machta Hammoud Village (shown as #3 in **Figure 2-8**), traveling east before connecting to an existing asphalt road to enter the Hawa Akkar Wind Farm.
4. The route traverses a network of internal tracks to be constructed within the Hawa Akkar Wind Farm, exiting at the Sahle Checkpoint before entering the Sustainable Akkar Wind Farm, also shown in **Figure 2-8**. The road that will connect the turbines within the Hawa Akkar site has already been established by the Lebanese Army as a dirt road, as shown in **Figure 2-9**. Leveling and widening the road to 6m when straight, and 10m at curves, will be undertaken to accommodate large vehicles carrying the turbine parts, creating openings within the piled soil, rocks, stone and gravel along the road sides.
5. The route traverses a network of internal tracks to be constructed within Sustainable Akkar, exiting at Qoubaiyat-Qasr Road, as shown in **Figure 2-10**.
6. The route travels south along Qoubaiyat-Qasr Road for approximately 3.5km. Upon reaching an existing asphalt road, the route turns south for 4.8km, where a new 1.5km section of track will be constructed to enter the Project site near LWP 14, as shown in red in **Figure 2-11**.

The transport of WTG components to the Project will not begin until all civil works to construct road segments has been completed, including internal tracks through Hawa Akkar, Sustainable Akkar and Lebanon Wind Power. All communities along the transport route have been engaged with to address potential concerns related to the frequency, timing and duration of the transport activities and access to roads, school, employment and livelihoods as discussed in **Section 6 Stakeholder Engagement and Consultation**.

Ahead of transport of the WTG components, removal of identified obstacles (i.e. concrete debris, roundabout curbs, poles, etc.) and raising of pedestrian bridges and placards to accommodate the necessary vertical clearance will be undertaken as discussed in **Section 19 Traffic and Transport**.

In February 2019, the Developer applied to the Ministry of the Interior and Municipalities (MOIM) in Lebanon to facilitate the passage and use of public roads between the Tripoli Seaport and the Project via the described transport route (Registration No. 4147, 25 February 2019). The request was made to: 1) permit the use of public roads for the transport of the WTG components; and 2) for the municipalities to provide escort during the transport of the WTG components. This request was granted on 7 March 2019, as presented in **Appendix C**.

Figure 2-8 Outside Chadra to Hawa Akkar Wind Farm

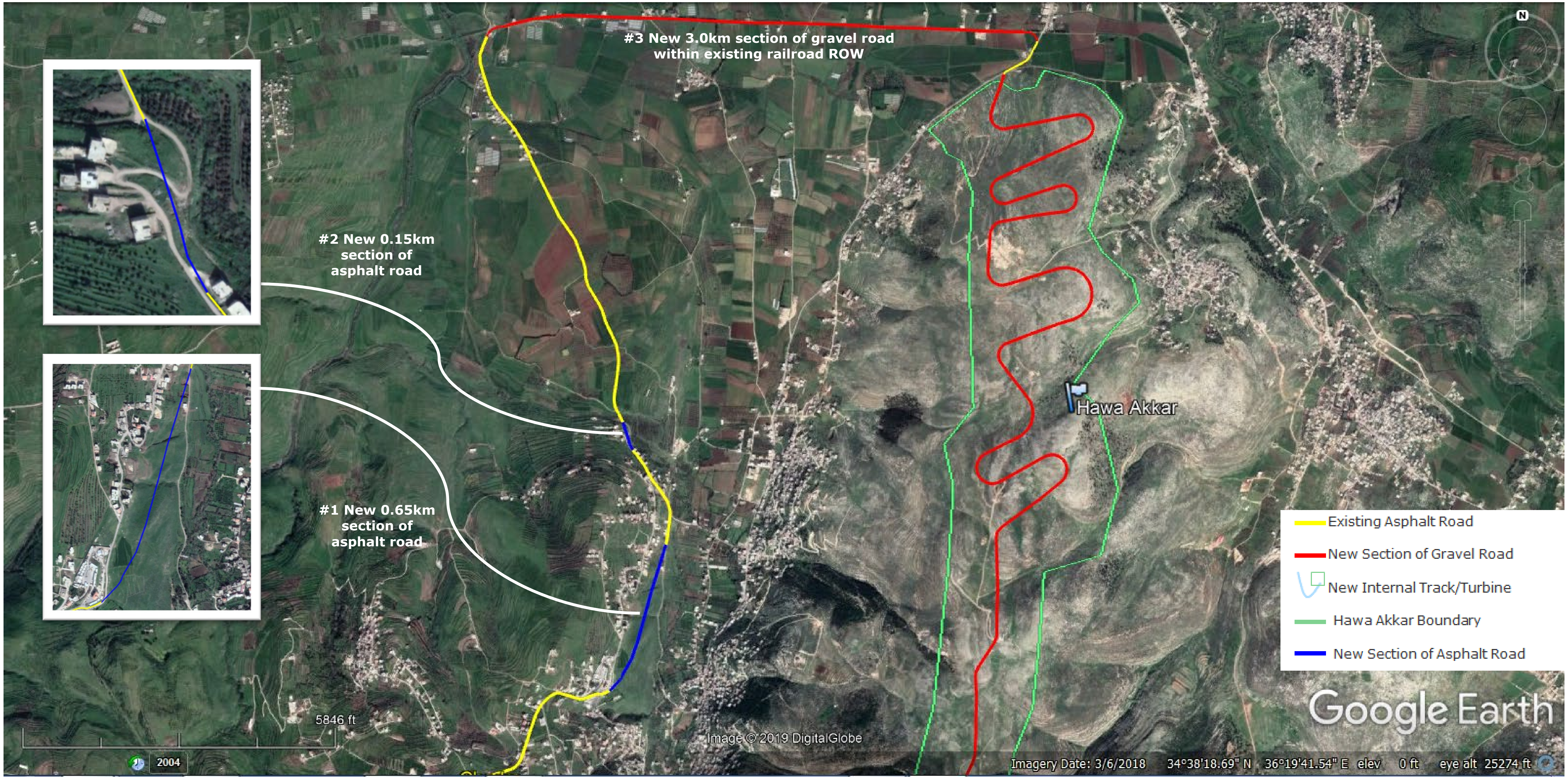
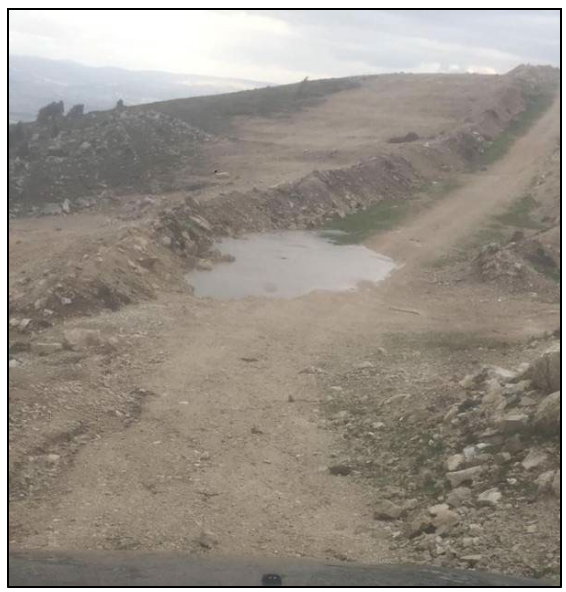


Figure 2-9 Photographs of Hawa Akkar Track

Unpaved road established by Lebanese Army

Army equipment at side of unpaved road

Unpaved road established by Lebanese Army



Soil and rock pile adjacent to unpaved road

Figure 2-10 Internal Tracks through Sustainable Akkar

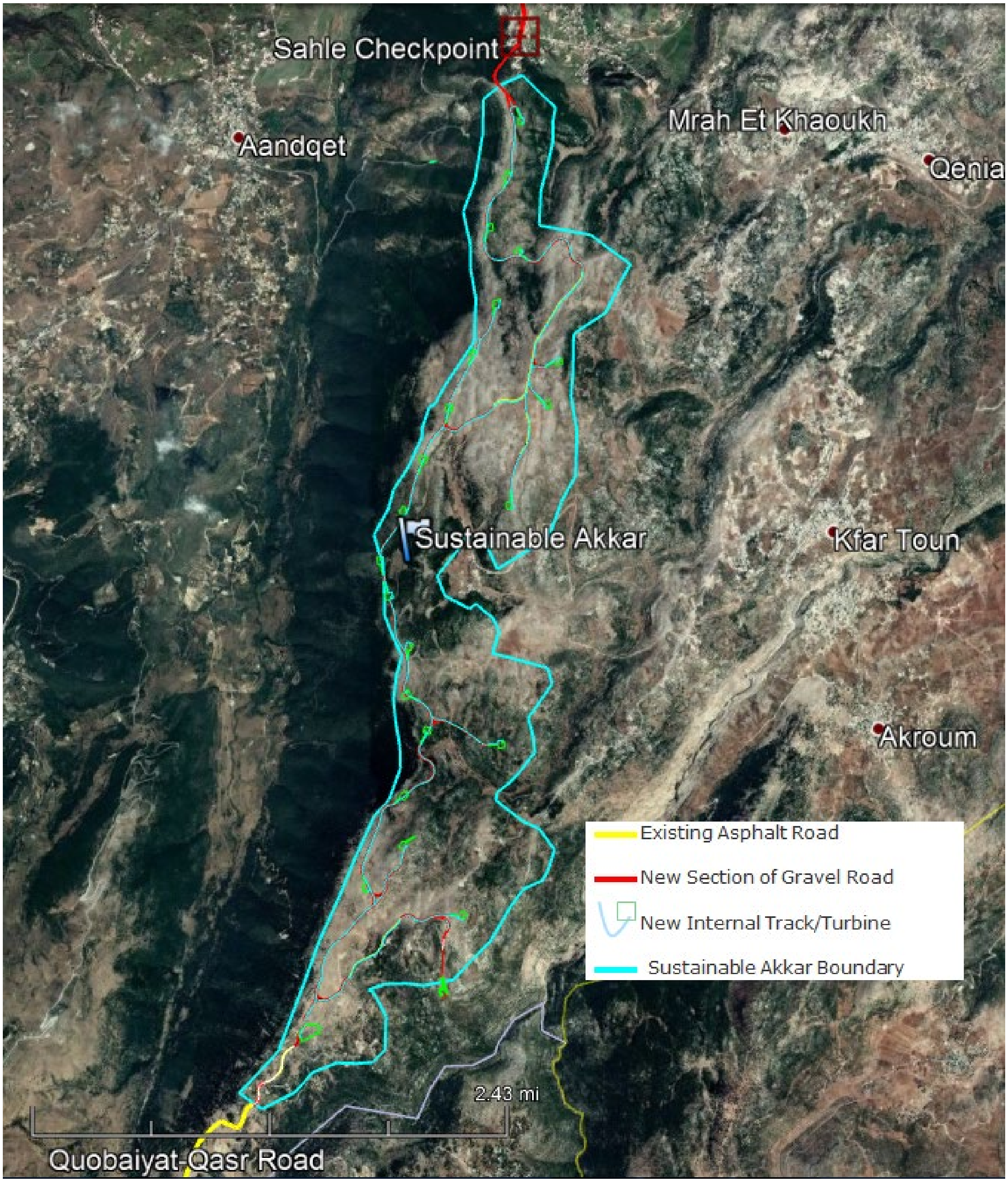
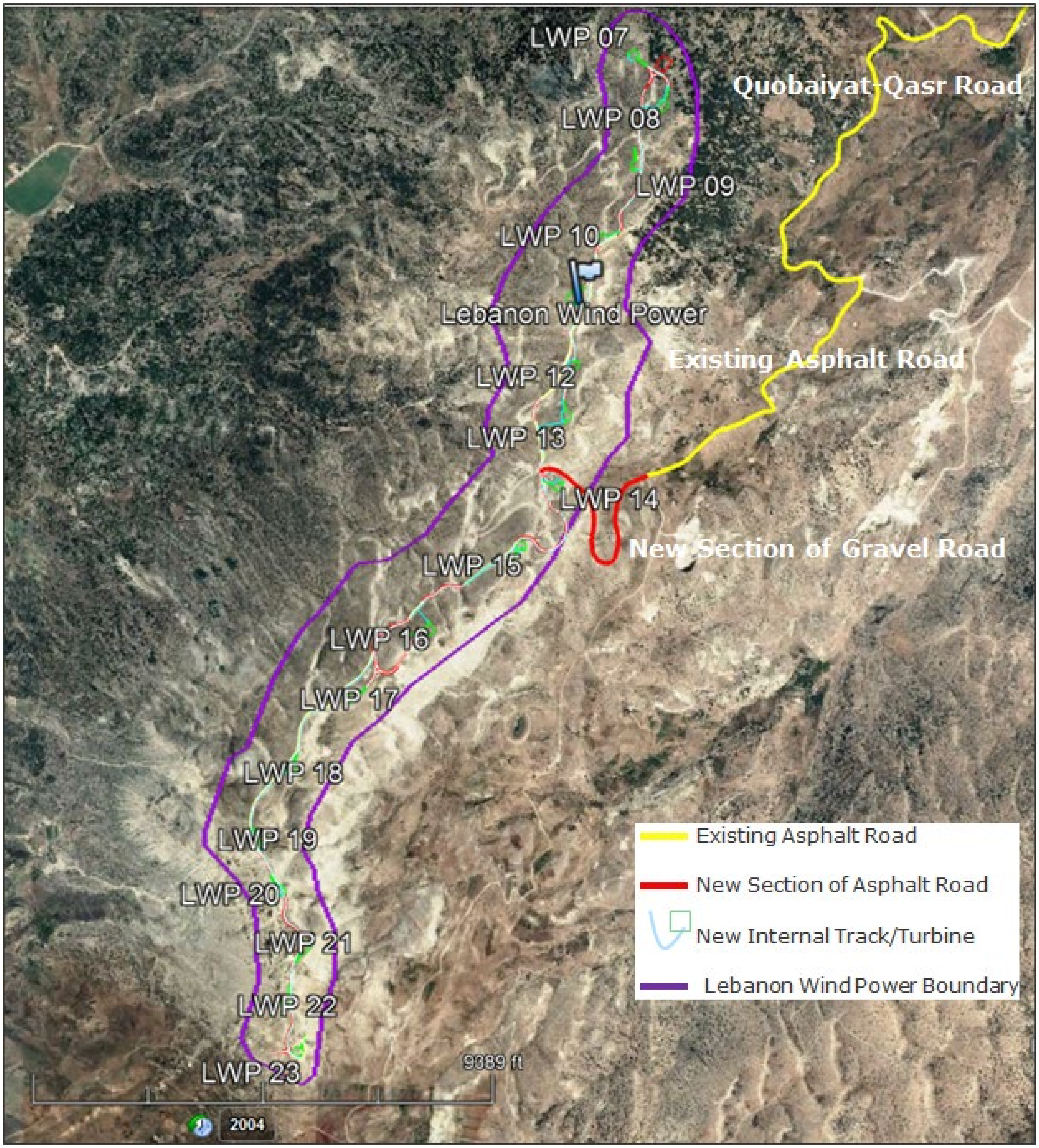


Figure 2-11 Quobaiyat-Qasr Road to the Project



2.4. Land Ownership and Lease Information

Land issues are one of the most important considerations during Project development and implementation. Land parcels needed for the Project are owned by the Municipality of Fnaidek to the west and the Jaafar Family to the north and east (i.e. Karm Chbat and Rweimeh Village). Engagement with the Jaafar Family leadership began in 2017 to support the planned development of the Project, as summarized in **Table 2-4**.

Table 2-4 Face-To-Face Meetings with Family Leadership in Affected Communities

Name	Village Represented	Date
Abbas Jaafar, Kamel Jaafar, Mohamad Jaafar and Abdo Jaafar	Karm Chbat	2-Mar-17
Hussein Jaafar, Youssef Jaafar	Rweimeh	8-Mar-17
Ali Jaafar, Toaan Jaafar and Noura Jaafar	Karm Chbat	11-Sep-17
Hassan Jaafar, Ahmad Jaafar and Medhit Jaafar	Rweimeh	9-Oct-17
Riyad Jaafar, Imad Jaafar and Mohamad Jaafar, Ali Jaafar and Ajaj Jaafar and Rached Jaafar	Rweimeh	16-Nov-17

Preliminary discussions were undertaken with officials regarding land rentals and potential ownership impacts from turbines such as noise, shadow flicker and visual amenity as follows:

- 20 July 2018 - Meeting with Mayor of Fnaidek Ahmad Baarini.
- 20 July 2018 - Meeting with Fnaidek Municipal Official Mohamad Aalah El Din.

Along with the general terms of the rental contract, discussions included what job opportunities would be created by the Project.

On 6 December 2018, meetings were held between the Developer and representatives of the Municipality of Fnaidek to discuss the terms of the rental contract. Fnaidek municipality was represented by the Mayor Mr. Ahmad Baarini, Dr. Mohamad Ali while the Developer was represented by Project attorney Me. Adele Halabi, Mr. Jules Assi and Eng. Sarkis Farah. The main topics discussed included the following:

1. *Duration of this contract – why the rental is for 28 years?* To cover all three phases of the Project: Phase 1 – Technical Studies and Installation, Phase 2 – Operations and Maintenance, and Phase 3 – Decommissioning.
2. *Number of parcels to be rented for the Project?* Total of 18 parcels, for a maximum installation of 16 turbines to be installed among 17 parcels and 1 parcel for installation of the Project substation.
3. *Price clarification as suggested by the companies?* The municipality asked if the $7,000 USD/MW was per installed capacity or per produced. The companies replied that the suggestion is per installed capacity.
4. *Will a copy of the Lebanon Wind Power ESIA be provided?* Once the study is completed, it will be published on all of the lenders' websites for comment, and therefore, the Developer will share it with the municipality.

Following the cadastral survey undertaken in 2018, land leases with the Jaafar Family (trading as "Skylight") for the construction of Project wind turbines and platforms for WTGs 7, 8, 9, 10, 11, 14, 19, 20, 21, parking area and access road, and land purchase for the construction of the substation were finalized in accordance with and '*Ilm w Khabar*' (Acknowledgement Certificates) attesting the ownership of a real estate property which is un-surveyed and un-registered in the official real estate records.

Paperwork was filed by the Developer with the Ministry of Finance General Directorate of Land Registry and Cadastre to lease land parcels in Fnaidek Municipality and Karm Chbat.

The plots subject of the abovementioned lease agreements are free from any occupant, liabilities, rights, liens, or encumbrances. The Project land take will not result in resettlement/economic displacement (loss of livelihoods).

Land tenure has been secured for a period of 28 years at an agreed value of US$34,000/year during Phase 1 Technical Studies and Installation, US$7,000/MW/year during Phase 2 Operations and Maintenance ("Implementation"), and US$583.33/MW/month during Phase 3 Decommissioning.

Executed Acknowledgement Certificates, along with Lease Agreements with the Municipality of Fnaidek for land for other wind turbines, platforms and internal access roads, are as summarized in **Table 2-5** and **Figure 2-12a** and **Figure 2-12b**. **Appendix D** presents the Executed Acknowledgement Certificates.

In addition to the land leases needed for installation of the wind turbine components, land is needed to construct the new 0.65km and 0.15km sections of asphalt road (shown as #1 and #2 on **Figure 2-8)**. Again, it is noted that these new road segments are being constructed to mitigate impacts during the transportation of wind turbine components.

Further, a new 3.0km section of gravel road will be constructed within the existing railroad right of way (ROW) managed by Machta Hammoud Village (shown as #3 in **Figure 2-8**), traveling east before connecting to an existing asphalt road to enter the Hawa Akkar Wind Farm.

2.5. Footprint of the Project Components

This section provides an estimate on the footprint of the Project components discussed in the previous section. It is noted that the land lease or acquisition detailed in **Table 2-5** is significantly less than the area that will be occupied by the component. For example, while the parcels being leased for the installation of the turbine, platform, parking area and access road ranges between 4,299m^2 (WTG18) and 18,607m^2 (WTG12).

As noted in **Table 2-6**, the total area of disturbance for the project is small and is significantly less than the entire Project area which is 2.6km^2. This number is based on installation of a maximum of 16 turbines; we note that the number of turbines can be as low as 12 should GE be the selected OEM/EPC Contractor.

Table 2-5 Land Lease/Purchase Agreements

# on Map Area (m^2)	Cadastral Zone	Intended Use	Owner	Lessor	Lease Term	Leasing Value	Legal Rights (Ownership/Lease/Sub lease)	Underlying Documentation	Contractual Status
WTG 7 **6,771 m^2**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Ahmad Jaafar, Medhat Jaafar, Abbas Jaafar, Mouhamad Jaafar and Ali Jaafar	Abdo Jaafar & Partners Skylight for Trading Sal ("**Skylight**")	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG 8 **8,036 m^2**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Ahmad Jaafar, Medhat Jaafar, Abbas Jaafar, Mouhamad Jaafar and Ali Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG 9 **7,648 m^2**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Aahed Jaafar, Youssef Jaafar, Mouhamad Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG 10 **6,312 m^2**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Ali Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG 11 **7,236 m^2**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Hussein Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process

# on Map Area (m²)	Cadastral Zone	Intended Use	Owner	Lessor	Lease Term	Leasing Value	Legal Rights (Ownership/Lease/Sub lease)	Underlying Documentation	Contractual Status
WTG13 **9,821m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No.27	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG 14 **7,409 m²**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Abbas Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG15 **3,496 m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 28	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG16 **11,880 m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 29	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG17 **4,847 m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 30	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG18 **4,299 m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 32	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG 19 **9,047 m²**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Hasan Yaseen Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by	Acknowledgment Certificate dated 14-1-2019 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process

# on Map Area (m²)	Cadastral Zone	Intended Use	Owner	Lessor	Lease Term	Leasing Value	Legal Rights (Ownership/Lease/Sub lease)	Underlying Documentation	Contractual Status
							Skylight to Lebanon Wind Power		
WTG 20 **8,786 m²**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Riyad Ali Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 14-1-2019 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG 21 **10,397 m²**	Karm Chbat	Turbine + Platform + Parking Area + Access Road	Imad Ali Jaafar	Skylight	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be leased by Owner to Skylight - Land to be subleased by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 14-1-2019 - Lease Agreement - Sub-Lease Agreement	Forms of Lease and Sub-Lease Agreements being reviewed by Lenders' counsels - In process
WTG22 **6,035 m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 33	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
WTG23 **5,400m²**	Fneidek	Turbine + Platform + Parking Area + Access Road	Municipality of Fneidek	Municipality of Fneidek	28 years	1. **Phase 1 'Technical Studies and Installation':** US$34,000/year; 2. **Phase 2 'Implementation':** US$7,000/MW/year; and 3. **Phase 3 'Decommissioning':** US$583.33/MW/month	Launch of surveying and delimitation works in 2007 (In process) - Land owned by the Lessor as per Temporary Real Estate Certificate dated 11-10-2006 - Plot No. 34	Affiliation and related map, signed and dated by the real estate Judge in Tripoli on 11-10-2018 / lease agreement	Form of Lease Agreement being reviewed by Lenders' counsels - In process
LWP Substation **3,500 m²**	Karm Chbat	Installation of Lebanon Wind Power Substation	Abdo Mohammad Jaafar	Skylight	Will be purchased by Lebanon Wind Power	Will be purchased by LWP / down payment paid	Land owned by the Owner as per the Acknowledgment Certificate to be issued - Land to be purchased by Skylight - Land to be sold by Skylight to Lebanon Wind Power	Acknowledgment Certificate dated 05-11-2018 - Lease Agreement - Sub-Lease Agreement	Forms of Land Sale and Purchase Agreements being reviewed by Lenders' counsels - In process

Figure 2-12a Land Lease Parcels – Acquisition of LWP Substation

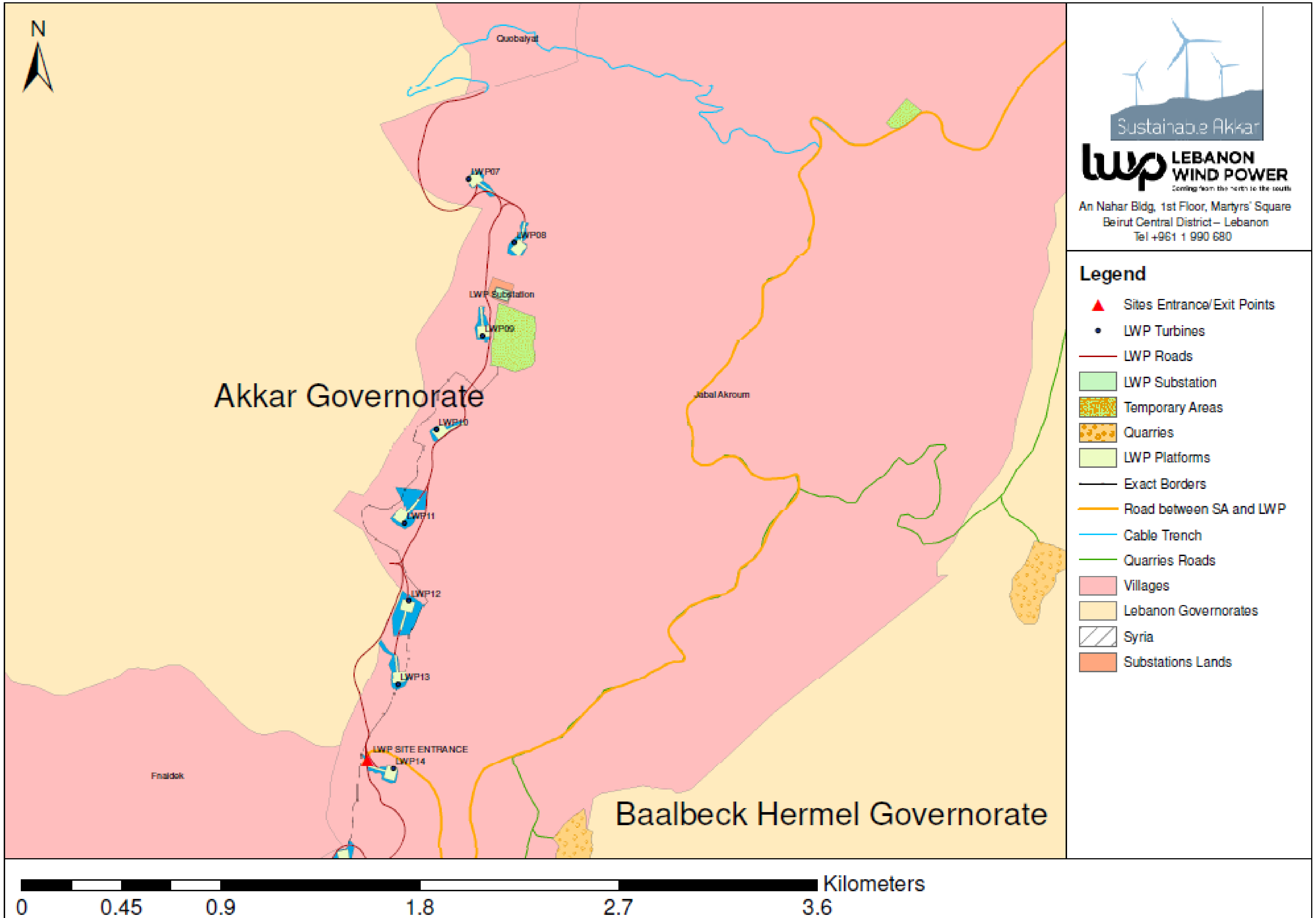


Figure 2-12b Leased Land Parcels

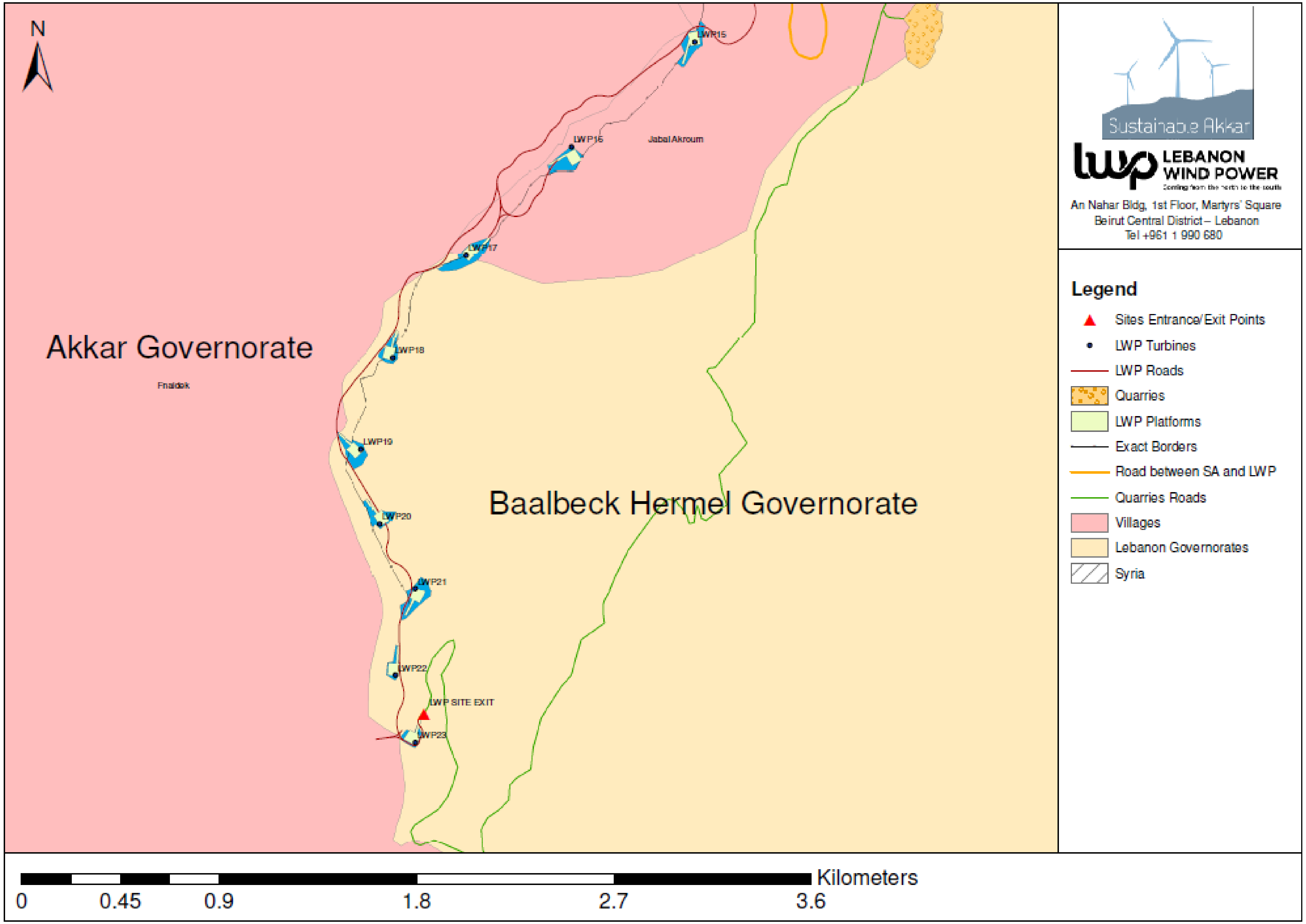


Table 2-6 Footprint of the Project Components

Component	Footprint	Description
Turbine platforms	29,120m^2	This includes the footprint for the foundation and the crane pad area for each of the 16 turbines. Each crane pad is likely to be around XXXXm^2 in area (38m in width and 40m in length), whereas each foundation is likely to be around 300m^2 in area.
Substation and Warehouse and Storage facilities	3,500m^2	Includes footprint of the substation area and all building facilities.
Construction Camp		Construction camp may be constructed, depending on the OEM/EPC Contractor selected.
Temporary Buildings		
Trenches for MV cables and communication cables		Trenches are likely to be around Xkm in length and a width of around Xm.
Laydown Areas		
Transmission Line (buried)	0.01km^2	Approximately 8km in length and an excavation width of 120cm to accommodate a 30cm transmission line.
New asphalt road segments		Road network is likely to be around Xkm in length and a width of around Xm.
New gravel road segment		
Total Project Footprint		**Project footprint is around X% of the total boundary of the Project area.**
Total Project site Boundary Area	**2.6km^2**	

The footprint of the Project components are currently being calculated and will be added to the final version of the ESIA Report.

2.6. Overview of Project Phases

This section presents the likely activities to take place during the Project development and which will include three distinct phases: (i) planning and construction, (ii) operation and (iii) decommissioning, each of which is summarized below. Construction is expected to begin in July 2019 and will require approximately 19 months for construction and commissioning. Operation of the Project is, therefore, expected to begin in February 2021. A Project schedule is presented in **Figure 2-13** (note: the Project schedule also shows the installation of the turbine components for Sustainable Akkar).

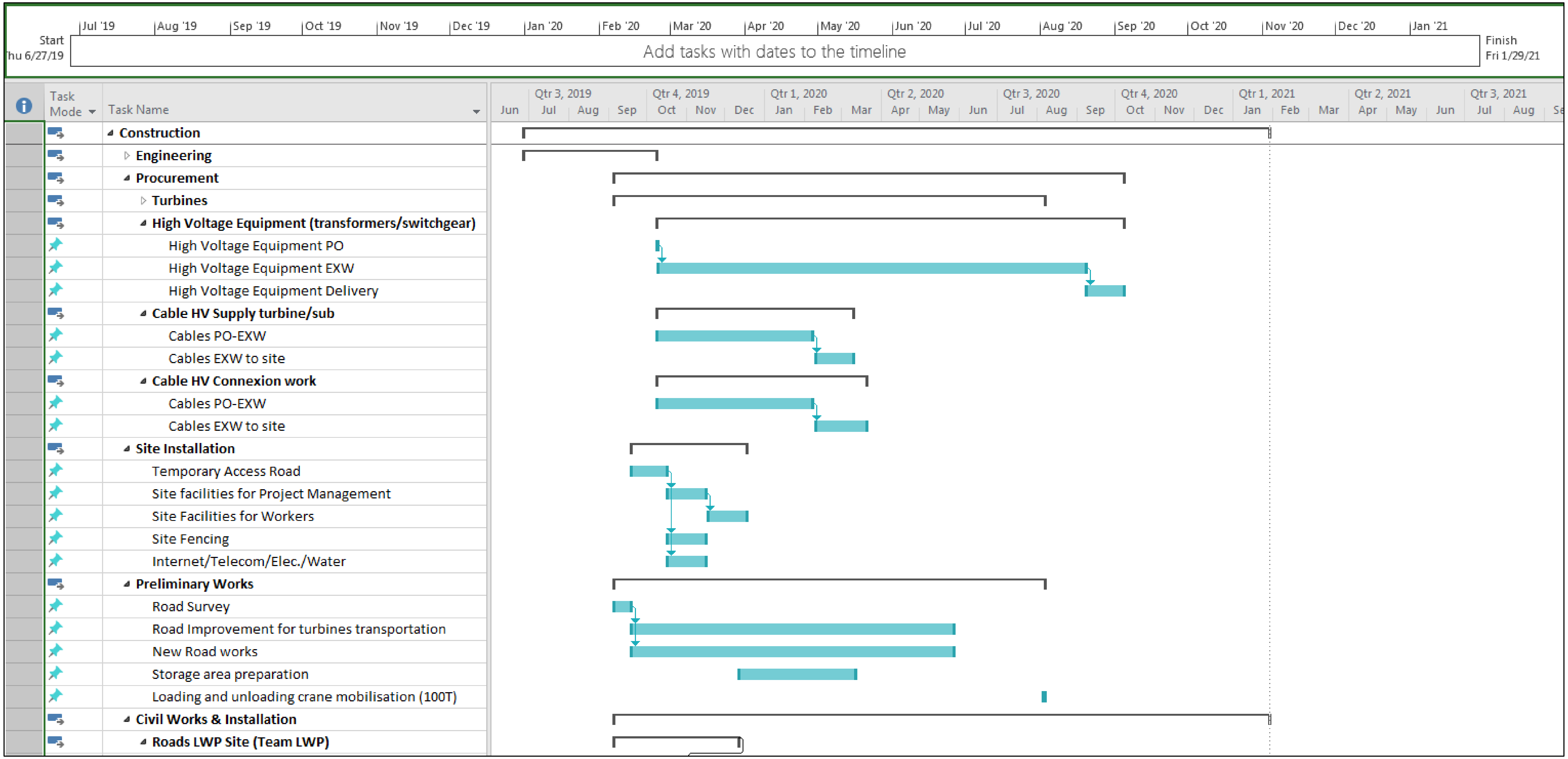
2.6.1. Pre-Construction Phase

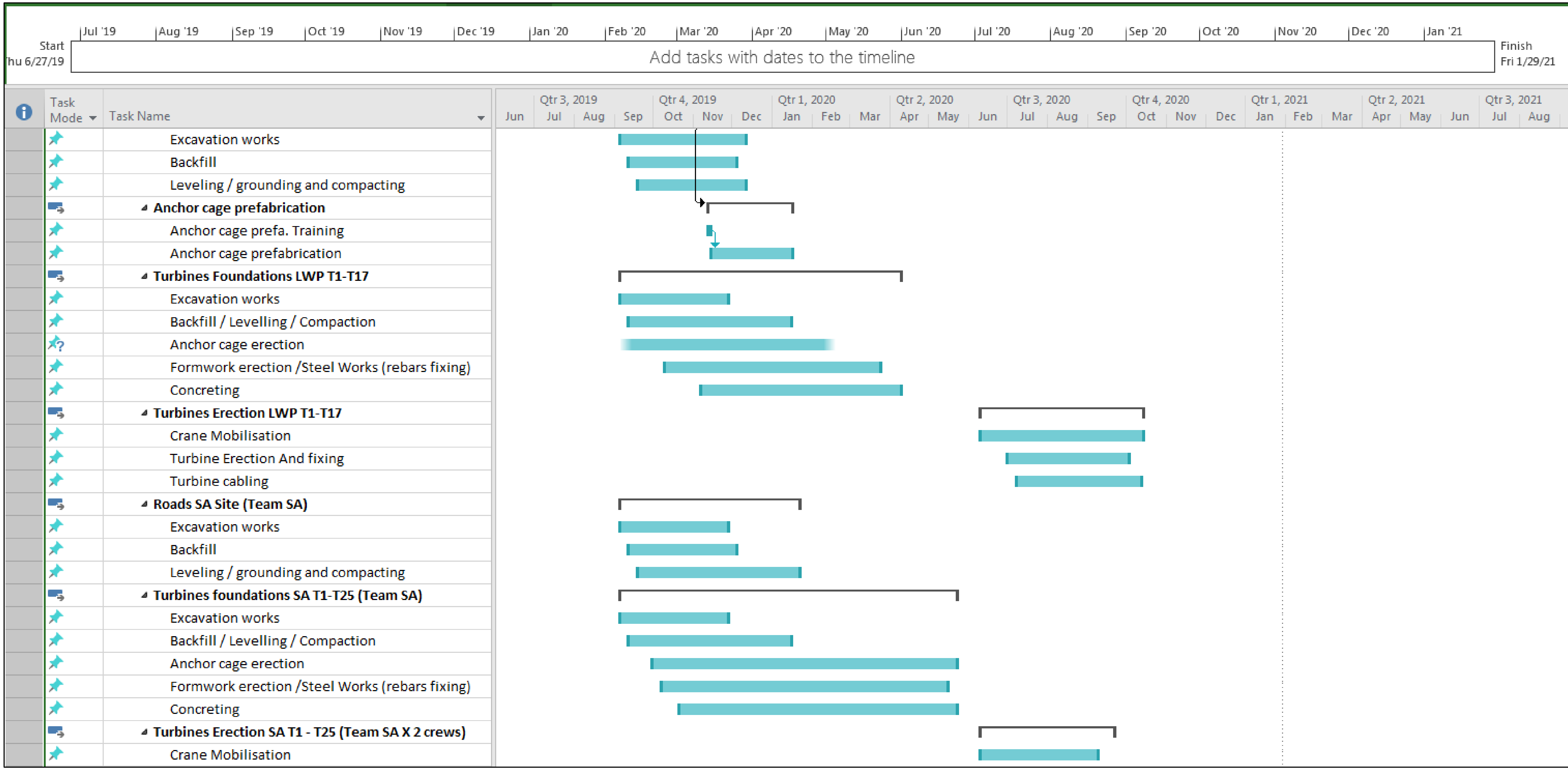
The pre-construction phase will include the following:

- Land Rentals: As previously summarized in Section 2.4, Project land will be secured through long term lease agreements with the land owners. A sub-consultant company, Skyline, was assigned the responsibility of investigating land ownership since the early project planning phases in order to incorporate land availability in layout development.
- Land Acquisition: The Project will be acquiring one area of land for the construction of the substation, control building and EDL building, while the remaining will be rented for 28 years.
- Selection of OEM/EPC Contractor: Vestas Wind Systems A/S, Siemens-Gamesa, Nordex Energy GmbH and GE have been shortlisted and have been asked to respond to a Request for Quote (RFQ) issued on 1 March 2019.
- Surveys and Studies:
  - A final transport route review once the specific model of wind turbine has been selected and dimensions of the components are understood. This will ensure that any changes to the likely impacts along the route are identified.
  - Additional topographical surveys as required to serve as a solid basis for the specification of the works.
  - Geotechnical investigations on all proposed sites for wind turbines, substations, transformers and related structures and buildings, for structures of transmission lines, along all site road routes for the purpose of construction and further public use and at other sites.
  - The analysis of the local site conditions.
  - Planned survey / monitoring (i.e. surveying of major karstic features, groundwater mapping, water quality monitoring of groundwater, local springs, etc.) to inform detailed design and address adverse impacts during construction.
- Detailed Design: The complete detailed design shall be provided by the selected OEM/EPC Contractor according to the scheduled milestones. To this end, the OEM/EPC Contractor shall prepare and submit the parts of the detailed design documentation, which relate to supplies and services in accordance with the applicable laws and regulations.

  During detailed design, the wind farm layout and yield calculations prepared by the Developer will be examined by the OEM/EPC Contractor to assess the best possible site configuration for installation of turbines among the 17 locations previously shown in **Figure 2-1**.

Figure 2-13 Project Schedule




Start
Thu 6/27/19
Jul '19
Aug '19
Sep '19
Oct '19
Nov '19
Dec '19
Jan '20
Feb '20
Mar '20
Apr '20
May '20
Jun '20
Jul '20
Aug '20
Sep '20
Oct '20
Nov '20
Dec '20
Jan '21
Add tasks with dates to the timeline
Finish
Fri 1/29/21
Task Mode
Task Name
Qtr 3, 2019
Qtr 4, 2019
Qtr 1, 2020
Qtr 2, 2020
Qtr 3, 2020
Qtr 4, 2020
Qtr 1, 2021
Qtr 2, 2021
Qtr 3, 2021
Jun
Jul
Aug
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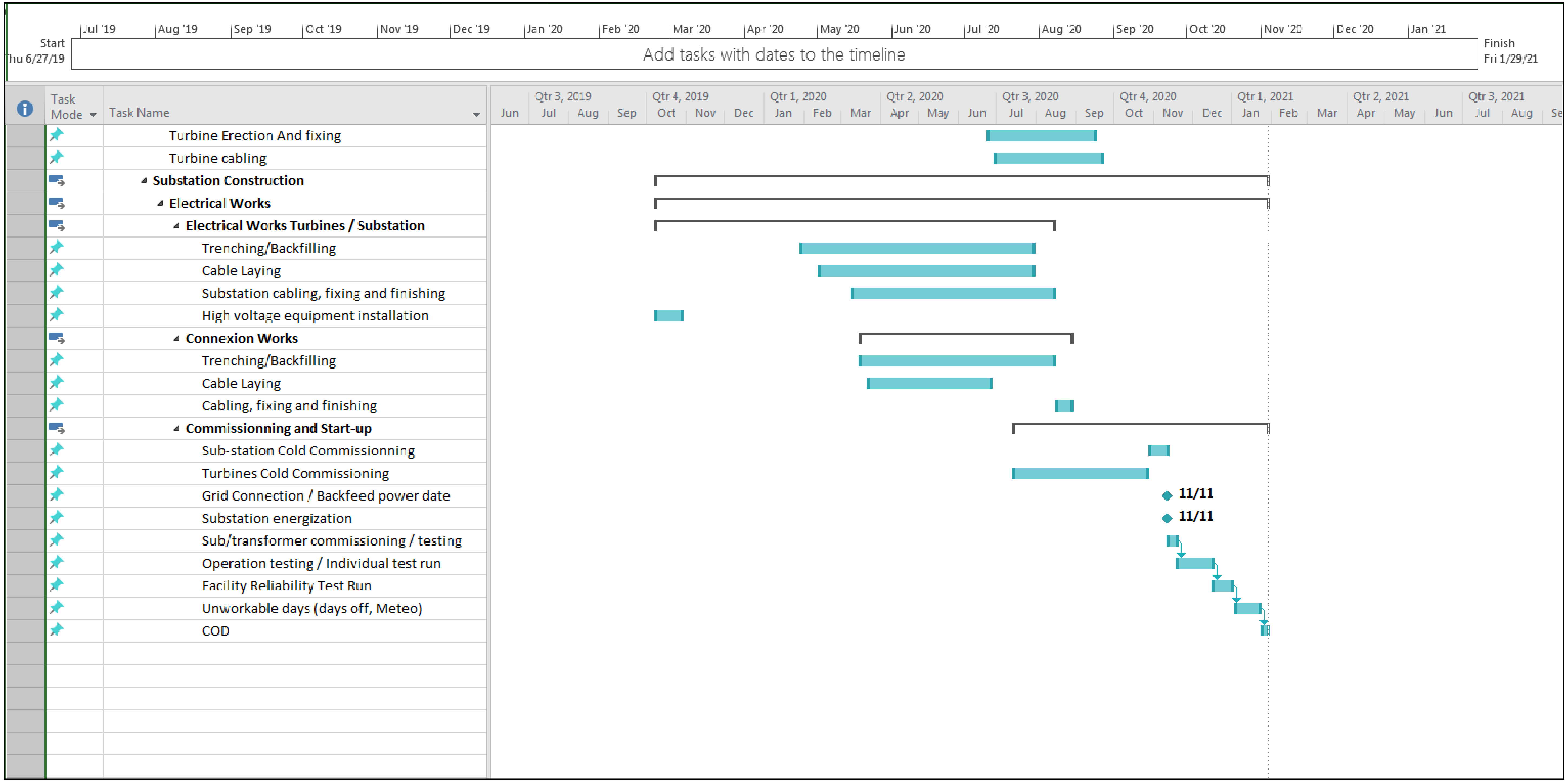
Jun
Jul
Aug
Se
Excavation works
Backfill
Leveling / grounding and compacting
Anchor cage prefabrication
Anchor cage prefa. Training
Anchor cage prefabrication
Turbines Foundations LWP T1-T17
Excavation works
Backfill / Levelling / Compaction
Anchor cage erection
Formwork erection /Steel Works (rebars fixing)
Concreting
Turbines Erection LWP T1-T17
Crane Mobilisation
Turbine Erection And fixing
Turbine cabling
Roads SA Site (Team SA)
Excavation works
Backfill
Leveling / grounding and compacting
Turbines foundations SA T1-T25 (Team SA)
Excavation works
Backfill / Levelling / Compaction
Anchor cage erection
Formwork erection /Steel Works (rebars fixing)
Concreting
Turbines Erection SA T1 - T25 (Team SA X 2 crews)
Crane Mobilisation



Start
Thu 6/27/19
Jul '19 Aug '19 Sep '19 Oct '19 Nov '19 Dec '19 Jan '20 Feb '20 Mar '20 Apr '20 May '20 Jun '20 Jul '20 Aug '20 Sep '20 Oct '20 Nov '20 Dec '20 Jan '21
Add tasks with dates to the timeline
Finish
Fri 1/29/21
Task Mode
Task Name
Qtr 3, 2019 Qtr 4, 2019 Qtr 1, 2020 Qtr 2, 2020 Qtr 3, 2020 Qtr 4, 2020 Qtr 1, 2021 Qtr 2, 2021 Qtr 3, 2021
Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Se
Turbine Erection And fixing
Turbine cabling
Substation Construction
Electrical Works
Electrical Works Turbines / Substation
Trenching/Backfilling
Cable Laying
Substation cabling, fixing and finishing
High voltage equipment installation
Connexion Works
Trenching/Backfilling
Cable Laying
Cabling, fixing and finishing
Commissionning and Start-up
Sub-station Cold Commissionning
Turbines Cold Commissioning
Grid Connection / Backfeed power date
Substation energization
Sub/transformer commissioning / testing
Operation testing / Individual test run
Facility Reliability Test Run
Unworkable days (days off, Meteo)
COD
11/11
11/11

Once the topographical survey has been completed, micro-siting will be undertaken to the degree necessary to locate the wind turbines to optimize production. However, it is noted that the site is located on a mountain ridge, and it is therefore anticipated that it will be optimal to place the turbines on rows perpendicular to the prevailing wind direction and within the confines of the leased land parcel. For this reason, it is not envisioned that the turbines will be significantly relocated during the detailed design and/or construction phase.

The OEM/EPC Contractor's detailed design will be used by the Developer to obtain the construction permit in accordance with the applicable laws and regulations. The OEM/EPC Contractor shall provide all support and documents to the Developer for application for construction permit.

- Employment and Workforce Training: For the performance of the Services during construction and operation, the OEM/EPC Contractor is encouraged to hire local personnel. After contract award, the successful bidder will be asked to present a hiring plan, including both local and international workforce. When local workforce is proposed, then the following information needs to be disclosed concerning the region from where they were hired, inter alia:

a. The surrounding villages.
b. The North Lebanon area.
c. Lebanon.
d. Lastly, international expertise.

Construction activities will employ around 150 workers during the construction phase for a duration of approximately 19 months. This will mainly include skilled opportunities (to include engineers, technicians, consultants, surveyors.) and unskilled job opportunities (mainly labor force but will also include a number of security personnel). Approximately 3 job opportunities will be available during the operations phase for a duration of 20 years. This will include skilled job opportunities (such as technicians) and unskilled job opportunities (such as drivers.). This number does not consider the security personnel that will be required onsite.

Taking the above into account, the Developer is aiming to hire local community members to the greatest extent possible throughout the construction and operation phase for skilled and unskilled jobs. The OEM/EPC Contractor shall provide comprehensive training to Employer's designated personnel covering all aspects of the Facility and the technical operation of the wind farm, safety at work, equipment and system for operations and maintenance. The training shall at least include the following:

- On the job training.
- Factory training.
- Wind Turbine maintenance and associated planning.
- Supervisory control and data acquisition (SCADA) software and hardware training.
- Operations and maintenance staff training.

2.6.2. Preparatory Works

The preparatory works include the provision of all goods and services of a temporary nature and required in order for the OEM/EPC Contractor to fulfill its obligations with regard to construction, installation and commissioning activities:

- Site preparation including compaction of soil, filling of low areas with imported fill and grading of the entire area of the site to the required lines levels and slopes, as required.
- Provision of temporary laydown areas, warehouses, workshops, vehicles, equipment etc. all as necessary for the construction phase.
- Provision of temporary firefighting and alarm system.
- Provision of temporary site drainage, storm water and sanitary drainage as necessary for the site, site facilities, temporary laydown areas, warehouses, workshops, as required.
- Disposal of sewage, as necessary.
- Provision of temporary site fencing including gates, as necessary.
- Provision of first aid, site safety and security system for the construction phase.
- Provision of temporary offices for the Employer and their representative.
- Provision of temporary offices for the Contractor.

2.6.3. Construction Phase

The scope of works in relation to civil works includes transportation, construction, erection, testing, commissioning and guaranteeing with respect to the items listed below will be undertaken in accordance with the EPC Technical Requirements, as follows:

- Removal of obstacles along the WTG component transport route.
- New asphalt road connections and internal road network and foundation construction.
- Internal road network and foundation construction within the Hawa Akkar wind farm, Sustainable Akkar wind farm and the Project.
- Other construction works (which could include excavations, land clearing activities, etc.) for the potential access road construction or upgrade and for the building infrastructure.
- Transportation of wind turbine components to the Project site. The components are expected to arrive by ship at the Tripoli seaport and then be transported by road to the Project site.
- Site preparation of the turbine foundations. Such activities are limited to relatively small individual footprints of the foundations and will include excavations and land clearing activities.
- Installation of turbine components to include tower assembly, hub, rotor, and nacelle lift and rotor assembly which most likely will occur through onsite mobile cranes.
- In addition to the erection of each turbine, there is additional construction work (which could include excavations, land clearing activities, electrical work, etc.) that must be conducted to connect each turbine to the power grid, this could include the installation and laying of transmission and communication cables, and the installation of the substation.
- Excavation for installation of the buried transmission line along Quobaiyat-Qasr Road and the existing track to the Project to connect the Project substation with the substation at the Sustainable Akkar wind farm.
- Other construction works (which could include excavations, land clearing activities, etc.) for construction for the building infrastructure (warehouse and offices).
- The scope of works of Contractor includes connection of the Plants to the existing electrical grid and energizing the interconnection facilities and the wind farm. The scope includes communicating and cooperating with EDL in order to ensure the timely connection and energization of the Project.
- Commissioning comprises the transfer of the plant from the state of mechanical completion into the state of continuous operation. Three months prior to the proposed start of commissioning, the

OEM/EPC Contractor shall submit to the Developer the commissioning plan (including test program, commissioning procedures, organization chart). Before commencement of commissioning, the OEM/EPC Contractor shall ensure that the following preconditions are fulfilled:

- Mechanical completion certificate are submitted.
- Approved commissioning procedures are available.
- Any required permit has been issued by the relevant authorities.
- Commissioning spare parts, consumables and tools.
- All temporary installation facilities/consumables required for the commissioning are made available by the OEM/EPC Contractor on site.
- All safety equipment is in place on site.
- The commissioning tests shall confirm the proper, safe and functional operation of all devices, controls and apparatus.

2.6.4. Operation and Maintenance Phase

The OEM/EPC Contractor shall manage and operate the Project, including:

- Management and administration of the facility.
- Environmental, health and safety management.
- Spare parts management including delivery, shipping and logistics for all required components and parts.
- Remote monitoring 24 hours a day, 7 days a week.
- Planning and supervision of the maintenance and repair activities.
- Communication with grid operator as well as operating the wind farm to satisfy EDL requirements.
- OEM/EPC Contractor’s home office technical support.

The OEM/EPC Contractor shall maintain and repair the Project, including:

- Full service including scheduled and unscheduled maintenance of the Facility including but not limited to wind turbines, access roads and crane platforms, MV and FOC networks, operation and storage buildings, MV switchgear, MV/HV transformer up to and including the interface to EDL Assets, in line with the requirements of the operation and maintenance manuals provided by the manufacturer for the equipment installed in the facility.
- All other services necessary for the safe and efficient operation of the facility.
- Perform regular (latest yearly) testing of safety equipment as required for safe operation, by the equipment manufacturer instructions or by applicable laws and regulations
- Scheduled maintenance shall be performed to examine the condition and the proper function of the wind turbines, its subsystems and components.
- Check on the tolerances foreseen in the specification of the component / system and indicate the status and remaining lifetime respectively for the required maintenance works and if required for a safe operation in accordance with the specification, replace components or systems that do not comply in this regard.
- All spare parts and consumables needed for the scheduled and unscheduled maintenance of the facility. In addition, all required services, manufacturing, delivery to site, custom clearance and installation of spare parts as required. Regular substitution of all consumables such as lubricants,

brake pads etc. as required for a safe and steady operation and in accordance with the wind turbine components and system's specification.

- Maintaining all O&M facilities including Operation Building, warehouse, sanitary sewers, lighting, HVAC, plumbing and IT.
- SCADA and connectivity maintenance including required software updates, virus protections, and firewalls.
- Supply of all crane and lifting support, as required.
- Perform all necessary environmental protection activities including spill prevention, spill cleanup and disposal of all contaminated waste at an approved facility.
- Maintain all aviation lights.
- Dispose of all site generated waste at an approved facility in line with local requirements and international best practice.
- Recycle all used oils, lubricants, and scrap materials at an approved facility.
- Reporting to the Developer.

The design lifetime of the wind farm is more than 20 years, noting that the turbines may last even longer with correct and consistent maintenance. **Table 2**-7 summarizes the anticipated maintenance activity types at the wind farm.

Table 2-7 Maintenance Activities

Type	Description
Preventive Maintenance	• Routine checks, testing and maintenance to determine whether any major maintenance work is required. • Ensures minimization of corrective maintenance. • Planned and scheduled. • Expenditure is budgeted.
Corrective maintenance	Tasks can either be identified through or triggered by: a. Routine preventive maintenance. b. System shutdown triggered by the protective system. c. Failure of a system component. Tasks include response to or correction of: a. Issues due to degradation of component integrity or excessive wear and tear. b. Human errors. c. Design faults and operational factors (such as turbine over-speeding, loss of grid connection, excessive vibration, other). Tasks are unplanned, unscheduled. Expenditure is condition-based.
Monitoring and System Diagnostics	Tasks include: a. Metering. b. Alarms. c. System diagnostics and checks. d. Condition monitoring. Expenditure is budgeted.

Thus, while abiding by the mitigation measures as per the ESMP, the Developer will implement a well-defined maintenance program that aims to:

- Increase efficiency and energy delivery.
- Decrease downtime (hours/annum) (while respecting and abiding by the limitations set within the ESMP).
- Ensure EHS and reducing risks.
- Extend wind farm system lifetime.
- Comply with manufacturer's warranty(ies).

Project operation will involve planned, scheduled and prepared-for maintenance activities. These will be conducted either (i) periodically, which is applicable for preventive maintenance, and monitoring, check-ups and system diagnostics, or (ii) as required, which is applicable to corrective maintenance and emergency maintenance procedures.

The types of routine maintenance activities as part of the preventive maintenance works of the Project are listed in **Table 2-8**.

Table 2-8 Preventive Routine Maintenance Works

Preventive Routine Maintenance Works	
Maintenance of turbine components	Brake adjustment
Brake pad maintenance	Lubrication
Inspection of security of fixings	Inspection of security of cable terminations
Generator overhaul	Access roads' maintenance
Maintenance of electrical components	Maintenance of areas around turbines (bases and platforms)
Control equipment maintenance	Other

Concerning liquid waste materials that may possibly be used during maintenance and operation activities of the wind farm, these include oils, lubricants, paints, solvents and pesticides. Such hazardous materials that would potentially be used during operation and maintenance of the wind farm components, including transformers, may pose a risk to staff members involved in handling, storage and use.

2.6.5. Decommissioning Phase

The PPA between the Project and the GOL will be for 20 years. The landowner's leasing contract is for 25 years; 5 years were added to decommission the Project and return the land to its original state (stated also in the contract). The lease agreements state that a daily rental fee will be paid during the decommissioning phase, on the basis of the number of turbines that are still producing electricity.

Decommissioning activities will adhere to the requirements of the MOE, MOEW, local authorities and international bodies (OPIC, EIB, FMO) and will be in accordance with local permits and international guidelines and requirements. Decommissioning activities will be undertaken in accordance with the Decommissioning Plan, to be approved by the Developer as part of the detailed design.

The decommissioning and restoration process comprises removal of aboveground structures, below ground structures to a depth of 1m or greater, removal of access roads if required by the land owners (or local authorities), restoration of topsoil, re-planting and re-vegetation, seeding and implementation of a two-year monitoring and remediation period, in a manner aimed at reducing the damage that may affect the land.

Any damage to the land caused by decommissioning activities will be repaired to restore the land to its original state. Aboveground structures include the turbines, transformers, substation, maintenance buildings and office in Kfartoun.

Below ground structures include turbine foundations, transmission lines, drainage structures (if any) and internal road sub-base material. The removal of wind farm structures will involve the evaluation and categorization of components and materials for disposition according to the following sequence: 1) recondition and reuse; 2) salvage; 3) recycle; and 4) dispose.

The decommissioning of the wind farm can be divided into three different phases:

- Phase I - Project management and planning: operations are scheduled taking into account the time and costs involved, aiming to achieve the most efficient and sustainable solution.
- Phase II - Removal of wind farm structures.
- Phase III - Post decommissioning processes: monitoring the destination of the removed elements and site recovery.

Table 2-9 presents the planned decommissioning activities per element, and in their order of occurrence.

Table 2-9 Delineation of Decommissioning Activities per Element

Element	Removal during Decommissioning
Turbines	• Access roads to turbines will be widened, if needed, to sufficient width to accommodate movement of appropriate-sized cranes or other machinery required for the disassembly and removal of the turbines. • Control cabinets, electronic components and internal cables will be removed. • Blades, hubs and nacelles will be lowered for disassembly. • Tower sections will be lowered to the ground and further disassembled into transportable sections. • Blades, hubs, nacelles, and tower sections will either be transported whole for reconditioning and reuse, or dissembled into salvageable, recyclable, of disposable components.
Turbine foundation and base	• Topsoil will be removed from an area surrounding the foundation and stored for later replacement. • Turbine foundations will be excavated to a depth sufficient to remove all anchor bolts, rebar, conduits, underground cable, and concrete to a depth of 1 meter below grade. • The remaining excavation will be filled with clean sub-grade material of quality comparable to the immediate surrounding area. • The sub-grade material will be compacted to a density similar to surrounding sub-grade material. • Unexcavated areas compacted by equipment used in decommissioning shall be de-compacted to adequately restore the topsoil and sub-grade material to the proper density consistent and compatible with the surrounding area and suitable

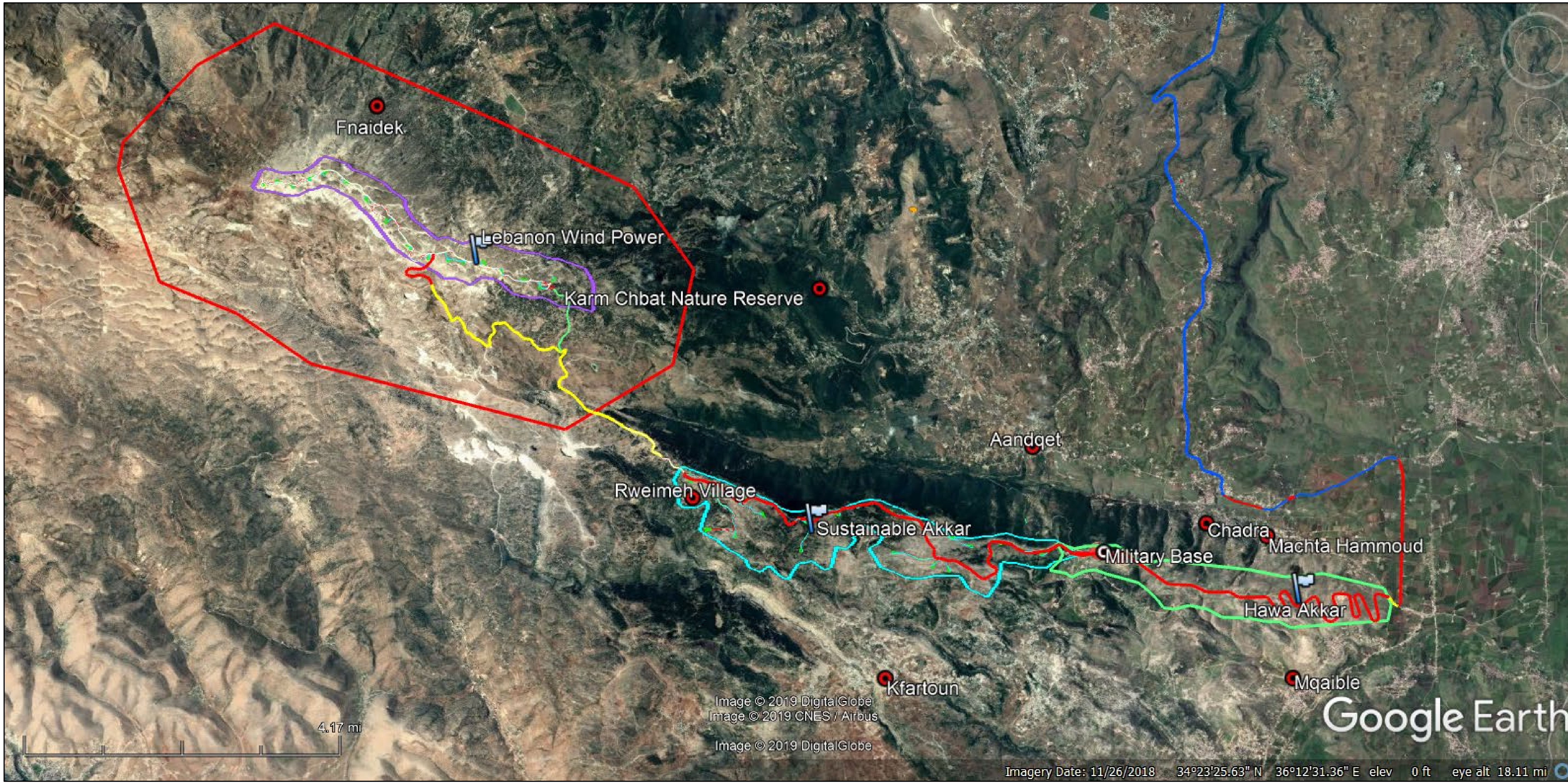
Element	Removal during Decommissioning
	for vegetation growth – noting that de-compaction activities are not recommended to take place starting October 1st, in order to ensure sufficient vegetation growth to prevent erosion over the winter months; otherwise this activity would be postponed to Spring, specifically the month of May.
Project substation	• Disassembly of the substation will include only the areas leased to Lebanon Wind Power. • Steel, conductors, switches, transformers, etc. will be reconditioned and reused, sold as scrap, recycled, or disposed of appropriately depending upon market value. • Foundations and underground components will be removed to a depth of 36 inches and the excavation filled, contoured, and re-vegetated.
Access roads, construction and maintenance platforms	• Last step after other decommissioning activities are completed. • Gravel will be removed from access roads and platforms and transported to a pre-approved location. • Drainage structures integrated with the access road or construction pad will be removed and backfilled with sub-grade material, the topsoil replaced, and the surface contoured and re-vegetated • Access gates, if any, will remain operational until completion of decommissioning after which they will be removed unless requested by the Municipalities of Rweimeh, Karm Chbat and Fnaidek that they remain. • Ditch crossings connecting access roads to public roads will be removed unless requested that they remain by the Municipalities of Rweimeh, Karm Chbat and Fnaidek. • Improvements to village roads that were not removed after construction and installation of the wind farm will probably remain in place at the request of the Municipalities of Rweimeh, Karm Chbat and Fnaidek.

In the interest of increased efficiency and minimization of transportation impacts, components and materials may be stored on site at a pre-approved location until the bulk of similar components or materials are ready for transport. The components and material will be transported to facilities for reconditioning, reuse, salvage, recycling or disposal, as appropriate.

2.7. Direct and Indirect Areas of Influence

The Direct Area of Influence (DAOI) for the ESIA is shown (in red) in **Figure 2-14**. The DAOI comprises a 3km radius around the Project footprint of land to be leased or purchased from landowners for the installation of the turbine platforms, internal roads, transmission line connecting the Project and Sustainable Akkar substation, and encompasses the noise, shadow flicker and visual receptors. In addition, it includes the office space to be leased in Kfartoun, land leased and acquired for the internal tracks to be developed within the Hawa Akkar and Sustainable Akkar wind farms, and the new segments of road:

Figure 2-14 Direct Area of Influence



- The new 0.65km section of asphalt road to avoid impacts to Chadra, Machta Hassan and Machta Hammoud to be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 2-8**).
- The new 0.15km section of asphalt road to be constructed between two existing sections of asphalt road in order to avoid hairpin turns near homes (shown as #2 in **Figure 2-8**).
- The new 3.0km section of gravel road to be constructed within the existing railroad ROW managed by Machta Hammoud Village (shown as #3 in **Figure 2-8**).

The Indirect Area of Influence (IAOI) for the ESIA is shown (in blue) in **Figure 2-15**. The IAOI comprises the existing transport corridor between the Tripoli seaport and the Project and extends up to 15km from the Project footprint to include sites and monuments of national importance potentially affected by the Project's visual impact.

For the assessment of individual environmental and social parameters, an appropriate thematic study area is determined for each theme on a case by case basis (i.e. ornithology). Such a thematic study area is clearly identified within the relevant section it relates to throughout this ESIA. In identifying these thematic study areas, the type and degree of the potential direct and indirect effects were taken into consideration. The core area where direct effects are likely to occur was determined, as well as the wider area of influence where indirect, combined and cumulative effects are likely to occur on the surrounding areas and communities.

2.8. Nearby Investments of Similar Nature

As indicated in **Section 1**, the GOL signed PPAs to purchase wind energy from three wind farms in Akkar. In addition to the Project, two other wind farms are planned:

- Sustainable Akkar SAL is planning to establish and operate a wind farm project in Jabal Akroum, immediately north/northeast of the Project. The Project comprises the construction and operation of up to 19 wind turbines which would generate a maximum licensed capacity of 82.5MW (plus 10%) to be delivered to the public grid.
- Hawa Akkar SAL is planning to establish and operate a wind farm project in the Wadi Khaled area in Akkar. The Hawa Akkar wind farm is expected to encompass 16 turbines which would generate a maximum licensed capacity of 68.3MW.

The proximity of the Sustainable Akkar and Hawa Akkar wind farms to the Project are shown in **Figure 2-16**. All three wind farms will use the same route for transport of WTG components, also shown in **Figure 2-16**. As described above, the Project's Direct Area of Influence includes the footprint of land needed for the Sustainable Akkar and Hawa Akkar internal tracks, many of which will be built atop existing tracks.

Relevant ESIA studies are currently underway.

Figure 2-15 Indirect Area of Influence

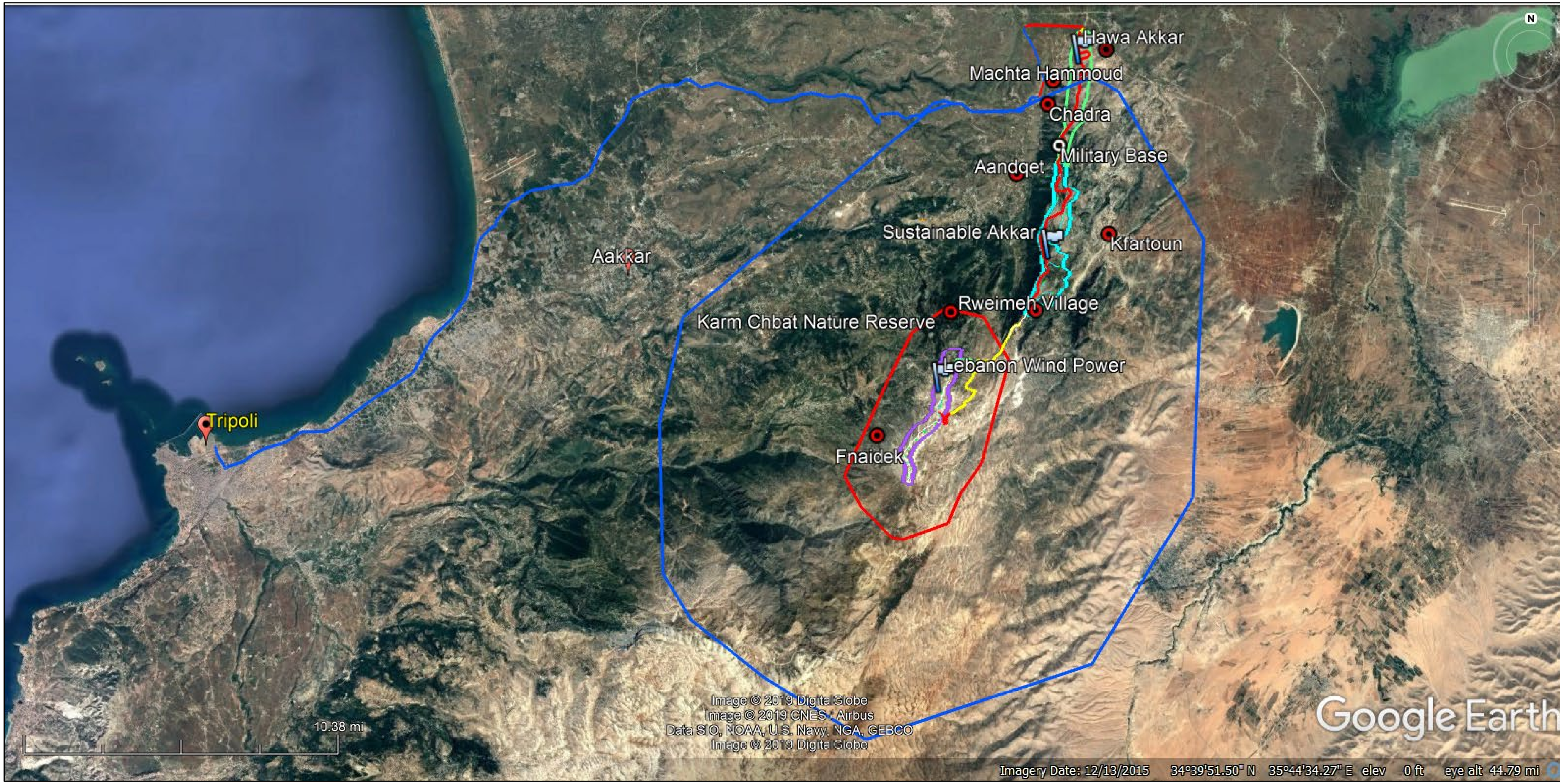


Figure 2-16 Location of Nearby Investments of Similar Nature

3. ANALYSIS OF ALTERNATIVES

The examination of alternatives is considered to be a key element of the ESIA process under good international practice, including IFC PS 1 and the associated IFC Guidance Note 1 (IFC, 2012). This section provides an analysis of certain alternatives to the Project development in relation to: 1) the Project site selection; 2) the Project design; 3) the chosen technology; and 4) the 'No Action Alternative', which assumes that the Project development does not take place. Based on such alternatives considered, the preferred choice for the Project was chosen as presented in **Section 2 Project Description**.

The application of the environmental and social mitigation hierarchy has been presented (i.e. to avoid, reduce, mitigate and manage, and compensate and offset), given that environmental and social considerations have been part of the planning of the Project since its inception and a core element of the decision-making process. Designing out the potential significant effects of a Project is the central tenet of the approach, encouraging adaptive management and continuous improvement to develop a more sustainable project. Specifically, the Developer endeavored to evaluate options to identify the preferred approach in consideration of the following:

- Site selection alternatives:
  - Overall Project site.
  - Turbine locations.
  - Substation location.
- Design alternatives:
  - Turbine types/specifications.
  - Alternative substation designs.
  - Alternative transmission designs.
- Transportation alternatives:
  - WTG component vehicle types/modalities.
  - Alternative road transport vehicle types/modalities.
  - Alternative road alignments.
- Technology alternatives.
- The Project vs No-Project alternative.

3.1. Site Selection Alternatives

3.1.1. Overall Project Site

Lebanon has a nationwide network of meteorological stations operated by Météo Liban (ML). In developing the Wind Atlas for Lebanon[1], ML supplied basic information and monthly wind data from 17 meteorological stations located throughout the country for the wind map analysis. In addition, hourly,

[1] The National Wind Atlas of Lebanon, Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon, 2011.

wind data from a subset of 5 meteorological stations were supplied. Further, wind data measured at 5 meteorological stations situated within Syria near to the Lebanese border were provided.

These data were used to derive information about long term annual and seasonal mean wind speeds at the meteorological stations and to establish a basic understanding of the dominant wind regimes in the country. A wind map for Lebanon at 80m heights was derived in coordination with the following constraints, which presents the priority development areas for wind farms as shown in **Figure 3-1**:

- Areas of high population density.
- Areas of high political instability.
- Military sites.
- Commercial interests (e.g. mining, fisheries, etc.).
- Civilian aviation sites.
- Areas in close proximity to radar or telecommunication sites.
- National parks.
- Conservation areas e.g. Cedar forests.
- Historic sites.
- Sites of religious significance.

As shown in **Figure 3-1**, the wind speeds present in the mountain ridge in Akkar represent the best wind conditions for siting a wind farm.

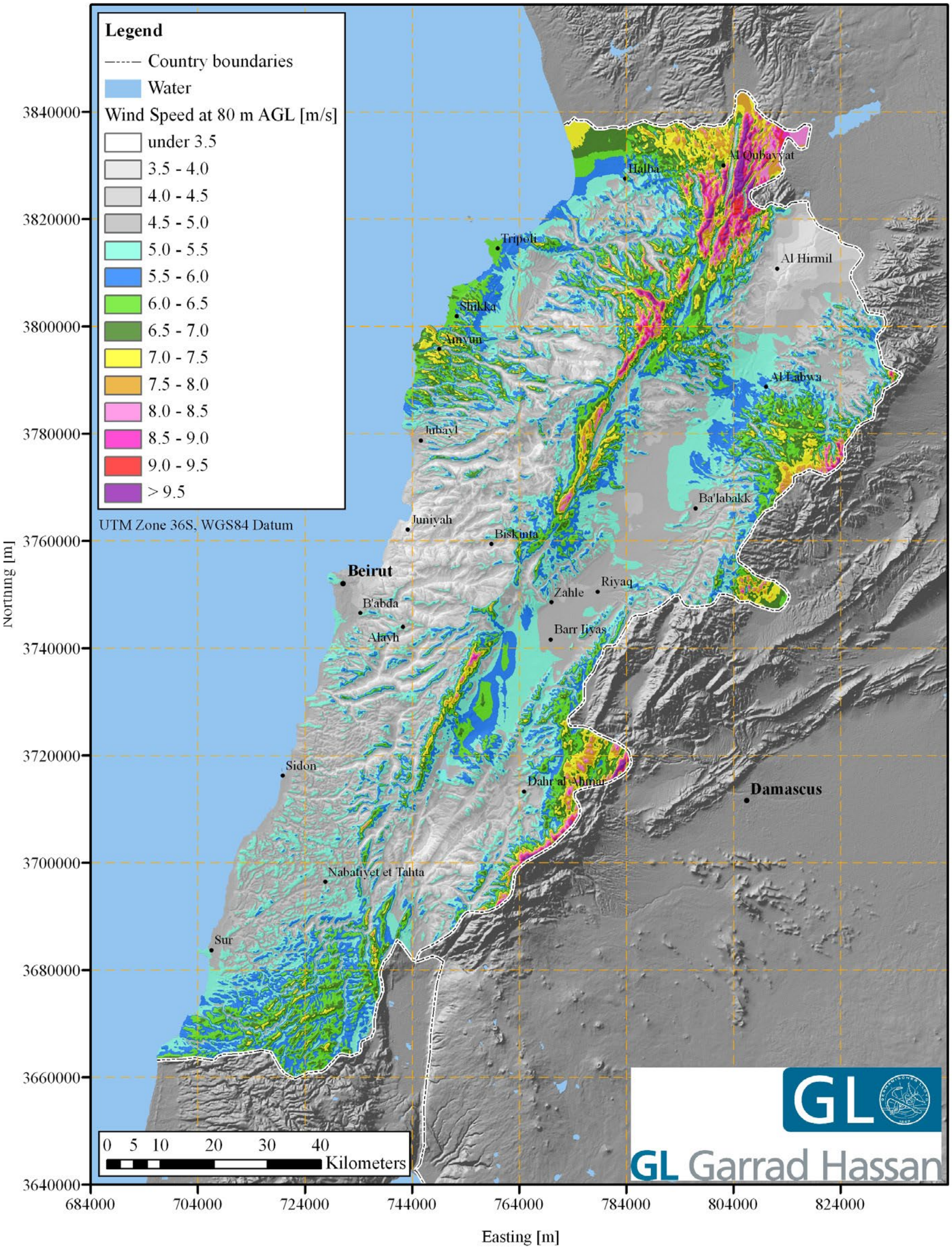
3.1.2. Turbine Locations

The number of turbine layouts were progressively developed across the undertaking of the ESIA. Mapping is currently being undertaken to present this information.

From 23 (WTG 01 to WTG 23) proposed turbine sites, 6 sites were eliminated (WTG 01 to WTG 06) for the following environmental and public exposure considerations:

- WTG 01 to WTG 04: removal of turbines as a result of the following:
  - Preliminary findings of noise simulations undertaken within the scope of the ESIA study.
  - Shadow flicker exceedance periods necessitating long curtailment periods, which in turn affect the energy yield requirement (at the recommendation of UL DEWI).
  - Located near the Karm Chbat Nature Reserve.
- WTG 05: located in the Karm Chbat Nature Reserve.
- WTG 06: located close to a receptor (individual house).

Figure 3-1 Wind Speeds at 80m Above Ground Level



3.1.3. Substation Locations

Alternative sites for siting the substation were assessed and included Sites 1, 2, 3 and 4, as shown in **Figure 3-2**.

The four sites were assessed relative to the presence of trees/shrubs, leveling requirements, satisfying the required distance from the nearest turbine (1.5 X the diameter of the turbine blade) and proximity to the Sustainable Akkar/EDL substation to be installed at the Sustainable Akkar wind farm, as summarized in **Table 3-1**.

Figure 3-2 Alternative Substation Sites

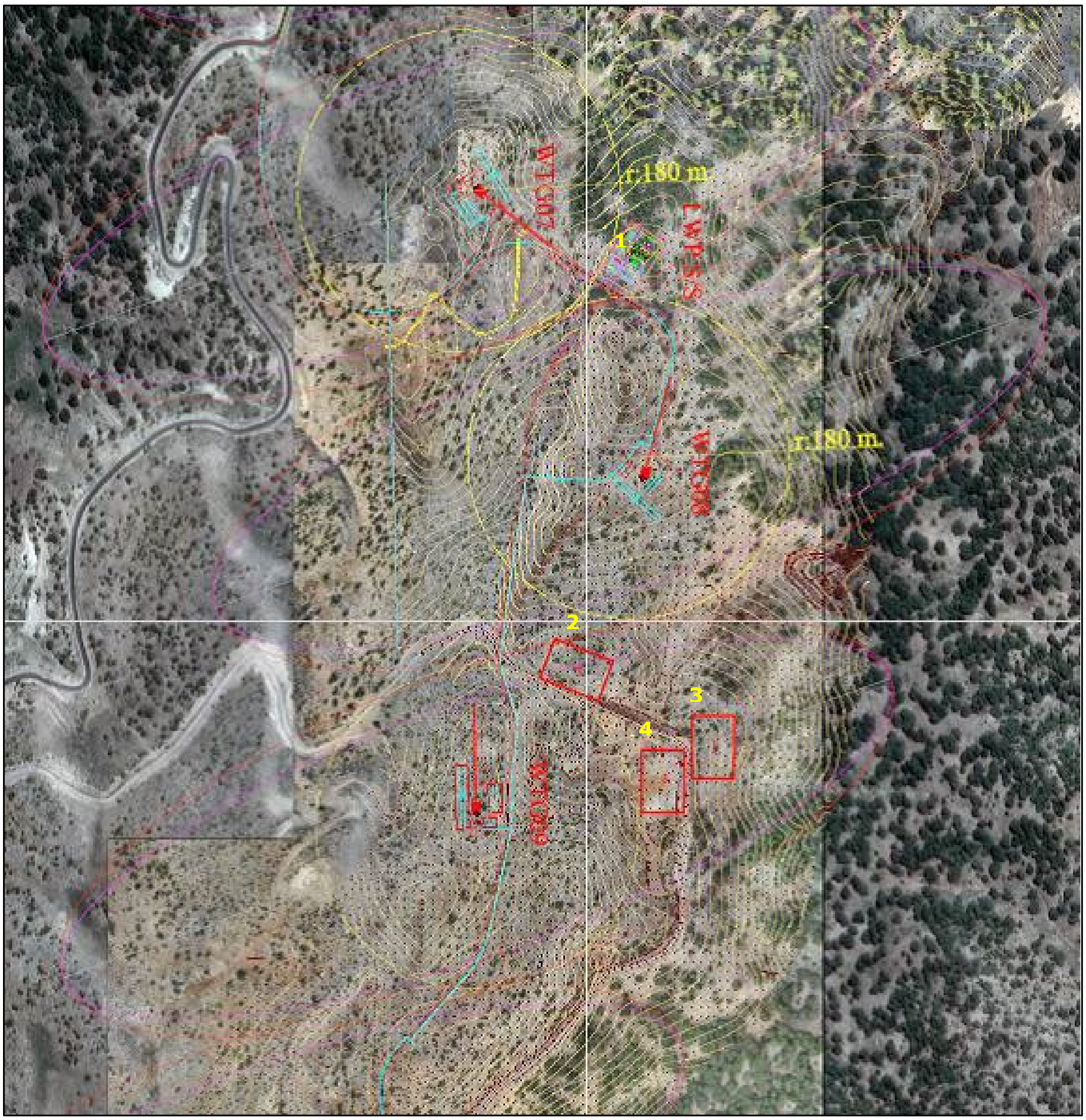


Table 3-1 Comparison of Substations Sites

Criteria	Site 1	Site 2	Site 3	Site 4
Presence of trees/shrubs	Moderate	Low	Low	Low
Leveling requirements	Low	Moderate	High	Low
Required distance from turbine	Yes	Yes	No	No
Proximity to the EDL substation planned for the Sustainable Akkar wind farm	Closest	Closer	Farther	Farthest

The comparison showed that Site 2 was the most favorable location for the Project substation as it satisfies the minimum distance away from turbine and is relatively close to the Sustainable Akkar EDL substation, while requiring the least amount of vegetative clearance and low leveling requirements.

3.2. Design Alternatives

3.2.1. Turbine Types and Specifications

Based on an initial request for an Expression of Interest (EOI), wind turbines from the following manufacturers were originally considered by the Developer:

- Vestas Wind Systems A/S.
- Siemens-Gamesa.
- Nordex Energy GmbH.
- GE.

Following review, Vestas Wind Systems A/S, Siemens-Gamesa, Nordex Energy GmbH and GE were shortlisted for further consideration. In addition to comparing the types of turbines provided by various turbine manufacturers, the Developer compared several turbines within the range provided by the same manufacturer. For this reason, the VESTAS 3.3MW and GE 3.8MW turbines were excluded in view of their low output capacity necessitating a larger number of locations.

In addition, customization of the VESTAS 4.2MW turbine to include a blade diameter of 150m, instead of 138m, was requested by the Developer in order to reach the energy yield requirement. The energy yield from the other manufacturers satisfied the required blade diameter --- 149m for the Siemens-Gamesa 4.5MW, 149m for the Nordex Energy GmbH 4.5MW and 158m for the GE 5.3MW, as was previously summarized in **Section 2 Project Description**.

Only models with hub height lower than 120m were retained in view of the level of turbulence caused at larger heights in high wind conditions.

The turbine selection process is ongoing and includes an energy yield assessment currently being implemented by an independent energy consultant (UL DEWI), as well as a financial feasibility assessment to consider the range of prices of the 4.2MW – 5.3MW turbines based on their dimensions, capacity and presence/absence of a gearbox, as summarized **Table 3-2**.

Table 3-2 Range of Prices of Candidate Turbines

Turbine Manufacturer	Range of Price in Thousand Dollars per MW
Vestas Wind Systems A/S	$700-800
Siemens-Gamesa	$750-800
Nordex Energy GmbH	$550-650
GE	$700-900

Following receipt of proposals in response to the Developer's Request for Proposal, Nordex Energy GmbH dropped out of the competition and only Vestas Wind Systems A/S, Siemens-Gamesa an GE remain under consideration. These are the potential turbine OEM/EPC Contractors detailed in **Section 2 Project Description**.

3.2.2. Alternative Substation Designs

Two different options were compared for the substation insulation design, the gas insulated substation (GIS) versus air insulated substation (AIS) systems. A comparative analysis of the two insulation methods is provided in **Table 3-3**, showing the advantages of the GIS system.

Table 3-3 Comparison of GIS and AIS Substation Insulation Design

Criterion	GIS	AIS
Land requirements	Lower	Higher
Insulation efficiency at altitude >1,100m	Yes	No
Cost	Higher	Lower

3.2.3. Alternative Transmission Designs

Two different transmission designs were compared including the 33 to 66KV and the 33 to 220KV designs. The final choice is inclined towards the 33 to 66KV design in view of the multi-criteria comparison provided in **Table 3-4**. It is noted, however, that the final decision will be made based on EDL preference.

Table 3-4 Comparison of Transmission Designs

Criterion	33 to 66 KV	33 to 220 KV
Location of lines / cables	Underground	Above ground
Need to buy lands	No (installed under roadsides)	Yes
Cost	Higher (insulation required)	Lower
Maintenance	Lower	Higher
Losses	Higher (up to 2%)	Lower (~0.1%)

3.3. Transportation Alternatives:

3.3.1. WTG Component Transport Vehicle Types/Modalities

Two main transport modalities were assessed during the early project planning phase and included air (helicopter) and road transport from Tripoli port to the Project site. A multi-criteria analysis was implemented, as shown in **Table 3-5**, clearly showing that road transport is more favorable than air transport in the context of the current project.

Table 3-5 Comparison of Air vs Road Transport of Turbine Parts

Criterion	Road Transport	Air Transport
Cost	5 million USD for road modifications and 6.8 million USD for transport (100,000 USD / MW)	25 million USD
Time Limitation	No limit on overall duration for transport	Transport should be completed within a 3-month periods
Suitability in High Winds	Always suitable	Not suitable when wind speed is higher than 7.5 m/s
Impact on CSR	Positive	Neutral
Sustainability	Yes (improved road can continue be used during maintenance including any part replacement)	No

3.3.2. Alternative Road Transport Modalities

Three different modalities are being assessed for the transport of wind turbine parts from the Tripoli Port to the Project site is provided in **Table 3-6**, namely 1- regular trailer until reaching an intermediate storage location then blade lifter, 2- regular trailer and 3- low trailer.

Table 3-6 Comparison of Different Road Transport Means

Criterion	Regular Trailer + Blade Lifter	Regular Trailer	Low Trailer
Cost	120,000-150,000 USD/MW	100,000 USD/MW	100,000 USD/MW
Speed	< 20 km/hour	> 20 km/hour	> 20 km/hour
Requirement of modification in pedestrian bridges to ensure clearance	Higher	Moderate	Lower
Need for road bump removal	Lower	Moderate	Higher
Tree pruning requirement	Higher	Moderate	Lower
Double handling	Yes	No	No

A multi-criteria analysis showing that the low trailer seems to be the most favorable means of road transport as it gives among others the advantage of minimization of double handling which is key to minimize damage to turbine parts. The final choice will however be made by the EPC Contractor who will be also responsible for the transport of the turbines to the Project site.

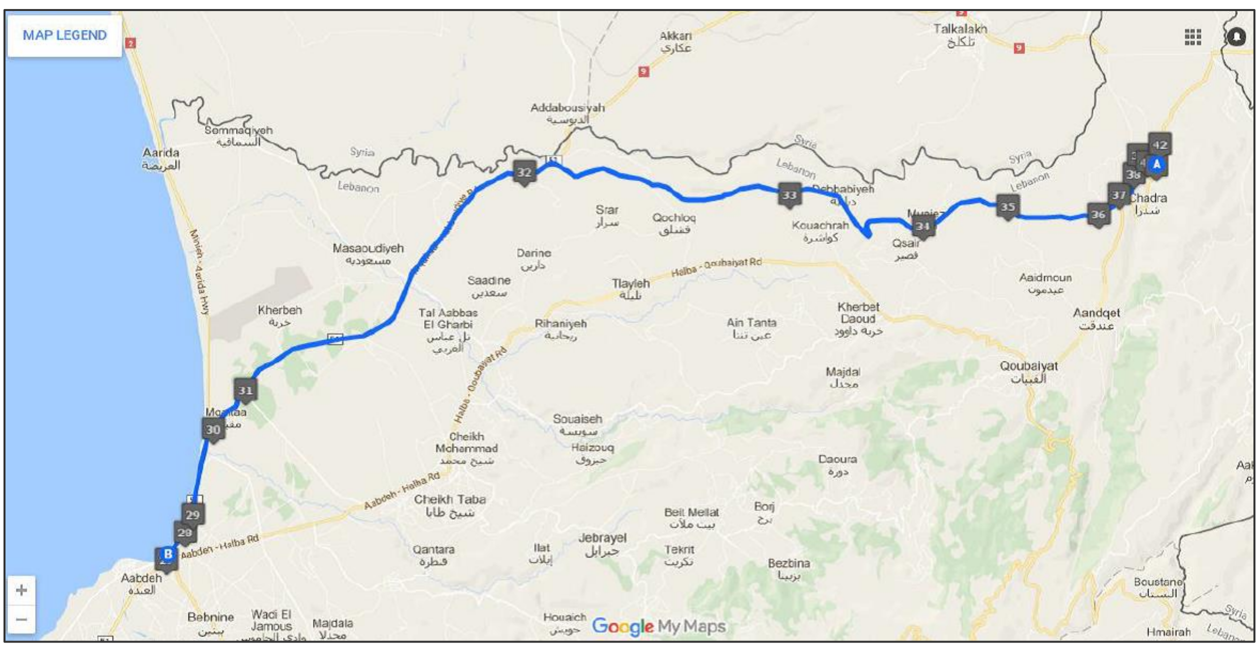
3.3.3. Alternative Road Alignments

Several alternative access roads were compared before reaching the proposed road scenario described in **Section 2 Project Description**. The following presents a comparison of the various compared road scenarios at different locations along the access road from Tripoli Port to the Project site.

Road from Abdeh to the Project Site

Two different access scenarios were compared during the early project planning phases, the first passing through Halba village until reaching Quobaiyat then to Chadra and the second being the proposed road alignment taking the seaside road instead of Halba village from Abdeh to Chadra and then to the Project site, as shown in **Figure 3-3**. The second alternative was chosen to avoid passing through the dense residential / commercial village of Halba which may pose large disturbance to the local population. Also, the village of Halba is subject to continuous development activities that may disrupt future turbine part transport activities during project maintenance.

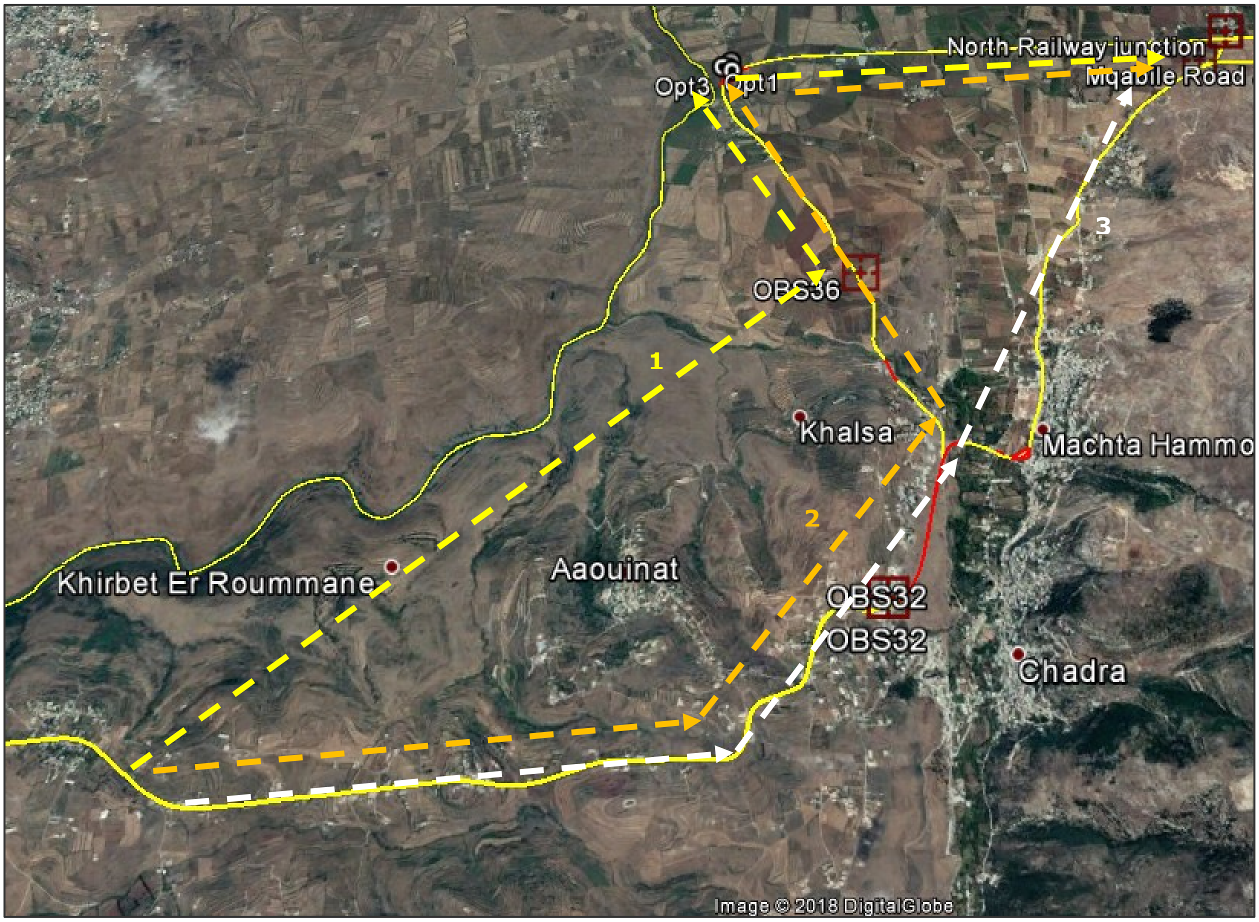
Figure 3-3 Alternative Road Scenarios After Abdeh Village



Road Between Khirbet Er Roummane and North Railway Junction

Three different alternative routes were assessed during the early project planning phases between the village of Khirbet Er Roummane and the North Railway Junction (see Route Nos. 1, 2 and 3 in yellow, orange and white, respectively, as shown in **Figure 3-4)**

Figure 3-4 Alternative Access Roads Khirbet Er Roummane to North Railway Junction



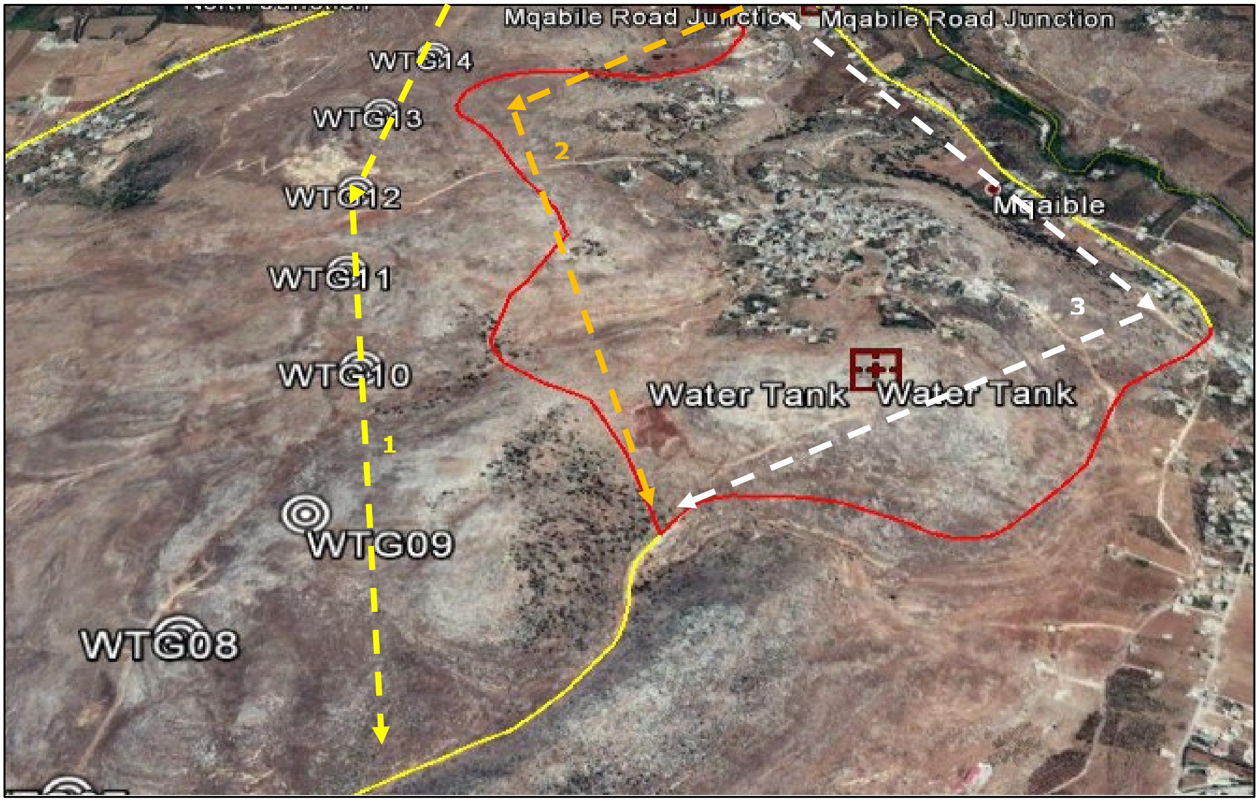
Route #1 was eliminated as it involved the acquisition of a land which could not be secured. Later, despite giving the advantage of absence of residential areas in need to be crossed, Route #2 was eliminated at the expense of Route #3 since the latter gave the advantages of shorter distance, absence of land to be purchased, and lower financial burden as the cost of road works would be co-shared with the developers of the neighboring Hawa Akkar wind farm who will use the same route.

Road Between Mqaible Road Junction and the Middle of the Hawa Akkar Site

Three different access roads were assessed during the project planning phases to connect the Mqaible Road Junction to the Hawa Akkar site, namely Roads 1, 2 and 3 indicated in yellow, orange and white, respectively in **Figure 3-5**. From the latter roads, Road #3 is selected so far as it clearly involves the lowest road development requirement.

A shift to Road #1 may take place later depending on the negotiations with the Hawa Akkar wind farm proponent. The decision will be based on financial analysis, i.e. the comparison of the cost of co-sharing the expenses for land purchase and road development within the Hawa Akkar site to that of road development solely along the trajectory of proposed Road #3. Road #2 has however been eliminated due to the high cost for road development.

Figure 3-5 Alternative Access Roads - Mqaible Road Junction to HA Site



Road Through Military Base to Sahle Checkpoint

Two alternatives for proposed new access roads were assessed during the planning phase to pass through the existing military base, as indicated in red on **Figure 3-6**. The first alternative involves the construction of a small stretch of road connecting to an existing road within the military base. Despite being small, the proposed stretch of road turned out to be unfeasible as the land encounters a very steep slope which is >17%, thus unsuitable for turbine part transport.

The other proposed alternative was selected, i.e. a longer road to be developed running parallel to military site (and not within the site, which is another advantage of the road), with the hosting land requiring much less leveling activities to satisfy the required slope.

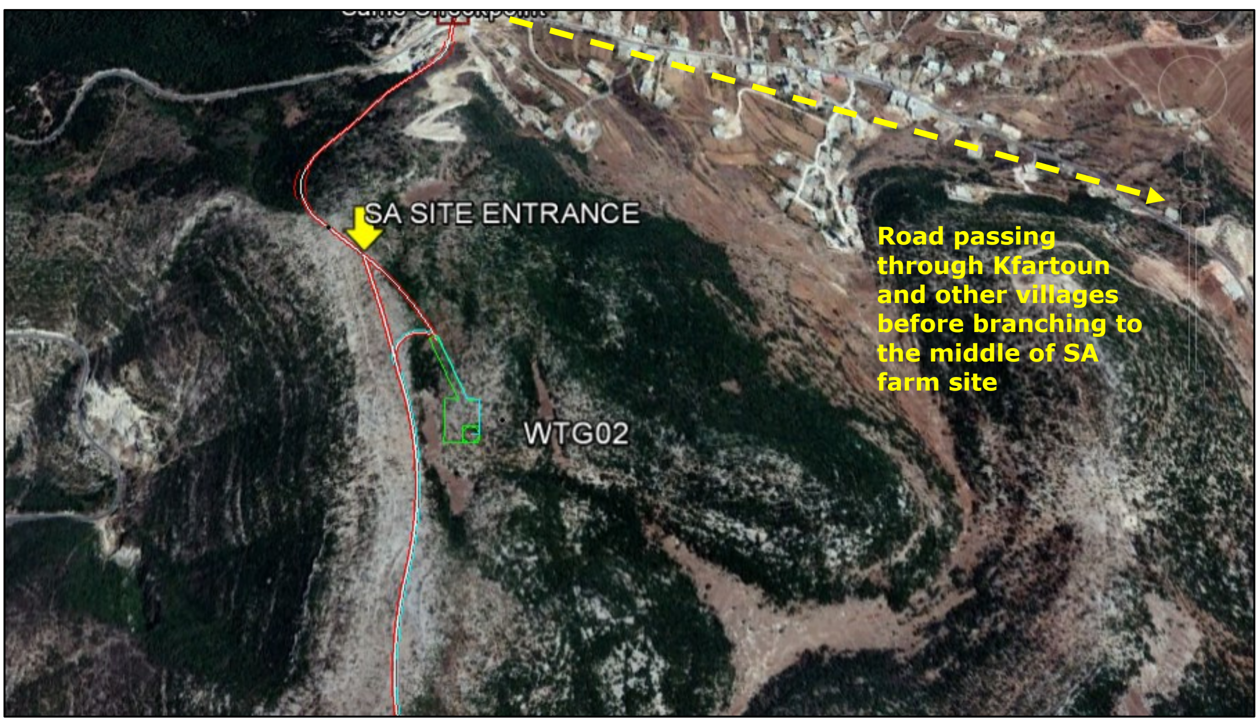
Road Connecting the Hawa Akkar and the Sustainable Akkar Sites

Two alternative roads were studied and compared during the project planning phases to connect the Hawa Akkar and Sustainable Akkar wind farms. The first alternative is the proposed Project alternative shown as a red line in **Figure 3-7** involving the development of a new road to connect the two sites. The second alternative uses existing roads to connect the Sahle Checkpoint to the middle of the Sustainable Akkar wind farm; however, involves the crossing of residential villages the densest of which is the Kfartoun village bordering the Sahle Checkpoint from the east.

Given the fact that even if the existing road can connect to the Sustainable Akkar wind farm site, internal roads reaching the northernmost turbine will need to be established, the Developer found it more appropriate to develop the new road connecting the two sites, thus avoiding the use of a long and potentially disturbance causing track passing through residential villages.

Figure 3-6 Alternative Access Roads through the Military Base

Figure 3-7 Alternative Connection Roads Between HA and SA Wind Farms



3.4. Comparison of Alternatives

A comparison of the alternatives considered during the planning stage is provided in **Table 3-7**. The comparison is made based on the comparative scoring of the various alternatives with respect to their feasibility from technical, environmental, social and cost points of views. A score of 1 to 3 was assigned depending on whether the feasibility of the alternative is low, moderate or high. A score of 0 indicates that the alternative is neutral for a certain consideration. The final score is a sum of all scores. As such, the higher the score the more feasible the alternative is based on considerations during the planning phase.

3.5. Technology Alternatives

This section discusses several alternatives besides the development of a wind farm project. This mainly includes other renewable energy alternatives suitable for Lebanon, i.e. solar power projects and conventional thermal power plants.

3.5.1. Solar Power

According to the National Renewable Energy Action Plan (NREAP), Lebanon's decentralized solar target set at 100MW by 2020. According to the 2017 Solar PV Status Report for Lebanon, solar capacity in Lebanon continues to grow annually. By the end of 2017, Lebanon had installed 35.45MW of solar PV capacity, as shown in **Figure 3-8**.

Figure 3-8 Solar PV Capacity and Annual Additions

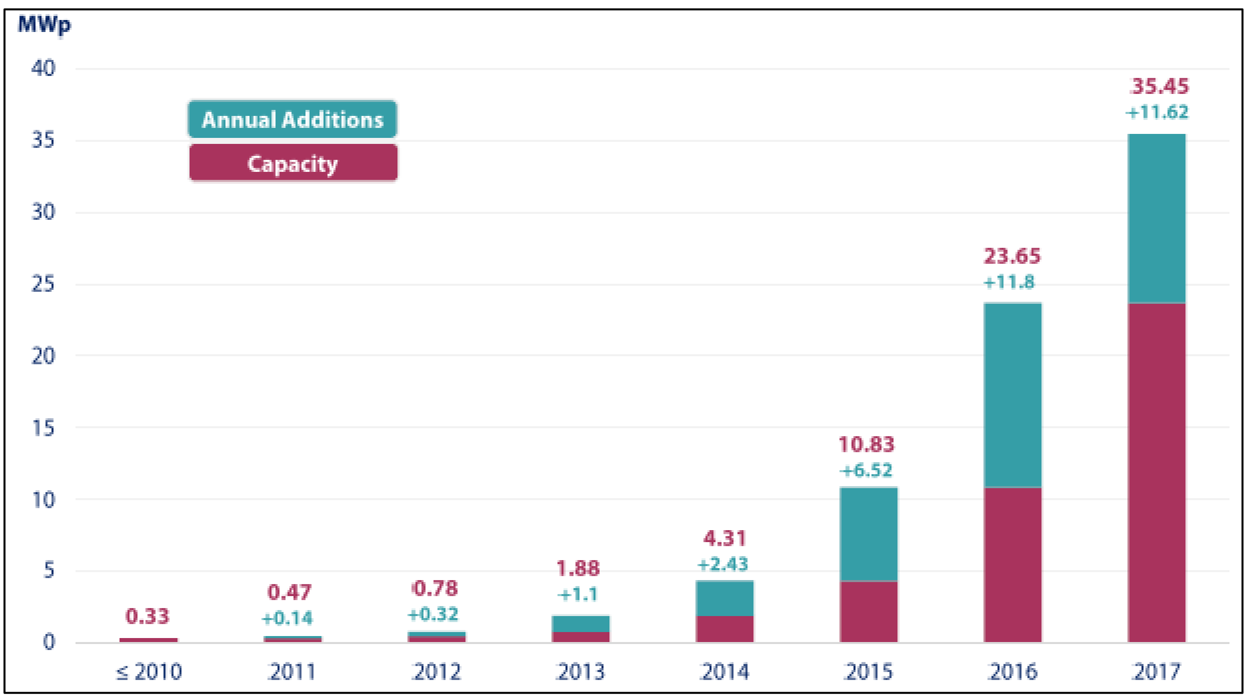


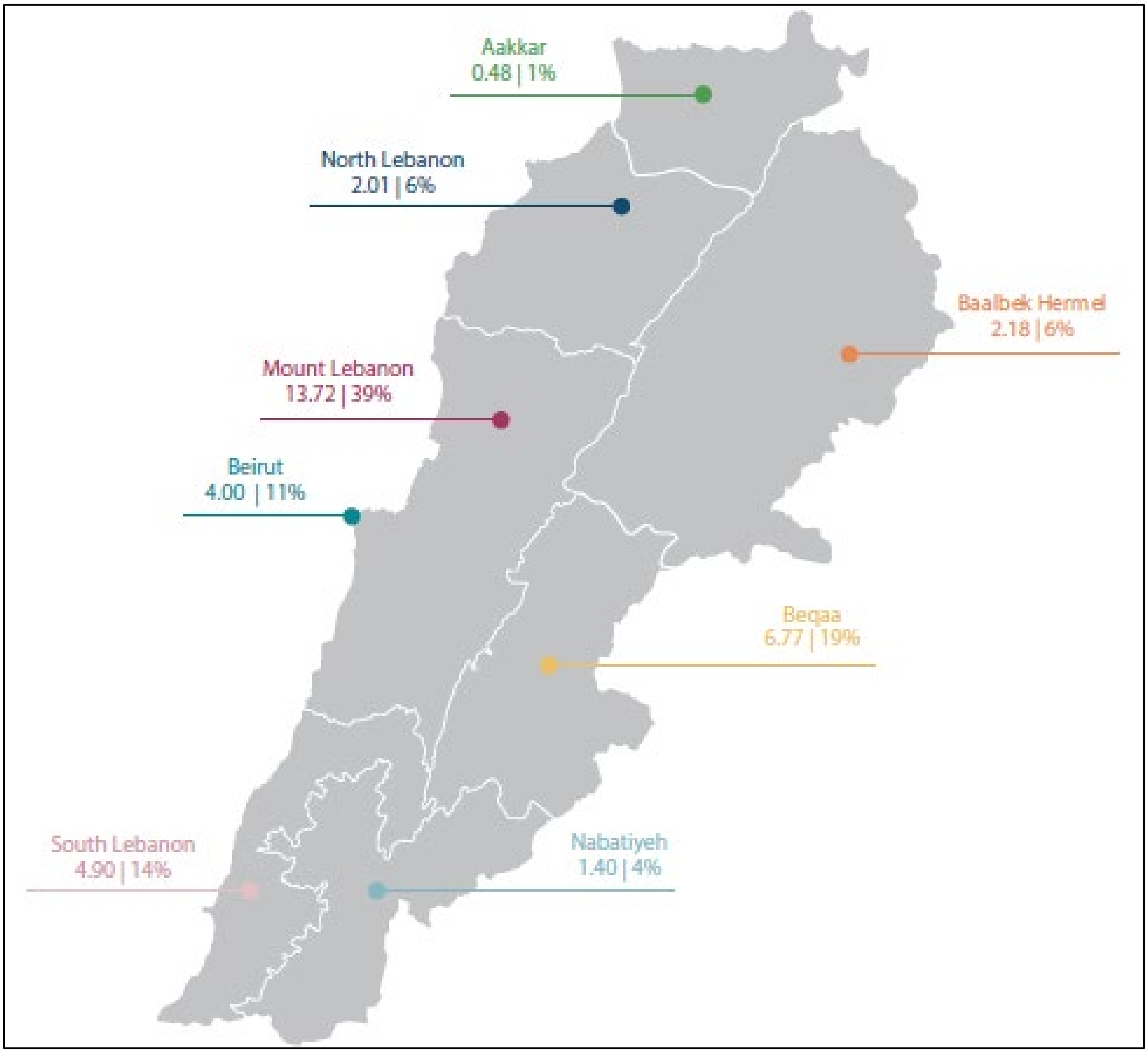
Table 3-7 Comparison of Alternatives

Alternatives	Alternatives	Individual Scores*				Final Score
		Technical	Environmental	Social	Cost	
Turbine locations	LWP 1	3	1	0	0	4
	LWP 2	3	1	0	0	4
	LWP 3	3	1	0	0	4
	LWP 4	3	1	0	0	4
	LWP 5	3	1	0	0	4
	LWP 6	2	3	0	0	5
	LWP 7 to 23	3	3	0	0	6
Turbine parts transport	Road transport	3	2	3	3	11
	Air transport	3	3	0	1	7
Road transport modalities	Regular trailer + blade lifter	1	2	0	1	4
	Regular trailer	2	2	0	3	7
	Low trailer	2	3	0	3	8
Road from Abdeh to Site	Seaside road	3	3	3	3	12
	Road through Halba village	2	1	1	3	7
Road from Khirbet Er Roummane to North Railway	Road #1	1	2	2	2	7
	Road #2	2	2	2	2	8
	Road #3	3	1	1	3	8
Road from Mqaible to HA	Road #1	1	1	0	2	4
	Road #2	2	1	0	1	4
	Road #3	3	2	0	2	7
Road through military base to Sahle checkpoint	Road within military base	1	2	0	1	4
	Parallel to military base	2	2	0	2	6

Alternatives	**Alternatives**	**Individual Scores***				**Final Score**
		Technical	**Environmental**	**Social**	**Cost**	
Road connecting HA and SA	New road	2	2	3	1	8
	Existing through Kfartoun	3	1	1	2	7
Road for transport of construction material	Road #1	2	3	3	2	10
	Road #2	3	2	2	2	9
Substation sites	Site #1	3	1	0	2	6
	Site #2	3	2	0	2	7
	Site #3	2	1	0	1	4
	Site #4	1	2	0	3	6
Substation designs	GIS	3	2	0	1	6
	AIS	1	1	0	2	4
Transmission designs	33 to 220 KV underground	3	2	3	1	9
	33 to 66 KV underground	1	2	3	2	8
	33 to 220 KV above ground	2	1	2	2	7

The solar PV capacity by Governate is shown in **Figure 3-9**.

Figure 3-9 Solar PV Capacity by Governate (MWp | %)



The top 3 Governorates leading the solar PV Market in Lebanon are Mount Lebanon with 13.72 MWp, Beqaa with 6.77 MWp, and South Lebanon with 4.90 MWp. Of the 8 Districts in Lebanon, Akkar represents the lowest solar PV capacity:

- 39% Mount Lebanon.
- 19% Beqaa.
- 14% South Lebanon.
- 11% Beirut.
- 6% Baalback/Hermel.
- 6% North Lebanon.
- 4% Nabatiyeh.
- 1% Akkar.

For the market to reach the 2020 targets of 100 MWp and 160 GWh per year for decentralized solar PV, solar projects need to be further encouraged and expedited. The industrial sector continues to dominate the solar PV market with 10.78 MWp of installed capacity. Investing in solar PV continues to be more affordable year after year with the average turnkey price dropping from $1,872 per kWp in 2016 to $1,545 in 2017.

In February 2018, Lebanon's Center for Energy Conservation (LCEC) issued an EOI for the construction of three 100MW solar PV plants combined with large-scale battery systems across four different regions: Bekaa and Hermel, South and Nabatieh, North and Akkar, and Mount Lebanon. In each project, the minimum power capacity of one given Solar PV farm is 70MW and the maximum power capacity is 100MW with Battery Energy Storage of minimum of 70MW power with a minimum of 70 MWh of storage capacity, regardless of the Solar PV sizing. In March 2018, the Lebanese Customs exempted imported solar PV panels from customs duty.

Selected bidders will be responsible for the design, development, financing, construction and operation of the facilities, which will sell power to local power utility, EDL under a long-term PPA. A detailed call for project proposals was circulated to the 75 responding consortiums in December 2018. The solar PV sector's positive effect on job creation is clear with at least 670 jobs created since 2008. Significantly more jobs will be created when Lebanon starts building its first utility-scale PV farms.

3.5.2. Power Plants

In 2009, EDL produced more than 15,000 GWh through 7 major thermal power plants located in different areas of Lebanon. The thermal generation units are operating using heavy fuel oil-fired steam turbines at Zouk, Jieh and Hreysheh; diesel-fired combined cycle gas turbine (CCGT) commissioned in 1994 at Beddawi and Zahrani; and diesel-fired open cycle gas turbines (OCGT) at Tyre and Baalbeck.

In addition to the thermal units, the sector includes hydroelectric power plants with a total installed capacity of 274MW, but due to their old age and the drop in water resources, the nominal generation capacity is around 190MW, constituting around 11% of the total generation capacity of the country.

GHG emissions from the power sector constituted 49% in 1994 and up to 54% of total emissions in 2004, and the sector came second behind the waste sector in having the biggest increase in GHG emissions. This is due to the significant growth in demand for electricity, due in part to the changing socio-economic conditions and to the expansion of the national grid. According to the SNC (MoE/UNDP/GEF, 2011) , the sharp increase between the 1994 and 2000 emissions is due to the increase in gas/diesel oil consumption that resulted the installation and operation of the Baalbeck, Tyre, Beddawi and Zahrani diesel power plants during this period.

In response, the Government of Lebanon has set a number of priorities for the development of the energy sector in general, and for the modernization and expansion of the power sector in particular. The government committed itself in Copenhagen in 2009 to a voluntary target of reaching 12% renewable energy in the current energy mix and presented this commitment in a Policy Paper in 2010.

3.6. The Project vs No Project Alternative

The ‘No Project’ alternative assumes that the 68.3MW Project will not be developed. Should this be the case, then the Project site area would remain the same. While the No Project Alternative offers the advantage of absence of disturbance to the natural environment at the Project site, the Project remains more attractive as it gives several advantages over the No Project Alternative including:

- Decreased power outage.
- Contribute to increasing energy security through development of local energy resources and reducing dependency on external energy sources.
- Increased use of renewable green energy and less reliance on conventional polluting energy production.
- Demonstrating the commitment by Lebanon in realizing clean energy production and reducing greenhouse gas emissions.
- Positive socio-economic impact due to benefit from land rental and creation of job opportunities.

Should the Project not move forward, then the Project-related negative environmental impacts discussed throughout this ESIA would be averted. However, such impacts can be adequately controlled through the mitigation and management measures presented in **Section 22 Summary of Impacts and Mitigation.**

4. POLICY, LEGAL AND INSTITUTIONAL FRAMEWORK

This section provides an overview of the environmental clearance process for the Project as governed by the Ministry of Environment (MOE). Existing national legislations and policies related to environmental protection, land classification, and environmental control requirements are presented. As the Project is seeking financing from prospective lenders, the section highlights the environmental and social policies and requirements of the IFC and EIB, which must be adhered to by the Developer.

4.1. National Framework and Requirements

4.1.1. Existing Legislation

The ESIA process follows the stipulations of key national laws and regulations which are summarized in **Table 4-1**. The major legal texts are further described in the subsections below.

The ESIA is also based on the requirements and conditions set by the MOE in their response to the Scoping Report (see **Appendix E**). The main national legal framework which is considered in this ESIA are as follows:

- Law 444/2002[1] related to Environment Protection, and its related Application Decree No. 8633/2012 on the Fundamentals for Environmental Impact Assessment.
- Law 462/2002[2] related to the Electricity Sector which sets up the rules and principles governing the Electricity sector, with the aim to bringing in the private sector as a partner in power generation in Lebanon. This law was further updated in 2014 by Law 288.
- Law 48/2017[3] related to Public Private Partnership (PPP) that encourages private sector investments in the public sector.
- Application Decree 2366/2009[4] related to the National Physical Master Plan for the Lebanese Territory (NPMPLT) covering land use and zoning of lands.
- MOE Decision No. 52/1[5] of 29 July 1996 setting air quality standards, including thresholds for air pollutants and safe noise exposure limits.

The legal basis for EIA and its 9 annexes is established in the Environmental Law No. 444/2002 and Law No. 690/2005.[6] Law No. 444 emphasizes the principle of EIA as a tool for planning and management, and stipulates that proponents undertake assessment for all projects likely to affect the environment due to their sizes, nature, impacts or activities for review and approval by the MOE.

This legislation is further implemented by Decree No. 8633/2012: Fundamentals of Environmental Impact Assessment and the MOE's Decision 261/1 of 2015: Review Process for EIA scoping and EIA reports.[7]

[1] Chapter 4, Article 21-23 [Annex 1] of Law 444/2002.
[2] Law 462-2002 product of electricity EN, EDL, Lebanon, 2002.
[3] Article IV, Law 48 dated 7/9/2017 Regulating Public Private Partnerships.
[4] Decree No 2366 of 2009 defining the Comprehensive Plan for Lebanese Territory Arrangement.
[5] MoE Decision 52/1 of 1996: National environmental quality standards.
[6] Law No. 690 of 2005 regulating the Ministry of Environment and defining its tasks and competences.
[7] Decision 261/1, 12/6/2015, MOE, EIA Review Procedures.

Table 4-1 Relevant National Legislation

Legislation	Organization	Date of Issue	Description	Relevance
LAWS				
Law for the Protection of Forests	GoL	1949	Protection of forests.	The proposed Project must protect forests.
Law 20	MOEW	1966	Establishment of Ministry of Energy and Water (MOEW) resources.	Government institution directly responsible of the proposed Project.
Law 69	DGUP	1983	Urban planning law established by the Directorate General of Urban Planning (DGUP).	Governs any proposed development involving construction activities.
Law 85	MOE	1991	Protection of forests and shrublands.	The proposed Project must protect forests and shrublands.
Law 216	MOE	1993	Creation of the MOE and its responsibility to develop a management strategy for solid waste.	Government institution responsible of the Environmental Impact Assessment process.
Law 253	MOE	1993	Ratification of two treaties related to the ozone layer.	Proposed project contributes towards the protection of the ozone layer through reducing the need for thermal energy.
Law 360	MOE	1994	Ratification of the United Nation Convention on Biological Diversity signed at Rio de Janeiro.	Stresses the need for the protection of biodiversity throughout Lebanon including project area.
Law 412	MOE	2002	Authorization for the Government to join the convention on Asian/African Migratory water birds.	Any Asian / African migratory water birds observed in project area need to be protected.
Law 444	MOE	2002	Environment protection indicating the necessity to conduct EIA and IEE for development projects.	Proposed project requires the development of EIA study.
Law 462	MOEW	2002	Organization of Electricity sector.	Electricity generated by the proposed project will be sold to the Government and will be governed by this law.
Law 775	MOEW	2006	Amendment of Law 462 of 2002; No longer relevant.	Electricity generated by the proposed project will be sold to the Government and will be governed by this law.
Energy Conservation Draft Law	LCEC	2010	The 'Energy Conservation Draft Law' for the promotion of energy efficiency and renewable energy in Lebanon. This draft law has not yet been approved by the Lebanese Parliament. The draft law offers a legal framework for energy audits, energy efficiency standards and labels, financial incentives for energy efficient appliances and net-metering and the institutionalization of the LCEC.	The proposed Project contributes towards the promotion of energy efficiency and renewable energy.
Law 288	MOEW	2014	Replaced Law 775 of 2006 and is a temporary measure for "one year" and "two years" respectively during which the COM shall be in charge of granting the production permits and licenses upon the proposal of the MOEW and the MOE, this until the members of the regulatory commission, described under Law No. 462, are appointed and start carrying out with their tasks.	Electricity generated by the proposed project will be sold to the Government and will be governed by this law.
Law 48		2017	The Public Private Partnership (PPP) that encourages private sector investments in the public sector.	A PPP agreement was signed to allow the purchase of the electricity generated by the proposed project by the Government.
Law 78	MOE	2018	The law comprises 34 articles related to ambient air pollution, monitoring air pollutants, assessment of their levels in the Lebanese atmosphere, prevention, control and surveillance of the ambient air pollution from human activities.	The proposed Project must comply with the provisions of this law.
DECREES				
Decree 2866	GOL	1959	Tender regulation that applies to all State tenders over 25000L.L. except for those to the Ministry of Defense, Security Force and Public Security (amended by Decree 8703 of 1962 and Decree 13221 of 1963).	Governs any State tender which may arise from the proposed project.
Decree 13472	DGUP	1963	Law on Urban Planning.	Governs any proposed development involving construction activities.

Legislation	Organization	Date of Issue	Description	Relevance
Decree 16878	GOL	1964	Establishment of the EDL as an autonomous state-owned entity under the authority of the MOEW. This legislative text entrusts the generation, transmission and distribution of electricity across Lebanon to EDL. Article 4 of the Decree provides that no license, concession or permit generation, transmission or distribution of electricity may be granted to another entity.	Electricity generated by the proposed Project will be sold to the Government and will be governed by this decree.
Decree 7580	GOL	1974	Projects financing is mainly governed by EDL Investment System Regulation.	Electricity generated by the proposed Project will be sold to the Government and will be governed by this decree.
Decree 2604	MOE	2009	Control of ozone depleting substances.	The proposed Project contributes towards the protection of the ozone layer through reducing the need for thermal energy.
Decree 2366	Presidency of the COM	2009	The NPMPLT which was issued by the CDR in 2005 and approved as a strategic development plan for the territory of Lebanon to which all public authorities are bound.	Relevant for any development project throughout Lebanon; it is usually referred to when the proposed project falls in a zone which is not classified by a regional / local land zoning decree.
Decree 5305	COM	2010	Outlines mandatory standards for the Compact Fluorescent Lamp and the Solar Water Heating.	Serves the same purpose as the proposed Project, namely the promotion of renewable energy.
Decree 8075	MOE	2012	Draft Law on the Protection of Air Quality/Lebanon's National Strategy for Air Quality Management.	Air quality in the project area needs to be protected.
Decree 8633	MOE	2012	The EIA Decree. EIA decree 8633 provides in its Annex 1 a list of project types requiring an EIA; included in this list are the various projects the establishment of which requires an EIA and in particular "the establishing of power generation projects" (Article 8 of Annex I). The decree also outlines the elements to be examined in an EIA Report, which are consistent with the scope of work presented herein.	The proposed Project requires the development of an EIA study.
Decree 620	MOEW	2017	Convention of the Statute of the International Renewable Energy Agency (IRENA).	The proposed Project contributes towards the promotion of renewable energy.
Decree 3320	MOE	2018	Related to the convention for the protection of migratory species (CMS) signed in Bonn in 1979.	Migratory species need to be protected.
Decree 2251	MOEW	2018	Ratification of the modified Decree 1543 dated 25/11/1978 of the draft establishment of hypertension line 66KV between the Al Bared plant and Halba Plant for the acquired columns basis (Akkar Governorate – Akkar Caza).	Electricity generated by the proposed project will be sold to the Government and may require similar decrees.
DECISIONS				
Decision 52/1	MOE	1996	Decision by the Ministry of Environment for determining the standards and specific levels for limiting air, water and soil pollution.	The proposed Project needs to control its emissions and discharges to ensure decision limits are not breached.
Decision 8/1	MOE	2001	Specifications and Standards Relative to Air Pollutants, and Liquid Discharges from Classified Industries and Wastewater Treatment Plants.	The proposed Project needs to comply with discharge limits.
Decision 176/1	MOE	2010	Mechanism for the review of projects under the Kyoto Protocol's Clean Development Mechanism.	The proposed Project contributes towards the promotion of renewable energy.
Decision 1	COM	2010	Consists of ten integrated and correlated strategic initiatives which are focused on remedying the problems of the energy sector in respect to infrastructure, supply and demand, and the legal framework.	Proposed project contributes towards reducing the need for thermal energy thus helping with Kyoto protocol objectives.
Decision 26	COM	2011	National Energy Efficiency Action Plan for Lebanon 2011-2015 and 2010-2020 (NEEAP) includes 14 independent but interrelated national initiatives of energy efficiency and renewable energy proposals for enhancing the legal and regulatory framework.	The proposed Project contributes towards the promotion of energy efficiency and renewable energy.
CIRCULARS, LETTERS				
Circular 10/1	MOE	2011	Governs an informal structure for electricity subscription (private generators) which is provided by the private sector in the status of electricity supply shortage.	Proposed project contributes towards eliminating this informal structure of electricity production.
Minister Letter 14175	MOE	2017	Stresses the requirement of ESIA study preparation for the three wind farms and describes the required scope for the three studies.	Proposed project is directly governed by this Letter.

Further, all development projects must adhere to the environment quality standards for air, water and soil (MOE Decision 52/1 of 1996) as well as to air emission standards and wastewater discharge (MOE Decision No 8/1 of 2001).[8]

The law and the decree assign full authority to the MOE to arrange the screening, review, control, and follow-up of the EIA process and its implementation. The approval of an EIA is a pre-requisite for any subsequent license or permit by any or all other relevant authorities that may be required prior to construction. The efforts of the MOE aim at improving the Lebanese environmental performance on the international level, alike all developed countries, and the coordination, cooperation and follow up between the MOE and concerned parties, as the private and public sectors or the civil society organizations that may have a real positive impact on achieving a global unified vision related to all what concerns the protection of the environment.

4.1.1.1. Environmental Quality Standards and Criteria for Air and Noise

Air quality standards, including thresholds for air toxics and criteria pollutants are specified in Ministerial Decision No. 52/1 of July 1996. While the operation of wind turbines is expected to generate negligible emissions, construction activity will result in emissions from fuel combustion and material movement. National Ambient Air Quality Standards (NAAQS) are listed in **Table 4-2**.

Table 4-2 National Ambient Air Quality Standards (NAAQS)

Parameter	NAAQS (µg/m^3)
Sulfur Dioxide (SO_2)	350 (1 hr.) 120 (24 hrs.) 80 (annual)
Nitrogen dioxide (NO_2)	200 (1 hr.) 150 (24 hrs.) 100 (annual)
Carbon monoxide (CO)	30,000 (1 hr.) 10,000 (8 hrs.)
Ground-level Ozone (O_3)	150 (1 hr.) 100 (8 hrs.)
Total Suspended Particulate (TSP)	120 (24 hrs.)
PM_{10}	80 (24 hrs.)
$PM_{2.5}$	N/A
Lead	1 (annual)
Benzene	16.2 (annual)

[8] The Minister of Environment's decision No. 8/1-2001, Setting national standards and criteria regarding air pollutants and liquid wastes generated by classified establishments and wastewater treatment plants.

Safe noise exposure limits are specified in Ministerial Decision No. 52/1 of July 1996 and provided in **Table 4-3**.

Table 4-3 Limits for Noise Levels per Decision No. 52/1 of July 1996

Region Type	Limit for Noise Level dB(A)		
	Day Time (7 am - 6 pm)	Evening Time (6 pm – 10 pm)	Night Time (10pm - 7am)
Residential areas having some construction sites or commercial activities or that are located near a road.	50-60	45-55	40-50
Urban residential areas.	45-55	40-50	35-45
Industrial areas.	60-70	55-65	50-60
Rural residential areas.	35 – 45	30 – 40	25 – 35

4.1.1.2. Zoning of Lands in Lebanon

The Project area is located in an area classified as natural zone N2. Development allowances and restrictions per MOE Decree No. 2366 (June 2009) are as outlined in **Table 4-4**.

Table 4-4 Zone N2 Description

Parameter	Description
General exploitation factor	Very low except for ski resorts.
Building heights	Low in residential areas; Very low outside residential areas.
Building setbacks	20 meters from forest borders according to Village Master Plan recommendations.
Urban expansion and its location in respect to the current urbanized area	Preferably near the urbanized village, unsuitable far from it.
Land sorting for construction	Preferably near the urbanized village, unsuitable far from it.
Large scale projects	Possible for ski resorts after the submission of EIA and landscape study.
Quarrying	Not possible.
Industries and industrial buildings	Possible for mineral water facilities, for vital cooperative facilities such as petrol stations after the submission of EIA and landscape study.

4.1.2. International Conventions, Treaties and Protocols

International conventions, treaties and protocols which are triggered by the current project are provided in **Table 4-5**.

Table 4-5 Treaties and Conventions Ratified by Lebanon

Convention Title	Year	Signature/ Adhesion/ Ratification/ Accession	Description	Relevance
ENVIRONMENT				
Convention on Migratory Species of Wild Animals (CMS); Bonn Convention"	1979	Signed in 1979: Entered to force in 1983.	Aims at conserving terrestrial, marine and avian migratory species throughout their range.	Biodiversity impacts of proposed project should be properly managed.
Convention on Biological Diversity; Rio De Janeiro.	1992	Ratification: Law No. 360 dated 11/08/1994.	This convention aims to ensure conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of benefits arising from genetic resources.	Biodiversity impacts of proposed project should be properly managed.
Convention on Wetlands of International Importance especially as Waterfowl Habitat – Ramsar.	1999	Adhesion: Law No. 23 dated 01/03/1999.	The Ramsar convention is an international treaty for the conservation and sustainable use on wetlands. Every three years, representatives of the contracting parties meet to administer the work of the convention and improve the way in which the Parties are able to implement its objectives.	Biodiversity impacts of proposed project should be properly managed.
Cartagena Protocol on Biosafety to the CBD.	2000	Ratification: Law No. 31 dated 16/10/2008.	This international treaty concluded and adopted in the framework of the Convention of Biological Diversity (CBD). The CBD has much broader aims regarding the conservation and sustainable use of biological diversity and the sharing of benefits arising from the use of genetic resources.	Biodiversity impacts of proposed project should be properly managed.
Agreement on the Conservation of African-Eurasian Migratory Water Birds (AEWA).	2002	Adhesion: Law No. 412 dated 13/06/2002.	The Agreement on the Conservation of African-Eurasian Migratory Water-birds (AEWA) is an intergovernmental treaty dedicated to the conservation of migratory water-birds and their habitats across Africa, Europe, the Middle East, Central Asia, Greenland and the Canadian Archipelago. Developed under the framework of the Convention on Migratory Species (CMS) and administered by the United Nations Environment Program (UNEP), AEWA brings together countries and the wider international conservation community to establish coordinated conservation and management of migratory water-birds throughout their entire migratory range.	Biodiversity impacts of proposed project should be properly managed.
CULTURAL AND NATURAL HERITAGE				
UNESCO Convention on the protection of Cultural and Natural Heritage.	1972	Adhesion: Law No. 19 dated 30/10/1990.	This convention links together in a single document the concepts of nature conservation and the preservation of cultural properties. It recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two.	Any cultural heritage potentially present in project area would need to be protected.
AIR and CLIMATE CHANGE				
Vienna Convention for the Protection of the ozone layer.	1985	Adhesion: Law No. 253 dated 30/03/1993.	The Vienna Convention, concluded in 1985, is a framework agreement in which States agree to cooperate in relevant research and scientific assessments of the ozone problem, to exchange information, and to adopt "appropriate measures" to prevent activities that harm the ozone layer. The obligations are general and contain no specific limits on chemicals that deplete the ozone layer.	Proposed project contributes towards reducing the need for thermal energy thus helping with the protection of the ozone layer.
Montreal Protocol on Substances that deplete the ozone layer.	1987	Adhesion: Law No. 253 dated 31/03/1993.	The Montreal Protocol on Substances that Deplete the Ozone Layer was designed to reduce the production and consumption of ozone	Proposed project contributes towards reducing the need for thermal

Convention Title	Year	Signature/ Adhesion/ Ratification/ Accession	Description	Relevance
			depleting substances in order to reduce their abundance in the atmosphere, and thereby protect the earth's fragile ozone Layer. The original Montreal Protocol was agreed on 16 September 1987 and entered into force on 1 January 1989. The Parties to the Montreal Protocol have amended the Protocol to enable, among other things, the control of new chemicals and the creation of a financial mechanism to enable developing countries to comply. Amendments must be ratified by countries before their requirements are applicable to those countries.	energy thus helping with the protection of the ozone layer.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; London.	1990	Adhesion: Law No. 253 dated 31/03/1993.	This was to reinforce the measures laid down in the 1987 Montreal Protocol by extending its scope to new substances and establishing financial mechanisms. The Montreal Protocol aims to protect the ozone layer through enhanced international cooperation by taking precautionary measures to control equitably total global emissions of substances that deplete it.	Proposed project contributes towards reducing the need for thermal energy thus helping with the protection of the ozone layer.
Amendment to the Montreal Protocol on Substances that deplete the ozone layer; Copenhagen.	1992	Adhesion: Law No. 120 dated 03/11/1999.	Indicates that for the adequate protection of the ozone layer a higher degree of control of chlorofluorocarbons, halons, carbon tetrachloride and 1,1,1-trichloroethane (TCA) is required than that provided by the Montreal Protocol as amended in 1990 (London Amendment). Additional controls should also be placed on methyl bromide, hydrobromofluorocarbons (HBFCs) and hydrochlorofluorocarbons (HCFCs). The first Amendment to the Protocol was adopted on 29 June 1990 and subsequently approved on behalf of the Community.	Proposed project contributes towards reducing the need for thermal energy thus helping with the protection of the ozone layer.
United Nations Framework Convention on Climate Change aiming to fight global warming.	1992	Ratification: Law No. 359 dated 11/08/1994.	The UNFCCC entered into force on 21 March 1994. It is a "Rio Convention", one of three adopted at the "Rio Earth Summit" in 1992. Its sister Rio Conventions are the UN Convention on Biological Diversity and the Convention to Combat Desertification. The three are intrinsically linked. It is in this context that the Joint Liaison Group was set up to boost cooperation among the three Conventions, with the ultimate aim of developing synergies in their activities on issues of mutual concern. It now also incorporates the Ramsar Convention on Wetlands. Preventing "dangerous" human interference with the climate system is the ultimate aim of the UNFCCC. The Convention: - Recognized that there was a problem. - Sets a lofty but specific goal. - Puts the onus on developed countries to lead the way. - Directs new funds to climate change activities in developing countries. - Keeps tabs on the problem and what's being done about it. - Charts the beginnings of a path to strike a delicate balance. - Kicks off formal consideration of adaptation to climate change.	Proposed project contributes towards reducing the need for thermal energy thus helping with the fight against global warming.
United Nations Convention to Combat Desertification; Paris.	1994	Ratification: Law No. 469 dated 21/12/1994.	This convention aims to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies by international cooperation and partnership arrangements. It is based on the principles of participation,	Proposed project involves limited land clearing activities which may contribute to desertification if improperly managed.

Convention Title	Year	Signature/ Adhesion/ Ratification/ Accession	Description	Relevance
			partnership and decentralization- the backbone of Good Governance and Sustainable Development.	
Beijing Amendment of the Montreal Protocol.	1999	Adhesion: Law No. 758 dated 11/11/2006.	Under the amendment, countries have agreed to monitor the consumption and production of bromochloromethane which is an industrial solvent and a fire extinguisher under the name Halon-1011.	Proposed project contributes towards reducing the need for thermal energy thus helping with the protection of the ozone layer.
Kyoto Protocol.	2005	Ratification: Law No. 738 dated 15/05/2006.	The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change, which commits its Parties by setting internationally binding emission reduction targets. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. The detailed rules for the implementation of the Protocol were adopted at COP 7 in Marrakesh, Morocco, in 2001, and are referred to as the "Marrakesh Accords." Its first commitment period started in 2008 and ended in 2012.	Proposed project contributes towards reducing the need for thermal energy thus helping with the fight against global warming.
Euro-Mediterranean Energy Partnership HY-PA	2005	Partnership signed in 2009.	The main objective of the HY-PA is to promote and stimulate the application of Renewable Energy and Hybrid Systems in Mediterranean Partner Countries (MPC) for the provision of sustainable energy services based on locally available resources and to support policy making activities in the field of Renewable Energies. The HY-PA comprises three competent actors from Europe: Germany, Greece and France, as well as four Mediterranean Partner Countries Jordan, Lebanon, Morocco and Tunisia.	Proposed project involves the promotion of the use of wind energy.
International Renewable Agency (IRENA)	2009	Ratification: Decree No. 620 dated 4/5/2017.	Promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.	Proposed project involve the promotion of renewable energy.

4.2. International Guidelines

LWP is seeking Project Financing from Bank Audi, and as such, the following international guidelines apply (together with the Lebanese legislative requirements, referred to as 'the Applicable Standards'):

- International Finance Corporation (IFC) Performance Standards (PSs).
- Environmental and Social Standards (ESSs) of the European Investment Bank (EIB)
- International best practice, policies and guidelines including:
  - IFC's Environmental, Health, and Safety General (EHS) Guidelines (2007).
  - IFC's EHS Guidelines for Wind Energy (2015).
  - IFC's EHS Guidelines for Toll Roads (2007).

4.2.1. IFC Performance Standards

The IFC is a sister organization of the World Bank and member of the World Bank Group (WBG). It is the largest global development institution focused exclusively on the private sector in developing countries. The WBG has set two goals for the world to achieve by 2030: end extreme poverty and promote shared prosperity in every country.

The IFC aims at leveraging products and services to create markets that address the biggest development challenges. It applies financial resources, technical expertise, global experience, and innovative thinking to help clients and partners overcome financial, operational, and other challenges. IFC is also a leading mobilizer of third-party resources for projects.

IFC' Performance Standards (PSs) on Social and Environmental Sustainability, previously published in April 2006 and updated in January 2012, including IFC's General Environmental, Health, and Safety (EHS) Guidelines (2007), IFC's EHS Guidelines for Wind Energy (2015) and IFC's EHS Guidelines for Toll Roads (2007), will be applied. The relevant Performance Standards, and where they are addressed in the ESIA, are shown in **Table 4-6**.

The IFC and regional development banks have well established ESIA procedures which apply to their lending activities and projects undertaken by borrowing countries. Although their operational policies and requirements vary in certain aspects, they follow standardized procedures for the preparation and approval of ESIA reports.

The IFC's PSs are considered the most comprehensive standards available to international finance institutions working with the private sector. The PSs define a project's role and responsibilities for managing health, safety, environmental, and community issues to receive and retain IFC and/or Equator Principle Financial Institution (EPFI) lender support.

Table 4-6 Relevant IFC Performance Standards

Performance Standard	Comment	ESIA Section
PS 1: Assessment and Management of Environmental and Socials Risks and Impacts	Performance Standard 1 applies to all projects that have environmental and social risks and impacts and underscores the importance of managing environmental and social performance throughout the life of a project. The objectives are: • To identify and evaluate environmental and social risks and impacts of the project. • To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment. • To promote improved environmental and social performance of clients through the effective use of management systems. • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.	Section 6 – Stakeholder Consultation and Engagement Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
PS 2: Labor and Working Conditions	Performance Standard 2 recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic rights of workers. The objectives are: • To establish, maintain and improve the worker-management relationship. • To promote the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labor and employment laws. • To protect the workforce by addressing child labor and forced labor. • To promote safe and healthy working conditions, and to protect and promote the health of workers.	Section 2 – Project Description Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
PS 3: Resource Efficiency and Pollution	Performance Standard 3 recognizes that increased industrial activity and urbanization often generate increased levels of pollution to air, water, and land that may threaten people and the environment at the local, regional, and global level. The objectives are: • To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote the reduction of emissions that contribute to climate change.	Section 3 – Alternatives Analysis Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
PS 4: Community Health, Safety, and Security	Performance Standard 4 recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. The objectives are: • To avoid or minimize risks to and impacts on the health and safety of the local community during the project life cycle from both routine and non-routine circumstances. • To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security.	Section 22 – Summary of Impacts and Mitigation
PS 5: Land Acquisition and Involuntary Resettlement	Performance Standard 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on people who own or use that land. The objectives are: • To avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project designs. • To mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that	Section 6 – Stakeholder Consultation and Engagement Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation

Performance Standard	Comment	ESIA Section
	resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • To improve or at least restore the livelihoods and standards of living of displaced persons. • To improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.	
PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The objectives are: • To protect and conserve biodiversity. • To maintain the benefits from ecosystem services. • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.	Section 3 – Alternatives Analysis Section 6 – Stakeholder Engagement and Consultation Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
PS 7: Indigenous Peoples	Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. The objectives are: • To ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples. • To avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not feasible, to minimize, mitigate, or compensate for such impacts, and to provide opportunities for development benefits, in a culturally appropriate manner. • To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when they will be impacted by a project. • To establish and maintain an ongoing relationship with the Indigenous Peoples affected by a project throughout the life of the project. To foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples. To respect and preserve the culture, knowledge and practices of Indigenous Peoples. Performance Standard 7 does not apply because there are no Indigenous Peoples in Lebanon. However, vulnerable segments of the population, including Syrian and Palestinian refugees, have been considered in the avoidance and minimization of and compensation for impacts.	Section 3 – Alternatives Analysis Section 6 – Stakeholder Engagement and Consultation Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
PS 8: Cultural Heritage	Performance Standard 8 recognizes the importance of cultural heritage for current and future generations. The objectives are: • To protect cultural heritage from the adverse impacts of project activities and support its preservation. • To promote the equitable sharing of benefits from the use of cultural heritage in business activities. Performance Standard 8 does not apply because a review of secondary information does not support the presence of cultural heritage assets or resources in the Direct AOI of the Project. A Chance Find Procedure has been developed and incorporated in the ESMP for the Project.	Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation

4.2.2. IFC EHS Guidelines

IFC's EHS Guidelines will also be considered for the Project. The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities at reasonable costs by existing technology. The applicability of the EHS Guidelines may need to be established for each project based on the results of an environmental, health, safety and social assessment where site-specific variables, such as host country context, assimilative capacity of the environment, and consideration of other project factors. The applicability of specific technical recommendations should be based on the professional opinion of qualified and experienced persons.

The EHS Guidelines are technical reference documents and provide relevant industry background and technical information. This information supports actions aimed at avoiding, minimizing, and controlling environmental, health, and safety impacts during the construction, operation, and decommissioning phases of a project or facility. The General EHS Guidelines are organized to capture common themes which are applicable to any industry sector and project. The General EHS Guidelines and the Industry Sector EHS Guidelines are designed to be used jointly and include:

- Environmental Health and Safety Guidelines for Wind Energy (2015).
- Environmental Health and Safety Guidelines for Toll Roads (2007).
- Environmental Health and Safety Guidelines for Electric Power Transmission and Distribution (2007).

It is important to note in this context the IFC General EHS Guidelines for noise exposure which are summarized in **Tables 4-7** and **4-8**.

Table 4-7 Noise Level Guidelines per IFC General EHS Guidelines

Receptor	One Hour L_{Aeq}	
	Daytime (07:00-22:00)	Nighttime (22:00-07:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Table 4-8 Noise Limits for Various Working Environments per IFC EHS Guidelines

Location / Activity	Equivalent Level L_{Aeq}, 8h	Maximum L_{Amax}, Fast
Heavy industry (no demand for oral communication)	85 dBA	110 dBA
Light industry (decreasing demand for oral communication)	50-65 dBA	110 dBA
Open offices, control rooms, service counters or similar	45-50 dBA	-
Individual offices (no disturbing noise)	40-45 dBA	-
Classrooms, lecture halls	35-40 dBA	-
Hospitals	30-35 dBA	40 dBA

In addition, the WBG/IFC sector Guidelines for Wind Energy recommend that the predicted duration of shadow flicker effects experienced at a sensitive receptor not exceed 30 hours per year and 30 minutes per day on the worst affected day, based on a worst-case scenario.

4.2.3. EIB Environmental and Social Standards

As the long-term financing body of the European Union (EU), the EIB promotes EU policies through its financial and other support to sustainable investment projects. The increasing prominence given to environmental and social considerations within the EU and throughout the other regions of operation of the Bank is reflected in its priority lending objectives as well as in the regular review and revision of its environmental and social requirements and operational practices. The relevant ESSs, and where they are addressed in the ESIA, are shown in **Table 4-9**.

4.3. Institutional Framework

The main stakeholder in the energy sector is the Ministry of Energy and Water (MOEW). Other stakeholders of importance to the project include the Ministry of Environment (MOE), the Ministry of Public Works and Transport (MOPWT), the Ministry of Interior and Municipalities (MOIM), as well as several local and international agencies and programs.

4.3.1. Ministry of Environment

The MOE is the lead government agency responsible for environmental permitting based on the submission of the EIA report by the Developer. The MOE was established by Law 216/1993, amended by Law 690/2005, and then restructured by Decree 2275/2009. This decree defined the functions and responsibilities of each administrative unit including staff size and qualifications. According to Article 20 of Decree 2275/2009, the Service of Natural Resources at MOE is responsible for the protection of natural resources in the country including fauna and flora species, habitats, mountains, etc.

According to Article 25 of Decree 2275/2009, the Service of Environmental Technology - Department of Integrated Environmental Systems at MOE is responsible for adopting clean and renewable energy sources as well as reducing the use of polluting energy sources in the country. Moreover, the MOE is also responsible for meeting Lebanon's reporting obligations under the United Nations Framework Convention on Climate Change, particularly the Third National Communication on Climate Change (which includes emission data for the energy sector).

The Third National Communication, inventorying emissions for base-year 2005 and time-series covering the period from 1994 to 2010 was published and presented to the Government and national stakeholders in 2014. The third national communication gives an updated analysis of potential Greenhouse Gas (GHG) mitigation measures as well as an updated assessment of potential impacts of climate change in Lebanon and adaptation measures.

Table 4-9 Relevant EIB Environmental and Social Standards

Performance Standard	Comment	ESIA Section
ESS 1: Assessment and Management of Environmental and Socials Risks and Impacts	ESS 1 underscores the importance of managing environmental and social impacts and risks throughout the life of an EIB project through the application of the precautionary principle. The objectives are: • The development of an effective environmental and social management and reporting system that is objective and encourages continual improvements and developments. • Requirements for stakeholder engagement and disclosure throughout the life of the project.	Section 3 – Stakeholder Consultation and Engagement Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 2: Pollution Prevention and Abatement	ESS 2 recognizes the importance of avoiding and minimizing pollution from EIB-supported operations. The objective is: • A Project-level approach to resource efficiency and pollution prevention and control in line with best available techniques and internationally disseminated practices.	Section 6 – Analysis of Impacts Section 8-20 – Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 3: Biodiversity and Ecosystems	ESS 3 recognizes the intrinsic value of biodiversity and that its operations may have a potential impact on biodiversity and ecosystems. The objectives are: • The promoter has to take an approach and measures to protect and conserve all levels of biodiversity. • The standard applies to all habitats (marine and terrestrial) whether or not previously disturbed or legally protected. • Focus on major threats and supports the sustainable use of renewable natural resources and the equitable sharing of benefits from the project's use of natural resources.	Section 3 – Stakeholder Consultation and Engagement Section 6 – Analysis of Impacts Section 8-20 - Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 4: Climate-Related Standards	ESS 4 is aligned with EU climate policies, which should be taken into account at all stages of the project cycle, in particular regarding the assessment of the economic cost of greenhouse gas emissions and the climate vulnerability context. The objective is: • The promoter specifically must ensure that all projects comply with appropriate national and, where applicable, EU legal requirements, including multilateral agreements, related to climate change policy.	Section 6 – Analysis of Impacts Section 8-20 – Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 5: Cultural Heritage	ESS 5 recognizes the central role of cultural heritage within individual and collective identity, in supporting sustainable development and in promoting cultural diversity. The objectives are: • Identification, management and protection of tangible and intangible cultural heritage that may be affected by project activities consistent with the applicable international conventions and declarations. • Emphasize the need for the implementation of a "chance-find procedure", which outlines the actions to be taken if previously unknown cultural heritage is encountered.	Section 5 – Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 6: Involuntary Resettlement	ESS 6 recognizes that projects sometimes necessitate land acquisition, expropriation and/or restrictions on land use, resulting in the temporary or permanent resettlement of people from their original places of residence or their economic activities or subsistence practices. The objectives are:	Section 3 – Stakeholder Consultation and Mitigation Section 6 – Analysis of Impacts Section 8-20 - Baseline Environment and Impact Assessment

Performance Standard	Comment	ESIA Section
	• Respect and protection of the rights to property and to adequate housing, and of the standard of living of all affected people and communities. • Mitigation of any adverse impacts arising from their loss of assets or restrictions on land use. • Assisting all affected persons to improve or at least restore their former livelihoods and living standards and adequately compensate for incurred losses.	
ESS 7: Rights and Interests of Vulnerable Groups	ESS 8 seeks to protect all vulnerable project-affected individuals and groups, whilst seeking that these populations duly benefit from EIB operations. The objectives are: • Full respect for the dignity, human rights, aspiration, cultures and customary livelihoods of vulnerable groups including indigenous peoples. • The free, prior and informed consent of affected Indigenous groups.	Section 6 – Analysis of Impacts Section 8-20 – Baseline Environment and Impact Assessment Section 22 – Summary of Impacts and Mitigation
ESS 8: Labor Standards	ESS 8 recognizes the importance of good labor practices and the use of appropriate codes of conduct to ensure the fair treatment, non-discrimination and equality of opportunity of workers. The objectives are: • Ensuring that promoters of EIB projects comply with the core labor standards of the International Labour Organisation and with national labor and employment laws. • The establishment, maintenance and improvement of worker-management relationships.	Section 22 – Summary of Impacts and Mitigation
ESS 9: Occupational and Public Health, Safety and Security	ESS 9 recognizes the importance of protecting and securing public and occupational health, safety and security and promote the dignity of the affected community in relation to project-related activities. The objectives are: • Particular attention to vulnerable groups. • Promoters to adhere to the international norms and relevant human rights principles when using security services.	Section 22 – Summary of Impacts and Mitigation
ESS 10: Stakeholder Engagement	ESS 10 promotes the right to access to information, as well as public consultation and participation. The objectives are: • Promoters to uphold an open, transparent and accountable dialogue with all project affected communities and relevant stakeholders in an effective and appropriate manner. • The value of public participation in the decision-making process is stressed throughout the preparation, implementation and monitoring phases of a project. • The right to access to remedy, including through grievance resolution, is actively required.	Section 3 – Stakeholder Consultation and Mitigation

4.3.2. Ministry of Energy & Water

The MOEW is the lead government agency responsible for producing energy and for licensing renewable energy projects and programs, including SA. The MOEW was first established by Law 20/66 (dated 29/03/1966) amended several times and lastly (13 years ago) by Law 247 (dated 07/08/2000). Decree 5469 (dated 07/09/1966), that defined the functions and responsibilities of every Directorate (2 Directorates) at the Ministry and each administrative unit including staff size and qualifications was not amended and remains valid since 1966.

Under the Directorate of Water and Electrical Resources (1st Directorate at MOEW), the Directorate of Electrical Resources studies and implements Electricity Projects in the Country. Supervising all activities related to water and electricity at the MOEW are performed by the Directorate of Investment (2nd Directorate at MOEW).

The MOEW is the most active public body attempting to promote Energy Efficiency and Renewable Energy programs in Lebanon. To date, the most noteworthy achievement is the sponsoring of the Lebanese Center for Energy Conservation Program further discussed below as well as the development of the Policy Paper for the Electricity Sector.

4.3.3. Electricité du Liban

EDL was established in 1964 (Decree 16878 dated 10/07/1964). With the exception of four private concessions (Zahle, Jbeil, Alay and Bhamdoun representing about 82,000 subscribers) and private/semi-private hydroelectric power plants (Nahr Ibrahim and Kadisha) as well as a public hydropower plant owned by the Litani River Authority, EDL has quasi total monopoly over electricity production, transmission and distribution in the country; it controls around 90% of the Lebanese electricity sector.

4.3.4. Ministry of Interior and Municipalities

The Ministry of Interior and Municipalities (MOIM) has jurisdiction over Lebanon's estimated 994 municipalities organized according to Decree-Law 118 (dated 30/06/1977). The Akkar Caza counts 175 municipalities of which 6 are immediately affected by the proposed wind farm. Municipal councils are elected by their constituency and consist of 9, 12, 15, 18, 20 or 24 (Beirut and Tripoli only) members depending on the size of the constituency.

Municipalities are local administrations charged with the day-to-day management of all public works located inside their jurisdiction (municipal boundaries). Specific responsibilities are wide and diverse including landscaping and beautification works, water and wastewater networks, street lighting, waste disposal, internal roads, recreational facilities, as well as urban planning in coordination with the Directorate General of Urban Planning (Article 49).

Municipal Councils have also to approve all projects related to re-designing major roads in their municipal boundaries as well as any activity regulating the traffic in the municipal area (Article 51 of Decree-Law 118-1977 and Article 389 of Law 243-2012).

4.3.5. Ministry of Public Works and Transport

In 2000, the Ministry of Transport was cancelled, and the two Directorates were affiliated to the Ministry of Public Works by Law 247 (dated 07/08/2000). The Ministry of Public Works became, then, the Ministry of Public Works and Transport (MOPWT) which studies (technically and financially), evaluates and monitors the implementation and maintenance of public construction projects (buildings, road networks, etc.) and regulates land, sea and air transport.

The MOPWT comprises three directorates including the General Directorate of Urban Planning, which is responsible for permitting all construction projects including SA. The Ministry of Public Works was first established in 1959 by Decree 2872 (dated 16/12/1959) and included four Directorates; two of them were later affiliated to the Ministry of Energy and Water (Law 20/66 – 1966). The Ministry of Transport was first established by Law 214 in 1993 and included two Directorates: 1) the Directorate General of Civil Aviation; and 2) the Directorate General of Land and Maritime Transport.

4.3.6. Directorate General of Urban Planning

The Directorate General of Urban Planning (DGUP) falls under the authority of the MOPWT. Its mandate is to develop urban regulations and coordinate urban planning activities. Lebanon is divided into governorate (mohafazah), district (caza) and municipalities. The DGUP also plays a key role in the construction permitting process through the regional Departments of Urban Planning in each caza.

4.3.7. The Lebanese Center for Energy Conservation

Established in 2002, the Global Environment Facility funded the Lebanese Center for Energy Conservation Program (LCECP) which is currently hosted at the Ministry of Energy and Water and managed by UNDP. Registered under the name of the Lebanese Center for Energy Conservation (Attestation No. 172 dated 27/1/2011), the organization addresses end-use energy conservation and renewable energy at the national level by supporting the Government of Lebanon in developing and implementing national strategies that promote energy efficiency and renewable energy at the consumer level.

The LCEC has implemented Renewable Energy (RE) and energy efficiency (EE) projects in Lebanon including the installation of domestic solar water heaters (DSWH) in south Lebanon, management of the DSWH project "One DSWH for every house" aiming at installing no less than 1 million m² of collectors by 2020, management of the 3 million compact fluorescent lamp (CFL) lamps project, etc. LCEC is financially and administratively independent and operates under the direct supervision of the Minister of Energy and Water.

4.3.8. Community Energy Efficiency and Renewable Energy Demonstration Project

The Community Energy Efficiency and Renewable Energy Demonstration Project (CEDRO) is a partnership created in 2007 between the MOEW/Ministry of Finance (MOF)/Ministry of Economy & Trade (MOET)/Lebanon Recovery Fund (LRF)/Council for Development and Reconstruction (CDR)/United Nations Development Program (UNDP), with a five-year mandate and a budget of $9.73

million funded by the LRF by means of a donation from Spain. Its aim is to promote energy efficiency and renewable energy in Lebanon through awareness, capacity building, market incentives for EE and RE installations, as well as country-wide research and development activities.

CEDRO also initiated and financed several national milestone research documents related to RE including (1) the national bio-energy strategy that shed the light on available bioenergy resources in the country, and (2) the national Wind Atlas that establishes an understanding of the dominant wind regimes (onshore & offshore) in the country, essential to determine best areas to build wind farms in the country. CEDRO's January 2019 publication, Renewable Energy Sector in Lebanon, National Studies, concluded that:

- Wind energy can potentially employ up to 2,753 people under the optimistic scenario in 2021, roughly half of them in direct jobs.
- The largest number of jobs will be in the service sector and during the construction phase.
- The transport of wind energy equipment will also create employment wherever infrastructure is needed, be it at the port or along the roads. Roads have to be widened and the area around the roads has to be cleared.

4.4. International Organizations

4.4.1. The International Renewable Energy Agency

The IRENA was first established in January 2009. IRENA acts in accordance with the purposes and principles of the United Nations to promote peace and international cooperation, in conformity with UN policies and sustainable development. IRENA promotes the widespread and increased adoption and sustainable use of all forms of renewable energy and provides advice and support to governments worldwide on RE policy, capacity building, financing and technology transfer. The GOL is an applicant for IRENA membership.

4.4.2. The Global Wind Energy Council

The Global Wind Energy Council (GWEC) was established in 2005 to provide a credible and representative forum for the entire wind energy sector at an international level. It is a member-based organization that represents the entire wind energy sector including manufacturers, developers, component suppliers, research institutes, national wind and renewables associations, electricity providers, finance and insurance companies.

GWEC's mission is to (1) communicate the benefits of wind power to national governments, policy makers and international institutions, (2) provide authoritative research and analysis on the wind power industry around the world, (3) work with governments to give them transparent information about the benefits and potential of wind power, enabling them to make informed decisions about national energy policies and (4) support collaboration between policy makers in different countries to help them share best practices and experiences in adding clean power to their energy mix. The GWEC has no Lebanese members yet.

4.4.3. BirdLife International

Founded first in 1922 as the *International Council for Bird Preservation,* BirdLife International, named as such in 1993, is a global Partnership of conservation organizations that strives to protect birds by conserving their habitats and biodiversity worldwide, working with people towards sustainability in the use of natural resources. It is the World's largest partnership of conservation organizations, with over 100 partner organizations including the Society for the Protection of Nature in Lebanon (SPNL – founded in 1983).

4.4.4. UNDP/CEDRO EIA for Wind Farm Developments Guideline Report

In addition to best international practices applicable to ESIA studies for wind farms, the UNDP/CEDRO Environmental Impact Assessment for Wind Farm Developments Guideline Report (2011) was considered in the current ESIA study, including guidance for monitoring and mitigation of impacts to resources, particularly avifauna and bats.

4.5. Policy Setting

4.5.1. The Policy Paper for the Electricity Sector

In 2010, the Ministry of Energy and Water developed the Policy Paper for the Electricity Sector which seeks to redress the country's ailing electricity sector by 2015. It was unanimously approved by the COM in June 2010 (COM decision No.1 dated 21/06/2010). The Policy Paper is articulated along three strategic areas and formulates actions over three-time horizons (short 2010-2012, medium 2012-2014, and long term 2015 and beyond):

1. Infrastructure: electricity generation, transmission and distribution.
2. Supply and demand: choice of fuel and outsourcing, RE, EE, and tariffs.
3. Legislation: norms and standards, corporatization of EDL, and legal status.

On the generation side, the goal is to achieve 4,000MW of generating capacity by 2014 through new thermal power plants (2,200MW), rehabilitation of Zouk and Jieh (100MW) and upgrade of Beddawi, Zahrani, Baalbeck & Tyr (145MW). The Policy Paper also aims to increase hydropower by 40MW, harvest 60-100MW of wind power and 15-25MW through waste-to-energy plants. Consequently, at least 2,600MW of added capacity will be implemented in partnership with the private sector (Independent Power Producers).

The Lebanese COM agreed in March 2012 to lease power-generating ships to produce 270MW for a period of three years, and to build 1,500MW power plants. Effectively, in February 2013 the first Turkish power barge "Fatimaghoul Sultan" entered and moored in Lebanese shores; it will generate electricity to fill the gap caused when the Zouk Power Plant goes offline for rehabilitation for a period of three years.

4.5.2. The National Energy Efficiency Action Plan

The National Energy Efficiency Action Plan (NEEAP) developed by the Lebanese Center for Energy Conservation was adopted by the COM in November 2011.[9] The Action Plan included 14 initiatives related to energy efficiency and RE with proposed milestones and targets. The spectrum of available technologies envisaged is quite wide including wind turbines, photo-voltaics, domestic solar water heaters and waste to energy and geothermal heat pumps.

Already many initiatives are being implemented to favor the penetration of these technologies in the Lebanese market. Of importance to our project is initiative 6 of the NEEAP related to electricity generation from wind power [2]: "*introduce wind power via the private sector by building wind farms (60-100MW)*" which has prompted the CEDRO project to prepare the Wind Atlas for Lebanon mentioned earlier. Consequently, several firms (e.g. the Developer, Sustainable Akkar, Hawa Akkar) have stepped forward and showed great interest in investing in Wind Energy. RE in Lebanon will be a tremendous advantage as it will contribute to solving two of the thorniest issues facing the energy sector in the country namely energy security and energy acceptability.

The Second National Energy Efficiency Action Plan for the Republic of Lebanon (NEEAP 2016-2020) was published in March 2016 and builds on the first NEEAP 2011-2015.[10] NEEAP 2016–2020 is divided into two main sections: the power sector measures and the end-use measures. The power sector measures tackle energy efficiency in electricity generation, transmission, and distribution. The end-use section includes five chapters: 1) horizontal end-use measures; 2) end-use measures in the building sector; 3) end-use measures in industry and agriculture; 4) measures in mobility and transport; and 5) end-use measures in the public sector.

Moreover, NEEAP 2016–2020 includes different types of measures regarding policies, regulations, action plans, and implementation. The sum of the overall estimated savings of the proposed measures over the five years of the second NEEAP's implementation are 686.1GWH for the power sector and 828.1GWH for end-use energy which implies a total saving of 1,514.2GWH over the five years and leading to average yearly savings of 302.9GWH. By implementing the second NEEAP's 26 initiatives, the actual electric power growth rate of 7% could be reduced to 5.81% in 2020.

4.5.3. National Renewable Energy Action Plan

The MOEW/LCEC prepared Lebanon's National Renewable Energy Action Plan (NREAP 2016 – 2020).[11] The NREAP is the main national document that will lead the way for Lebanon to develop the different renewable energy technologies needed to reach the 12% target by the year 2020. By adopting this document, the MOEW is creating the path that all national efforts and international support need to follow to develop renewable energy in Lebanon. Being the main authority to develop the energy sector, MOEW, through the work of LCEC, is striving to align all efforts towards sustainable energy.

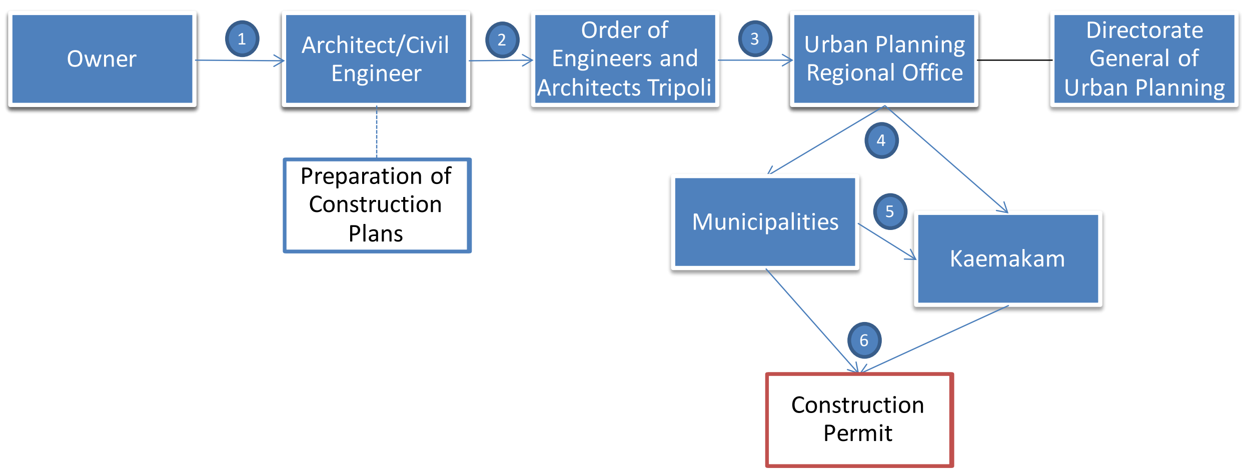
[9] Lebanese Center for Energy Conservation, The Second National Energy Efficiency Action Plan for the Republic of Lebanon, NEEAP 2011-2015.
[10] Lebanese Center for Energy Conservation, The Second National Energy Efficiency Action Plan for the Republic of Lebanon, NEEAP 2016-2020.
[11] Lebanese Center for Energy Conservation, The National Renewable Energy Action Plan for the Republic of Lebanon, NREAP 2016-2020.

4.6. Licenses and Permits

The permitting process of the Project is required at the level of several national institutions which mainly include the following:

- Municipalities or the Kaemakam (i.e. the title used for the governor of a provincial district) of the district clears the construction and operation permits as presented in **Figure 4-1**; municipalities, federation of municipalities, Governors, and Kaemakam fall under the MOIM.
- DGUP approval of the Project is required given that the surface area allocated to the Project exceeds 10 km^2 in light of allocation of Aandqet municipality of an area of 6km^2 to the Project due to lack of a land survey, thus increasing the total area of the Project.
- MOE's approval of the ESIA is required, MOE has also a role in inspecting the different phases of the Project.
- Ministry of Public Works and Transport issues permits for obstruction of aviation airspace as well as radar interference clearances.

Figure 4-1 Construction Permit Process



It should be noted that the Developer has already obtained the following permits:

- PPA between MOEW and the Developer signed in February 2018 allowing the government to purchase power from the private sector and Lebanon Wind Power will be able to seek a connection to the grid from EDL.
- Rental contract agreements with land owners have been established by the Developer (as provided in **Appendix D**).

Table 4-10 summarizes the implications of each ministry for the project phases.

Table 4-10 GOL Roles and Responsibilities in Relation to the Project

Ministry	Project Phase	Implications for the Project
Environment	Planning	• Review and approve EIA Report.
	Construction	• Inspect the construction of the Project to verify compliance with Project Proponent Environmental and Social Management Plan (ESMP) and mitigation measures by the OEM/EPC Contractor (wind turbine supplier) as per the ESIA Report.
	Operation	• Inspect the operation of the Project to verify compliance with Project Proponent Environmental and Social Management Plan (ESMP) by the OEM/EPC Contractor (wind turbine supplier) as per the ESIA Report.
	Decommissioning	• Inspect the decommissioning of the Project to verify compliance with Project Proponent Environmental and Social Management Plan (ESMP) by the OEM/EPC Contractor (wind turbine supplier) as per the ESIA Report.
Energy and Water	Planning	• Review and approve Developer's Proposal (along with the ESIA Report). • Issue a permit for Lebanon Wind Power to produce/distribute electricity though a Private Purchase Agreement (PPA).
Interior and Municipalities	Construction	• Traffic Management Agency (TMA) issues a permit for transporting materials (with specifications not included in Law 243/2012). • Municipalities and TMA monitor the transport operation.
Public Works and Transport, including DGUP	Design	• Delivers aviation airspace clearance permit. • Delivers construction permit.
	Construction	• Monitor the transport operation.
Municipalities	Construction	• Municipality or the Kaemakam clears construction permit.
	Operation	• Municipality or the Kaemakam clears operation permit.

5. ESIA APPROACH AND METHODOLOGY

This section describes the approach and methodology that was adopted for the ESIA study including the following:

- Approach to the scoping and assessment phase.
- Approach for the analysis of alternatives.
- Approach to stakeholder engagement.
- Approach to determining the spatial and temporal study area.
- Methodology for assessment of the baseline environmental and social conditions.
- Methodology used to assess the potential environmental and social impacts of the Project – including the approach to determining significance, development of mitigation measures and the assessment of residual effects.
- Approach used for the assessment of cumulative and trans-boundary effects.
- Approach for development of an Environmental and Social Management Plan (ESMP).
- Assessment of shortcomings or gaps in contemporary knowledge.

5.1. Scoping and Assessment

A Scoping Report (**Appendix E**) was submitted solely to the MOE and reviewed by an internal committee. In their letter of response to the Scoping Report (also in **Appendix E**), the MOE indicated the following:

- The scoping report is approved with a note on the necessity of addressing the comments of the reviewing committee and ensuring compliance with the following:
  - Form attached with the scoping letter.
  - Lebanon's Strategic Environmental Assessment (SEA) study for the renewable energy sector.[1]
  - MOE letter to Minister of Energy and Water No. 14175/B 2017 dated 19/12/2017.
  - EIA Guidelines developed by the Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon (CEDRO).[2]
  - Include in the ESIA relevant documents required in Decision 9/1 of 2014[3] and the rental agreements for Project area.
  - Include in the ESIA emergency plans for the management of earthquakes, fires, storms and lightning.
- A preliminary assessment of expected environmental impacts was performed as part of the Scoping Report development, and the following impacts were scoped out with the understanding that they are expected to have negligible significance:

[1] MoE/UNDP, 2014. Strategic Environmental Assessment of Lebanon's Renewable Energy Sector. Beirut, Lebanon.
[2] UNDP, Country Energy Efficiency and Renewable Energy Demonstration Project for the Recovery of Lebanon, Environmental Impact Assessment for Wind Farm Developments, A Guideline Report 2012.
[3] Circular No. 9/1 dated 26/06/2014 (Relevant documents to be annexed to IEE and EIA reports as per Decree No. 8633 dated 07/08/2012 - published in the Official Gazette No. 35 on 16/08/2012).

- Noise and vibration impacts during the construction and decommissioning phases.
- Impact of solid waste and loss of vegetative cover during the construction phase.
- Visual impact from the storage of aggregate materials, construction equipment and excavation waste during the construction phase.
- Visual impact from the onsite temporary storage of solid waste during the decommissioning phase.
- Pressure on the existing solid waste management infrastructure in the study area during the construction and operation phases.

No scoping responses were received by any other consultees.

The assessment was carried out to:

- Describe the components and activities of the Project.
- Characterize baseline conditions within the Project's Area of Influence (AOI) and Indirect Area of Influence (IAOI), leveraging the scientific body of knowledge that has previously been undertaken as well as additional studies that are specific to the Project.
- Identify and assess the potential direct, indirect, and cumulative environmental and social impacts that could credibly result from the Project, ancillary activities or facilities during the construction, operation and decommissioning stages.

5.2. Analysis of Alternatives

The examination of alternatives is also considered to be a key element of the ESIA process under good international practice, including IFC Performance Standard 1 (IFC, 2012) and the associated IFC Guidance Note 1 (IFC, 2012). Environmental and social considerations have been part of the planning of the Project and a core element of the decision-making process.

The analysis of alternatives was previously presented in **Section 3 Analysis of Alternatives**. This section discussed and compared alternatives for the Project development in relation to: 1) site selection alternatives; 2) design alternatives; 3) transportation alternatives; 4) technology alternatives; and 5) the Project vs. No Project alternative, which assumes that the Project does not take place.

5.3. Stakeholder Consultation and Engagement

Stakeholder consultation and engagement is an essential part of the ESIA process and has been carried out in accordance with the requirements in Lebanon and international best practice – to include requirements identified within the Law 444/2002 related to Environment Protection, and its related Application Decree No. 8633/2012 on the Fundamentals for Environmental Impact Assessment, as well as IFC Performance Standard 1 (IFC, 2012), EIB Environmental and Social Standard 1 and EIB Environmental and Social Standard 10.

The previous stakeholder consultation and engagement undertaken for the Project are discussed in detail in **Section 6 Stakeholder Consultation and Engagement**. Activities included high level consultation with municipalities, detailed engagement with family leadership of affected communities, meetings with key informants, household survey, public disclosure meetings, meetings with landowners, focus group meetings, meetings with the Lebanese Army and meeting with mayors and officials representing towns along the transport route. The results of the consultation and engagement are reflected in the ESIA Report and have been incorporated into the project design and planning, where relevant.

5.4. Delineation of Study Boundaries and Scope of Assessment

5.4.1. Definition of Spatial Study Area

The overall Study Area for the ESIA represents the potential Area of Influence (AOI) of the Project. This is '*the area over which significant effects of the Project could reasonably occur, either on their own, or in combination with those of other developments and projects'*.

As previously presented in **Section 2.7**, the Direct Area of Influence (DAOI) for the ESIA comprises the following:

- A 3km radius around the Project footprint of land to be leased or purchased from landowners for the installation of the turbine platforms, internal roads, which encompasses the noise, shadow flicker and visual receptors.
- The transmission line connecting the Project and Sustainable Akkar substation.
- The footprint of land needed to construct the internal roads for Sustainable Akkar and Hawa Akkar (as new segments of track to access the Project).
- The office space to be leased for the Community Relations Office in Kfartoun.
- The new segments of road:
    - The new 0.65km section of asphalt road to avoid impacts to Chadra, Machta Hassan and Machta Hammoud to be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 2-9**).
    - The new 0.15km section of asphalt road to be constructed between two existing sections of asphalt road in order to avoid hairpin turns near homes (shown as #2 in **Figure 2-9**).
    - The new 3.0km section of gravel road to be constructed within the existing railroad ROW managed by Machta Hammoud Village (shown as #3 in **Figure 2-9**).

The Indirect Area of Influence (IAOI) for the ESIA comprises the existing transport corridor between the Tripoli seaport and the Project and extends up to 15km from the Project footprint to include sites and monuments of national importance potentially affected by the Project's visual impact.

In identifying these thematic study areas, the type and degree of the potential direct and indirect effects were taken into consideration. The core area where direct effects are likely to occur was determined, as well as the wider area of influence where indirect, combined and cumulative effects are likely to occur on the surrounding areas and communities.

5.4.2. Temporal Scope of the Assessment

The Project will be developed in a three-phase sequence, as follows: 1) Construction Phase; 2) Operations and Maintenance Phase; and 3) Decommissioning Phase.

Construction Phase

This includes construction activities which will be undertaken by the OEM/EPC Contractor. This mainly includes preparing the detailed design and layout of the Project, transportation of Project components to the Project site, as well as site preparation and construction activities for installation of wind turbines, foundations, internal access roads, buildings, etc.

Operations and Maintenance Phase

This includes activities to be undertaken by the Project Operator. Activities expected to take place mainly include the normal daily operation of the wind turbines and the routine maintenance activities.

Decommissioning Phase

At the conclusion of the PPA term, the Project will be completely decommissioned by the Developer. The anticipated impacts throughout the decommissioning phase are similar in nature to impacts assessed during the construction phase – and specifically in impacts related to soil, air quality, and occupational health and safety. Therefore, the assessment of impacts for those receptors and mitigation identified during the construction phase is assumed to apply to this phase in particular without the need to reiterate or emphasize this throughout this section.

5.5. Environment & Social Baseline Conditions

As part of the ESIA process, the baseline environmental and social conditions of the study area were established. Describing the baseline includes identifying and defining the importance and sensitivity of the various environmental and social resources and receptors likely to be impacted, i.e. within the study area. Understanding the value or sensitivity of the resources and receptors to impacts and changes is an important consideration when determining the significance of effects and allows for better identification of the most appropriate measures that could be employed to avoid impacts, and to mitigate any adverse impacts.

The description of environmental and social baseline conditions has considered a wide range of data and information gathered from various sources, including:

- Desk-based studies and literature reviews.
- Data from stakeholders.
- Field surveys and site investigations.

Studies have covered all the environmental and social aspects related to the Project and represent those conditions which would prevail in the absence of the Project. Studies of the environment and social baseline are described under each section respectively and include the following:

- Climate and Climate Change.
- Geology.
- Geophysical Ground and Seismicity.
- Hydrology.
- Air Quality.
- Transport.
- Biodiversity.

- Bats.
- Ornithology.
- Socio-Economic Conditions (to include Land Use).
- Community Health, Safety and Security (to include Noise, Shadow Flicker, Visual Amenity and Traffic).
- Archeology and Cultural Landscape.
- Occupational Health and Safety.

Within each section, the methodology which was undertaken for assessment of each of those baseline conditions is described in detail.

5.6. Impact Assessment Methodology

The ESIA commences with an assessment of the positive environmental and economic impacts on the strategic and national level given the current challenges the energy sector in Lebanon currently faces (refer to **Section 7 Analysis of Alternatives**). It then moves forward and within each section (in **Sections 8 – 20 Baseline Environment and Impact Assessment**) the assessment of impacts on environmental and social parameters is undertaken as required. The following section provides a description of the approach, methodology and process adopted for the impact assessment presented within this ESIA.

The adverse and beneficial environmental and social impacts of the Project have been identified and assessed against the established baseline. A consistent approach to the assessment of impacts was followed to enable environmental and social impacts to be broadly compared across the ESIA. A set of generic criteria were used to determine significance which were applied across the various social and environmental parameters.

As far as possible, environmental and social impacts were quantified. Where it was not possible to quantify impacts, a qualitative assessment was conducted using professional experience, judgment and available knowledge, and including the consideration of stakeholder views. Where there were limitations to the data, and/or uncertainties, these have been recorded in the relevant chapters, along with any assumptions that were taken during the assessment.

In order to determine the significance of each impact, two overall factors are considered:

- The importance and/or sensitivity of the environmental and social receiving parameter, as determined during the assessment of baseline conditions.
- The magnitude and nature of the impact.

5.6.1. Sensitivity of Receptors

Receiving parameter sensitivity was determined using information taken from the baseline description on the importance, significance or value of the social or environmental component under examination. It is important to understand the sensitivity of the receiving parameter, as this is a measure of the adaptability and resilience of an environmental parameter to an identified impact. The following categories of sensitivity were applied to the assessment:

- High: The environmental parameter/receptor is fragile, and an impact is likely to leave it in an altered state from which recovery would be difficult or impossible.
- Medium: The parameter/receptor has a degree of adaptability and resilience and is likely to cope with the changes caused by an impact, although there may be some residual modification as a result.
- Low: The parameter/receptor is adaptable and is resilient to change.

The sensitivity of the receiving environment to changes caused by the Project was determined within each of the technical chapters using professional judgement, and existing information, where possible.

5.6.2. Impact Severity

The following factors are taken into consideration when evaluating impact severity:

- Likelihood or Probability of Occurrence: How likely the event is to occur during the Project lifecycle.
- Magnitude and Duration: The magnitude of the induced change such as size of area damaged, proportion of a species that is affected or a resource that is lost. The magnitude of the impact is the scale of change which the impact may cause compared to the baseline and how this change relates to accepted thresholds and standards, as presented in **Table 5-1**.
- Extent: The geographical area that could be affected by the impact.
- Reversability: Whether the impact will or will not be reduced and disappear over time once the Project ceases.

Table 5-1 Magnitude Criteria

Impact Severity	Definition
No Change	Where the Project would not cause any changes to the receiving environment, or the changes are unlikely to be noticeable.
Slight/Minor	Where the Project would cause very little change to the receiving environment. It is typically reversible, temporary (<1 year), and limited to the site only (immediate zone). The probability of occurrence is less than 20%.
Low	Where the Project would cause noticeable deterioration of the existing environment. It is typically reversible, short-term (1-5 years), and limited to the local area (Middle zone). Likelihood is 20-40%.
Medium	Where the Project would cause moderate deterioration of the existing environment. It is typically recoverable (with a degree of intervention). Medium-term (5-10 years) and expected to affect the Furthest zone. Likelihood is 40-60%.
High	Where the Project would cause significant and long-term deterioration of the existing environment, expected to last on the long-term (10-20 years) or the Project lifetime. It affects an area that is nationally important/ or has macro-economic consequences. Its probability of occurrence is 60-80%.
Very High	Where the Project would cause irreversible and permanent damage to the existing environment, typically enduring substantially beyond the Project lifetime, or permanently. It affects globally important resources. Its likelihood is 80-100% (i.e., the impact will occur).

Evaluation of impact severity also considers the following factors:

- Regulations and Guidelines: The degree of compliance with regulations and standards (e.g. environmental limit values). Relationship and alignment with national policies.
- Outcomes of public consultation: Carried out as part of the study.

5.6.3. Determining Impact Significance

Impacts are defined as the changes in baseline conditions due to the Project construction and/or operation. Impacts can be Direct (i.e. resulting from the Project), Indirect (i.e. resulting from activities caused by the Project), Secondary (i.e. impact occurrence causing a subsequent interaction within the environment) and Cumulative (i.e. impacts caused by the combination and/or interaction of Project-related activities with those from other activities including third-party projects and plans.

The significance of each impact is determined by associating the impact severity with the sensitivity of the receptor in the matrix, as provided in **Table 5-2**.

Table 5-2 Matrix for Determining Impact Significance

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Potential impacts are assessed using quantitative tools such as noise modeling, and qualitative techniques based on professional judgment such as biodiversity. However, uncertainty is inevitable when dealing with a live resource that varies and evolves with time and is affected by several natural and anthropogenic factors in addition to the Project. Where qualitative assessments were necessary, these have been based on professional judgement. The significance of impacts has been based on a conservative 'worst case' basis in accordance with the precautionary principle.

The quality of baseline data also affects the accurateness of the assessments made. Therefore, it was necessary to list the key assumptions made and any limitations identified, in producing this ESIA as can be seen in the appropriate technical sections. In general, the ESIA assumes that:

- The principal land use in the surrounding area will remain unchanged throughout the Project lifetime.
- The Project will be as outlined in **Section 2 Project Description**.
- The mitigation and monitoring measures stipulated in the ESMP will be implemented as appropriate.

The definitions of impacts and their severity are shown in **Table 5-3**.

Table 5-3 Definition of Impacts and Significance

Significance	Definition
Positive Impact	An Impact that is considered to represent an improvement on the baseline or introduces a new desirable factor.
Negligible Impact	No or imperceptible impact / Magnitude of change is comparable to natural variation (without the Project).
Minor Impact	Barely perceptible deterioration of the existing environment; impact is well within applicable standards, and/or receptor sensitivity is low.
Moderate Impact	Impact is within applicable standards and limits and leads to noticeable deterioration of the existing environment; normal functioning is altered but the baseline condition prevails, although in a modified state; should be mitigated to demonstrate that the impact has been reduced to a level that is As Low As Reasonably Practicable (ALARP).
Major Impact	Impact exceeds accepted limits and standards, or receptor sensitivity/value is high. Causes significant or complete modification of the baseline situation; must be mitigated to eliminate any high adverse residual impacts.
Critical Impact	Intolerable impact; not amenable to mitigation; alternatives or compensation measures must be identified.

5.7. Mitigation and Management Measures

Based on the impact assessment undertaken a set of mitigation and management measures are identified for each impact which aims to address it. Mitigation and management measures include the following:

- Additional Requirements: those are generally regulatory requirements which have been identified and which must be considered at a later stage.
- Additional Studies: for certain environmental/social receptors additional studies must be undertaken at a later stage. Such studies and their scope, timing, etc. have been highlighted where relevant.
- Mitigation Measures: a vital step in the ESIA process is the identification of measures that can be taken to ensure that impacts are mitigated or reduced to acceptable levels. The ESIA will firstly consider the significance of any impacts caused by the Project and then assign mitigation options through applying the following hierarchy:
  - Avoiding or 'designing out' impacts wherever possible.
  - Considering alternatives or modifications to the design to reduce the impacts wherever possible.
  - Applying measures to minimize and manage impacts on the receptor.
  - As a last resort, identifying fair compensation, remediation and offsetting measures to address any potentially significant residual effects.

- Some negative impacts can be easily mitigated, whilst others cannot or are too difficult and costly to mitigate. The various potential impacts are described in this ESIA, along with the provision of 'feasible mitigation measures' that can be implemented.
- Recommendations: for positive impacts, it is not possible to identify mitigation measures, but rather recommendations have been identified which aim to enhance the positive impact.

If there are mitigation measures, it is then necessary to assess the 'residual significance' after mitigation has been taken account. A re-assessment of Project impacts is then made, considering the effect of the proposed mitigation measures in order to determine the significance of the residual effects. Residual effects are discussed for each environmental and social theme in the ESIA sections.

5.8. Assessment of Cumulative Impacts

For each of the impacts assessed, the ESIA investigates the cumulative impacts which could result from incremental impacts from other known existing and/or planned developments in the area and based on currently available information on such existing/planned developments. Assessment of cumulative impacts is presented in **Section 21 Assessment of Cumulative Impacts**.

5.9. Assessment of Shortcomings or Gaps in Contemporary Knowledge

For each of the environmental and social aspects related to the Project, there will be a clear summary of the shortcomings or gaps in contemporary knowledge to inform the current and future collection of data. These will have been identified within the specific section, i.e. Sections 8-20; therefore, this section will serve to present a succinct summation of items.

5.10. Development of an Environmental and Social Management (ESMP) Framework

Based on the results of the impact assessment, a framework ESMP for the development of mitigation measures and development of a monitoring plan was prepared as a separate, stand-alone document. The ESMP will be a key document and will list the environmental/social requirements and detail the procedures necessary for managing the significant environmental/social issues connected to proposed Project activities.

The ESMP will be developed specifically to provide flexibility in the nature and exact location of operations, while ensuring all potential impacts are identified and properly mitigated and monitored throughout the later stages of the Project. The framework ESMP will be further developed by the Developer in collaboration with the selected OEM/EPC Contractor.

5.11. Assessment of Shortcomings or Gaps in Contemporary Knowledge

It is noted that additional data collection and surveys are currently being undertaken, and that findings from this work will be incorporated into the ESIA to inform mitigation as follows:

- Data regarding the presence and location of public wells located near the Project, as well as the hydrological implications of the Yammouneh Fault, is currently being collected.

- Data regarding the plans for the collection, storage and disposal of solid waste and hazardous waste, generated volumes and the disposal facilities are under development.
- Calculations for potable water requirements and wastewater that will be generated by the Project are currently being undertaken.
- Gross energy yield calculations for the Siemens-Games 5.0MW and GE 5.0MW wind turbines are currently being undertaken, as they have recently been added to the potential turbine layouts.
- The GWH/year for each of the OEM/EPC Contractors under consideration (i.e. Vestas, Siemens-Gamesa and GE) are currently being undertaken.
- The Project will reduce GHG emissions since it will be displacing a largely fossil fuel-based electricity generating system and save water in comparison to oil-burning power plants which utilize water for cooling. Calculations for metric tons of CO_2 displaced and millions of m^3 in water savings annually are currently being undertaken.
- Additional survey work is currently being undertaken to identify the number and location of public wells. The findings will be used to inform mitigation.
- Additional habitat surveys will be undertaken in Summer 2019 to update the mapping of boundaries between habitat types and the locations of existing features (such as tracks and borrow pits) to refine the habitat loss calculations. In addition, the surveys will aim to verify the potential presence of threatened and/or endemic floral species. The findings will be used to inform mitigation.
- A mammal survey will be undertaken in early Summer 2019 and will include field visit(s) to search for signs of mammals (such as tracks and scat) and the installation of camera traps. The findings will be used to inform mitigation.
- Additional bat surveys commenced at the Project in May 2019 and will continue for one year, following best practice methodologies. The findings will be used to inform mitigation.
- Additional ornithology data collected during Spring 2019 will be analyzed. Additionally, further vantage point bird surveys will be completed in Autumn 2019. In this way, the results of migratory bird movements previously recorded can be verified by having additional temporal and seasonal coverage following best practice methodology. The findings will be used to inform mitigation.
- Additional socioeconomic data is currently being collected as follows:
  - Survey by the Developer of landowners in the Direct Area of Influence: Rweimeh Village, Fnaidek, Karm Chbat, Aandqet, Jabal-Akroum Kfartoun, Chadra, Machta Hammoud and Mqaible.
  - Survey by the Developer of noise, shadow flicker and visual receptors of the Project.
  - Socioeconomic data provided by Statistics Lebanon to:
    - Villages in the Direct Area of Influence: Rweimeh Village, Fnaidek, Karm Chbat, Aandqet, Jabal-Akroum Kfartoun, Chadra, Machta Hammoud and Mqaible.
    - Villages in the Indirect Area of Influence: Villages along the transport corridor.

This information will be used to update the findings in the ESIA and inform mitigation.

6. STAKEHOLDER CONSULTATION AND ENGAGEMENT

This section discusses in detail the stakeholder consultation and engagement undertaken as part of the ESIA process for the Project and provides an overview of the findings. In addition, this section refers to the separate and stand-alone Stakeholder Engagement Plan (SEP) which summarizes the activities that are to take place as part of the Project development.

6.1. Introduction

Stakeholder consultation and engagement is an integral part of ESIA good practice and is a statutory requirement of the national EIA legal framework in Lebanon, within the IFC Performance Standards and EIB Environmental and Social Standards. The Developer is committed to a technically and culturally-appropriate approach to consultation and engagement with all stakeholders affected either directly or indirectly by the Project.

A stakeholder is defined as any individual or group who is potentially affected by the proposed Project or can themselves affect the proposed Project directly or indirectly. Stakeholder consultation is an inclusive process for sharing information that enables stakeholders to understand the risks, impacts, and opportunities of a development or Project, allowing them to express their views and articulate their perceptions towards it.

The consultation and engagement program for the Project is based on informed consultation and participation in line with national, IFC and EIB requirements with affected people and is designed to be both fair and inclusive. Consultation activities have been an ongoing process since March 2017.

6.2. Objectives

The objective of stakeholder consultation and engagement is to ensure that a participatory approach takes place, which in turn, documents concerns of all stakeholder groups and makes sure that such concerns are considered, responded to, and incorporated into the decision making process of the development. Stakeholder consultation needs to be a two-way communication process that imparts information to stakeholders, but also obtains additional and on-the-ground information from them. Stakeholder consultation and engagement must take place at the inception phase of the ESIA process and be implemented all through the study period.

The specific objectives of this section are to:

- Summarize national and international legal & policy requirements for stakeholder engagement.
- Describe and identify the stakeholders affected and/or with an interest in the Project.
- Summarize stakeholder engagement and consultation conducted to date. In addition, describe how the views and issues raised have informed and influenced the development of the Project.
- Outline the future approach to stakeholder engagement.

6.3. Requirements and Policy Requirements for Stakeholder Engagement

6.3.1. Lebanon Legal and Policy Standards

Based on the Application Decree No. 8633/2012 related to the “Fundamentals for Environmental Impact Assessment”, if an EIA is required, the project proponent should ensure local participation at several stages of the EIA process. At the scoping stage, Article 7 of the decree stipulates the following requirement concerning public participation:

- The Ministry of Environment will require that the Project owner informs all concerned stakeholders including ministries, municipalities and NGOs of the preparation of an EIA Report.
- Once advised, the municipality (or the governor or commissioner in case there is no municipalities) where the Project will be located, should immediately advertise the Project to inform the public. The advertisement should be placed on a public bulletin board and at the location of the Project for a period of 15 days requesting comments from the public. The Ministry of Environment will also give the public a chance to provide feedback to the Ministry or the official department concerned within one month from the date of the advertisement publication.
- The Project owner shall submit to the Ministry of Environment a report pertaining to the EIA scoping of the project including attachments of the remarks communicated to him, all incoming comments, the original minutes of public dialogue meetings or the minutes of bilateral meetings with the parties involved.

For the EIA report, Article 12 of the decree related to “Information Publication” confirms the right of the public and the parties involved in the project to have access to the final EIA Report. Moreover, Law 28 of 2017 on the Right to Access to Information has confirmed the right of any person, to access to information and documents available within the administration.

Based on the above, the national regulations require an initiation of the consultation process supporting public participation at the outset of the EIA/ESIA process and allow continuous access to information related to the Project.

6.3.2. Requirements in IFC Performance Standards on Environmental & Social Sustainability (2012)

The IFC Performance Standards form part of their Sustainability Framework, where IFC Performance Standard 1 (IFC, 2012) sets out the following recommendations for stakeholder engagement:

- Stakeholder Engagement as an on-going process that may involve: stakeholder analysis & planning, disclosure and dissemination of information, consultation & participation, grievance mechanism, and on-going reporting to local communities directly affected by the project (the Affected Communities).
- A SEP must be developed and implemented that is scaled to the Project risks and impacts and development stage, and to be tailored to the characteristics and interests of the Affected Communities.
- Affected Communities will be provided with access to relevant information on: 1) the purpose, nature and scale of the project; 2) the duration of proposed Project activities; 3) any risks to

and potential impacts on such communities and relevant mitigation measures; 4) the envisaged stakeholder engagement process; and 5) the grievance mechanism.

- When Affected Communities are subject to identified risks and adverse impacts from a Project, a process of consultation will be undertaken in a manner that provides the Affected Communities with opportunities to express their views on Project risks, impacts and mitigation measures, and allows the client to consider and respond to them.
- The extent and degree of engagement should be commensurate with the Project's risks and adverse impacts and concerns raised by Affected Communities.
- The consultation process will be tailored to language preferences of Affected Communities, their decision-making process, and the needs of disadvantaged or vulnerable groups.
- For projects with potentially significant adverse impacts, the client will conduct an informed consultation and participation.
- A grievance mechanism will be established to receive and facilitate resolution of Affected Communities' concerns and grievances about the client's environmental and social performance.

6.3.3. Requirements in EIB Environmental and Social Standards (2009)

The ESSs of the EIB, as well as the operational practices of the EIB, recognizing the importance of open and transparent engagement with Project stakeholders as an essential element of good international practice:

- Establish a systematic approach to stakeholder engagement that will help Borrowers identify stakeholders and build and maintain a constructive relationship with them, in particular project-affected parties.
- Assess the level of stakeholder interest and support for the project and to enable stakeholders' views to be considered in Project design and environmental and social performance.
- Promote and provide means for effective and inclusive engagement with Project-affected parties throughout the Project life cycle on issues that could potentially affect them.
- Ensure that appropriate Project information on environmental and social risks and impacts is disclosed to stakeholders in a timely, understandable, accessible and appropriate manner and format.
- Provide project-affected parties with accessible and inclusive means to raise issues and grievances and allow Borrowers to respond to and manage such grievances.

6.4. Stakeholder Engagement Plan

The SEP will be included in the ESIA package. The SEP includes stakeholder identification and analysis, the roles and responsibilities for the External Relations Manager, hired in 2018, and the first of three Community Relations Officers (CRO) to be hired in 2019, and describes the stakeholder engagement and information disclosure activities that have been conducted to date and those that are planned throughout the life of the Project. As stated in the description of the Project Communication Plan included in the SEP, the Community Relations team will meet monthly with each Affected Community throughout the Construction Phase, in accordance with a schedule mutually agreed upon among the parties (day and time), the LWP Project Representative (CRO) assigned to each village will deliver and install the Monthly Project Poster in the Bulletin Box in each village and will deliver a few copies of the Monthly Project Poster to the village mayor and conduct a meeting with the village mayor, key-people and anyone from the community who would like to participate.

The Community Grievance Mechanism is also included in the SEP. Suggestion boxes will be installed at the Community Relations Office in Kfartoun and in each of the Affected Communities, so all Affected Communities will have access to the Community Grievance Mechanism, and Grievance forms will be made available at each location to allow for the submission of confidential grievances.

The SEP will also mention that a copy of the Non-Technical Summary of the ESIA (in both Arabic and English) will be made available at the Community Relations representative office in Kfartoun and in each municipal office within the DAOI.

6.5. Stakeholder Identification and Analysis

The Project has been identifying potential stakeholders since March 2017. Project stakeholders and key informants were identified by the Developer and team based on the following: 1) categories of population usually affected by similar projects; 2) specific knowledge of the governance and social structure in the Project area; and 3) preliminary discussions with the MOE and their recommendations.

The Project has a wide range of stakeholders ranging from national and regional government institutions, in addition to communities within the area of influence of the Project. As such stakeholders have been identified at all geographic levels, including national, regional and local levels.

The three principal categories of stakeholders are as follows:

- <u>National governmental institutions</u>, including the MOE, MOEW, MOPWT, MOIM and other bodies involved in the permitting and ESIA process; and governmental authorities at the regional level, including the Governorate level (Governors) and District level (Kaemmakam).
- <u>Affected Communities</u>, defined as the local community as well as other people directly affected by the Project and/or those who have been identified as most vulnerable to change and who need to be engaged in identifying impacts and their significance, as well as in decision-making on mitigation and management measures.

  Specifically, within the affected communities, vulnerable groups must be identified. Vulnerable groups include those expected to be disproportionally affected by the Project, and therefore require special consideration throughout the consultation process. Vulnerable groups are project specific and depend on a range of issues which must be understood such as project location, socio-economic and demographic context, as well as the nature of the development and type of impacts anticipated. The vulnerable groups within this context were identified and included the following:

  - Women: due to cultural norms in Lebanon (and specifically within the context and setting of the Project area), the participation of women in the decision-making process is limited which could result in overlooking any specific concerns they might have.
  - Elderly: due to civil status and potential decline, this could limit their participation in the decision-making process which could result in overlooking any specific concerns they might have.

  - Informal settlements and Syrian and Palestinian refugees in Lebanon in general, and in Akkar in particular: people that have fled from their home to seek safety in Lebanon, many of whom are excluded from key facets of social, political and economic life. As they face restrictions on legal status and human rights, this could limit their participation in the decision-making process which could result in overlooking any specific concerns they might have.
- Other Interested Parties, defined as people and organizations that are interested in the Project and/or could affect the Project in some way. Those generally include universities and non-governmental organizations as follows:
  - Universities and research centers, such as the Lebanese Agriculture Research Center (LARI), the Lebanese University and the University of Balamand.
  - A national NGO (MADA) is also active in the region, including the Project area.

6.5.1. Affected Communities

The affected communities have been identified based on: 1) detailed understanding of the Project site location, its nature, administrative setup and the nearby surrounding receptors; and 2) the nature of the anticipated impacts from the Project throughout its various phases. Based on the above, the affected communities include the local communities of the Project area (including women and the elderly) and informal settlements. As discussed earlier, the Project site is located within Akkar Governorate and specifically within Akkar District. The communities that are likely to be affected by the Project development logically include those located within the vicinity of the Project site, and which are therefore anticipated to be impacted the most from the Project's activities (during construction, operation and decommissioning). This in turn was determined based on the detailed understanding of the nature and extent of the Project's impacts. The main anticipated impacts which could affect the nearby communities (as discussed in further detail in each of the relevant sections) are described in the following sections.

6.5.1.1. Direct Area of Influence (DAOI)

Villages in the DAOI are shown in **Figure 6-1**. The DAOI is considered to include the following:

1. Villages where land was leased or acquired for the Project, as well as villages where land was leased/acquired for the Hawa Akkar and Sustainable Akkar wind farms to access the Project (and connect to the Sustainable Akkar/EDL substation):
   - 4 villages where land was or will be leased/acquired for the Project:
     - Fnaidek.
     - Karm Chbat
     - Rweimeh Village; it is noted that Jawz, located 1.5km from the Project is considered part of Rweimeh Village.
     - Jabal-Akroum Kfartoun (where the CRO Office is to be leased).

- 3 villages where land was or will be leased/acquired for new segments of track through Hawa Akkar:
  - Chadra.
  - Machta Hammoud.
  - Mqaible.
- 3 Villages where land was or will be leased/acquired for new segments of track through Sustainable Akkar:
  - Aandqet.
  - Jabal Akroum-Kfartoun (same village as listed for the Project; so not counted twice).
  - Rweimeh Village (same village as listed for the Project; so not counted twice).

Therefore, there are a total of 8 villages in the DAOI.

2. Impacts to socioeconomic conditions (including land use access for shepherds and hunters) from the Project (refer to **Section 16 Socioeconomic Conditions**).
3. Impacts to community health, safety and security impacts from the Project in a 3km radius of the Project (refer **Section 17 Community Health, Safety and Security**) comprising individual receptors of:
   - Noise impacts generated by the operating turbines.
   - Shadow flicker generated from the operating turbines.
   - Visual impacts from the presence of turbines.
   - Localized traffic impacts for movement of construction materials during construction (limited to Rweimeh Village).

6.5.1.2. Indirect Area of Influence (IAOI)

The IAOI was considered to include the following: 1) the existing asphalt transport route; 2) the wider environment which extends up to 15km from the Project footprint to include sites and monuments of national importance potentially affected by the Project's visual impact. Therefore, affected communities in the IAOI include those local communities along the existing asphalt transport route, as previously shown in **Figure 2-8a** through **Figure 2-8g**, and include the following:

- Tripoli.
- Beddaoui.
- Deir Amar.
- Borj El-Yahoudiyé.
- Nabi Youcheaa.
- Minie.
- Zouq Bhannine.
- Al Mhamra.
- Bebnine.
- Qoubber Chamra
- Mqaiteaa
- Borj El-Yahoudiyé
- Kfar Melki Aakkar.
- Rmoul.
- Qaabrine.
- Sammouniyé.
- Tall Aabbas El-Gharbi.
- Hissa.
- Tall Aabbas Ech-Charqi.
- Tall Hmaire.
- Chir Hmairine.
- Hokr Jouret Srar.
- Iitige.
- Barcha.
- Kharmoubet Akkar.
- Janine
- Qachlaq.
- Aamaret El-Baykat.
- Noura Et-Tahta.
- Kouachra.
- Dibbabiye.
- Fraidis.
- Qsair Akkar.
- Menjez.
- Rmah.
- Chikhlar.
- Aaouaainat Aakkar.
- Mashta Hassan.

Figure 6-1 Affected Communities in the DAOI

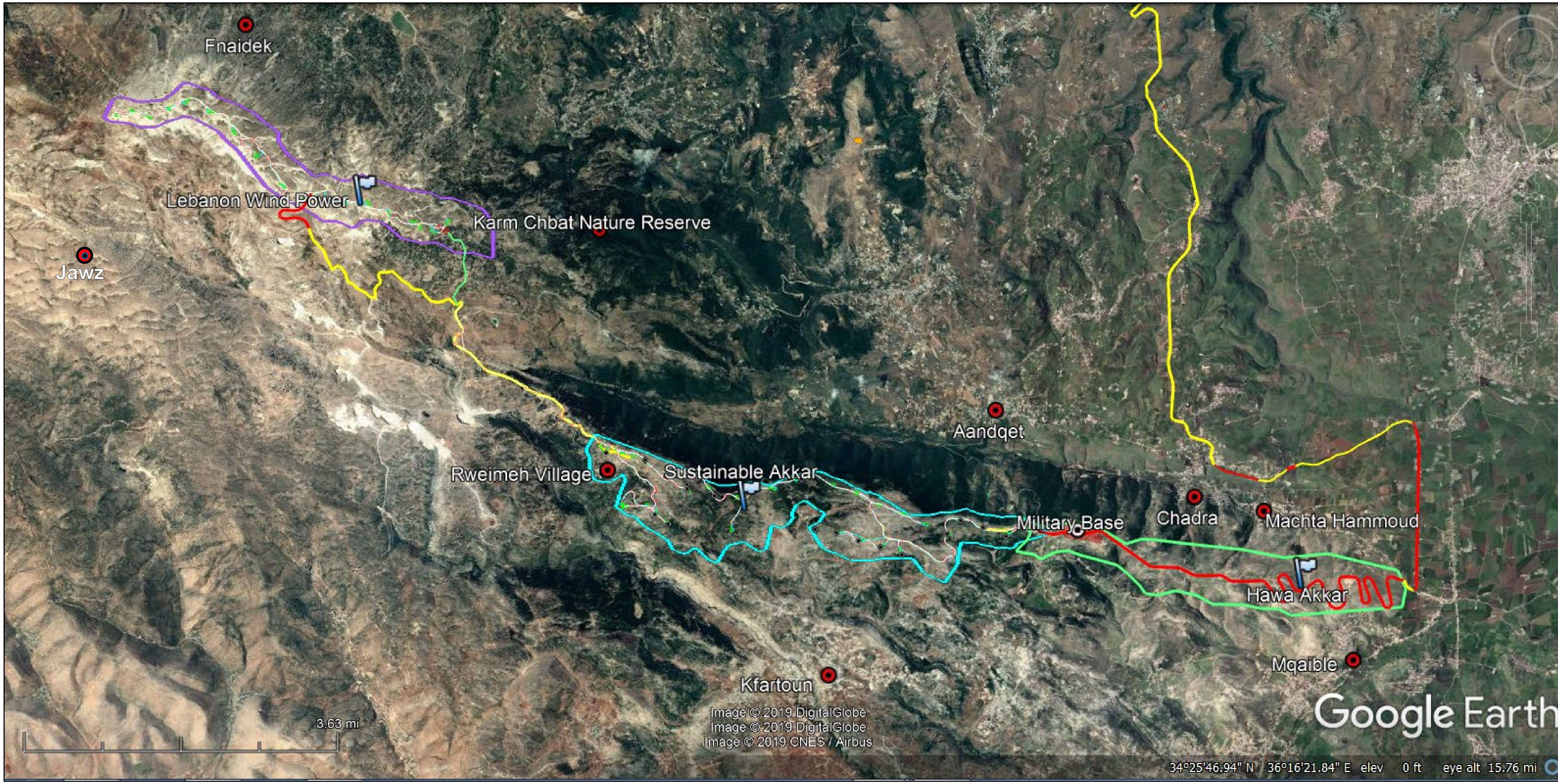


Figure 6-2a Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

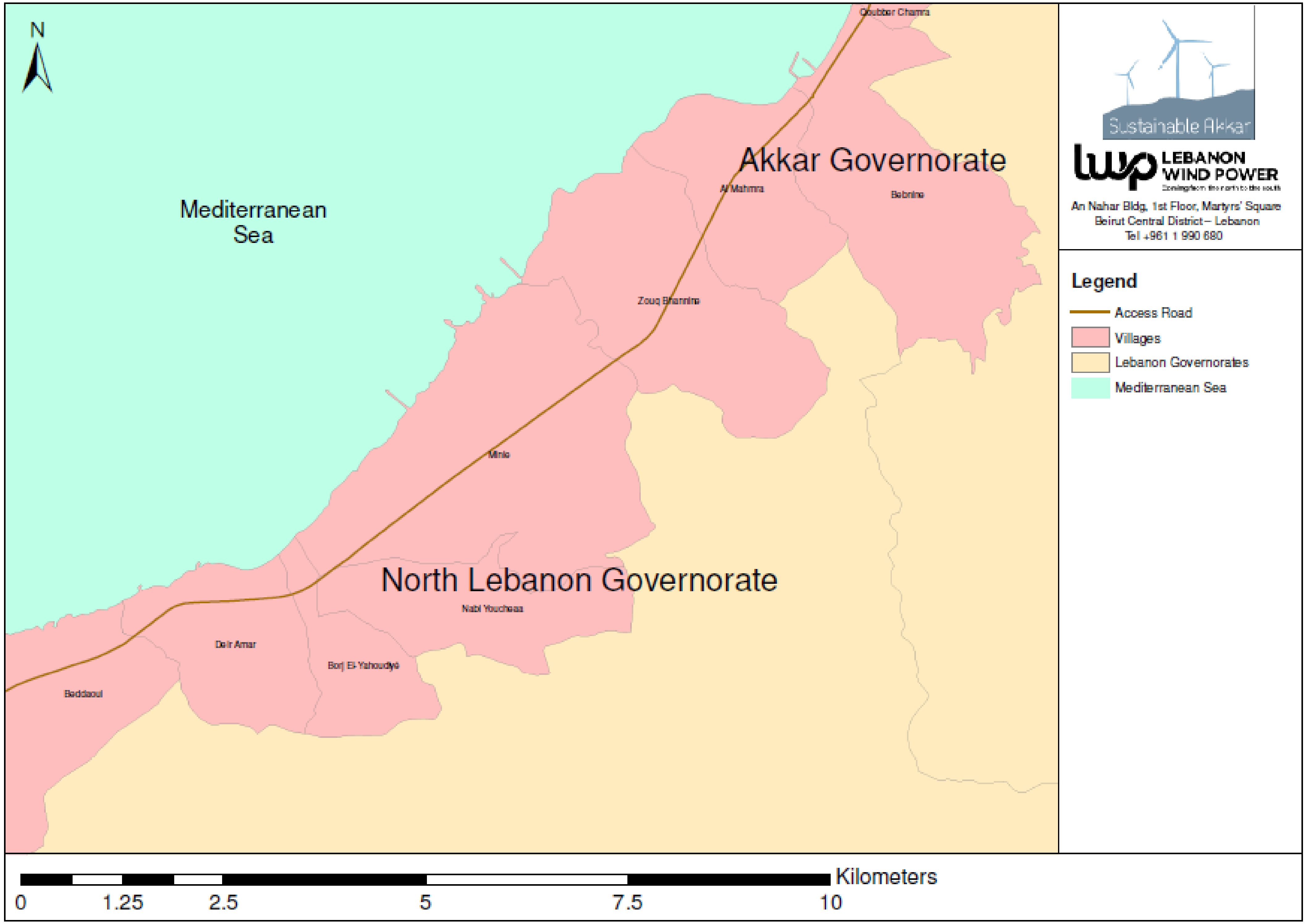


Figure 6-2b Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

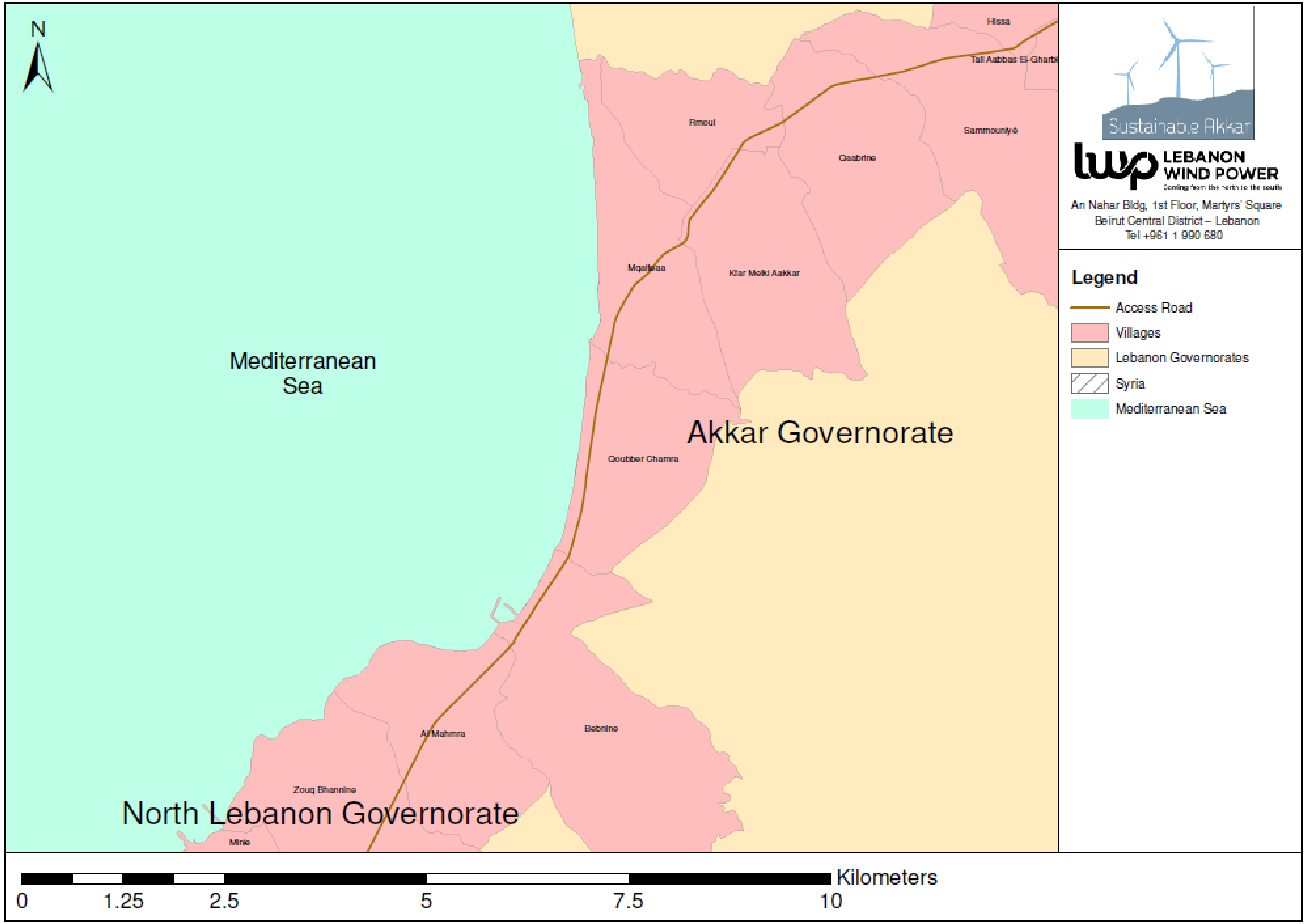


Figure 6-2c Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

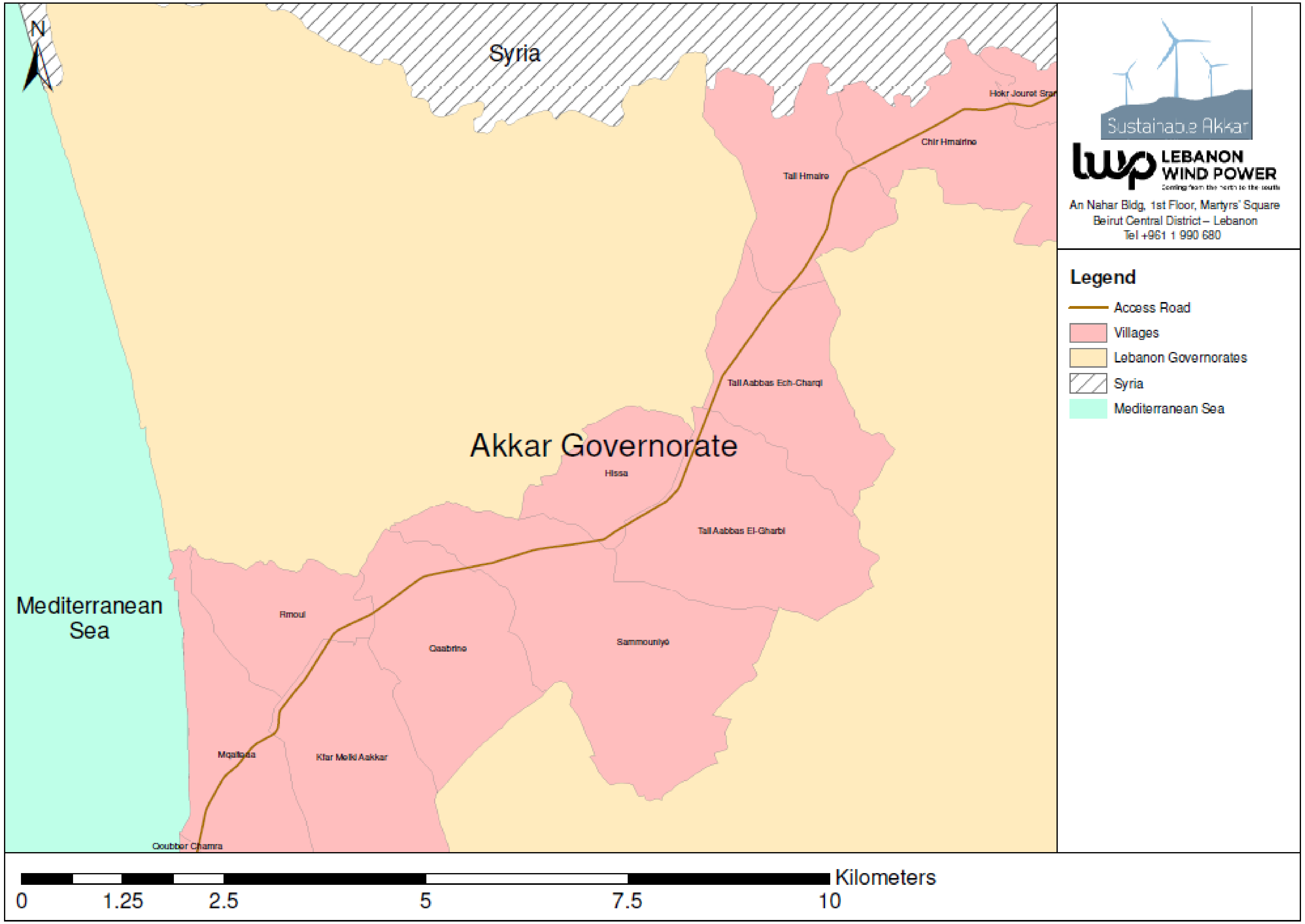


Figure 6-2d Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

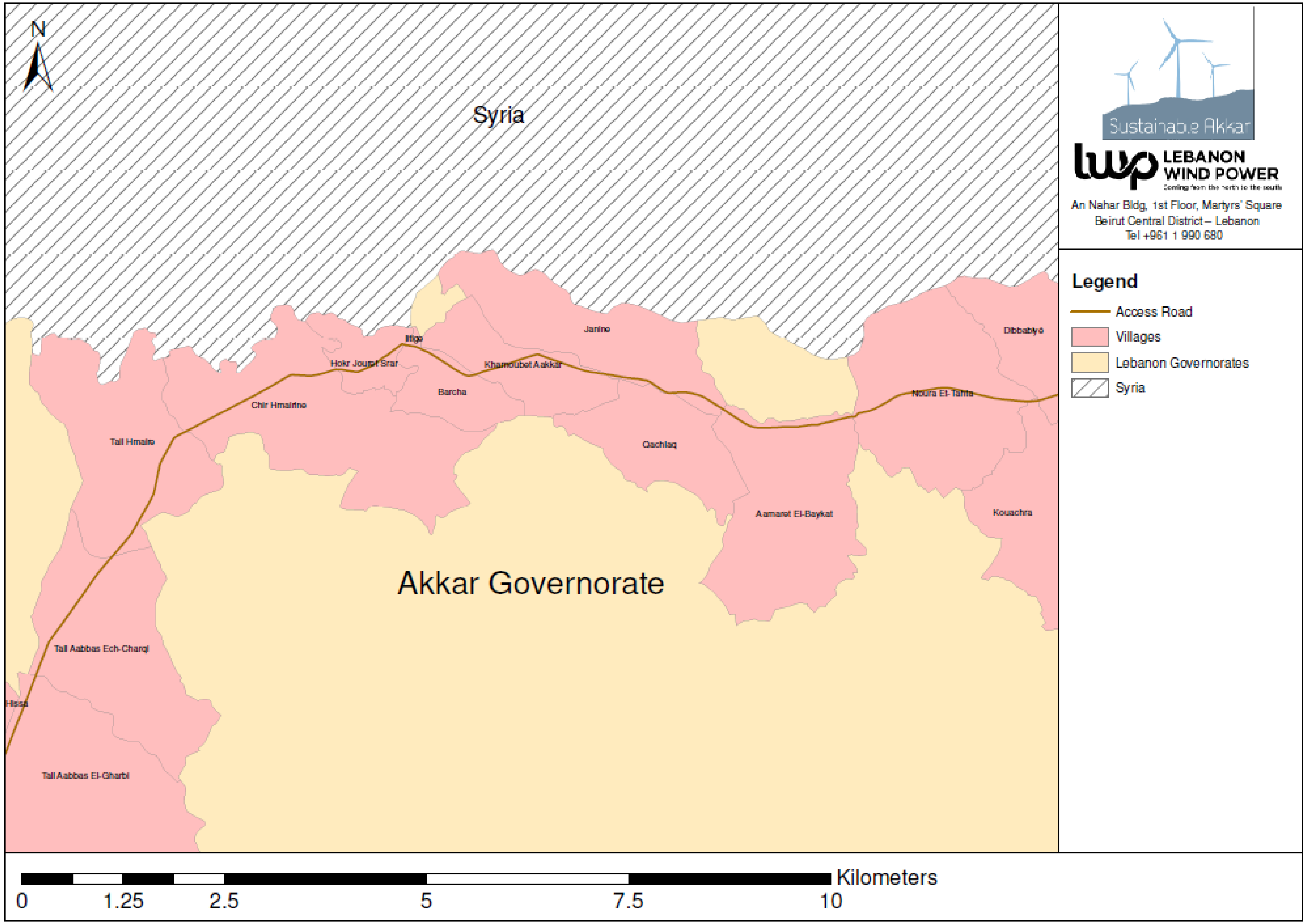


Figure 6-2e Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

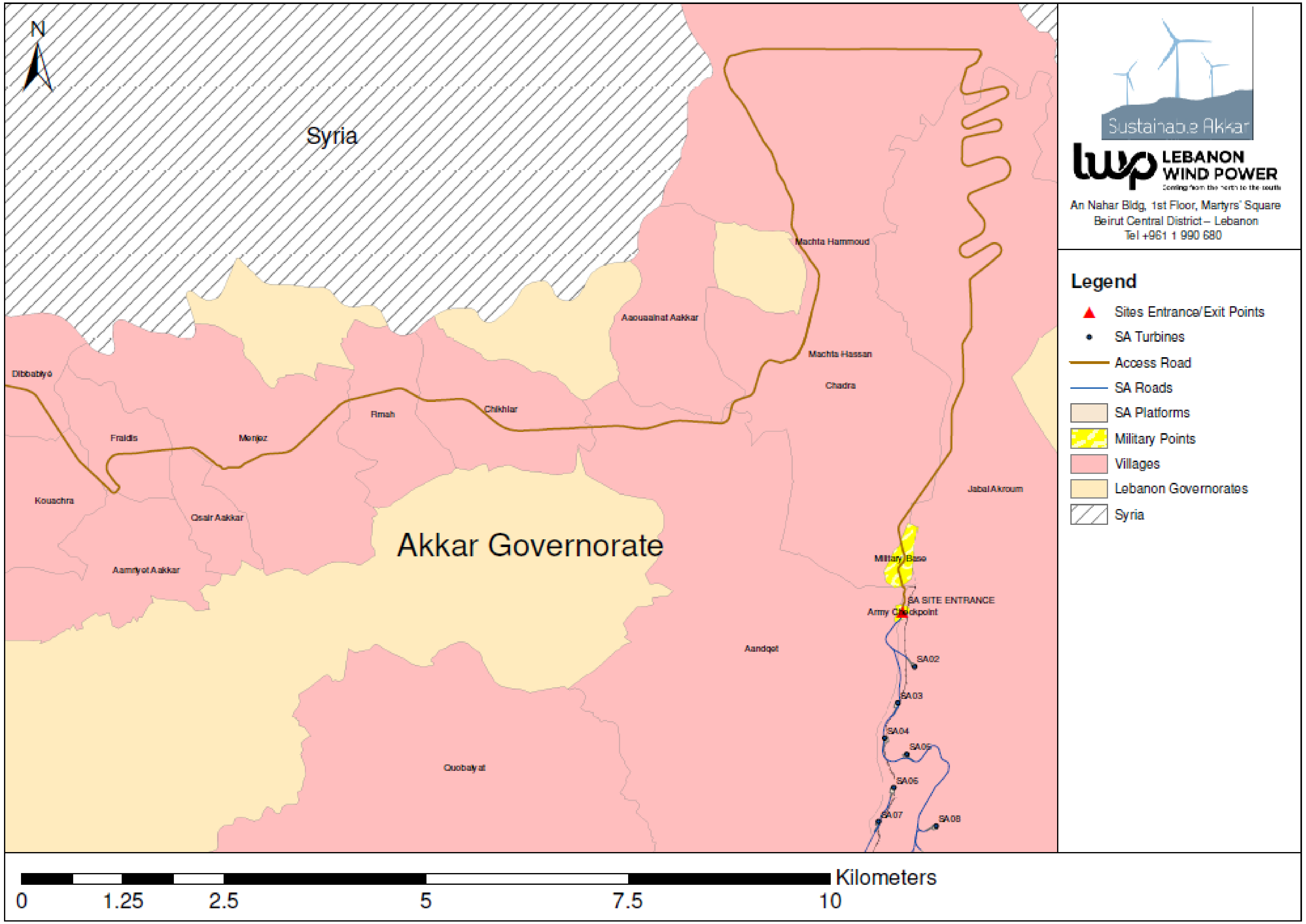


Figure 6-2f Villages Consulted Along the WTG Transport Corridor and Villages Near the Project

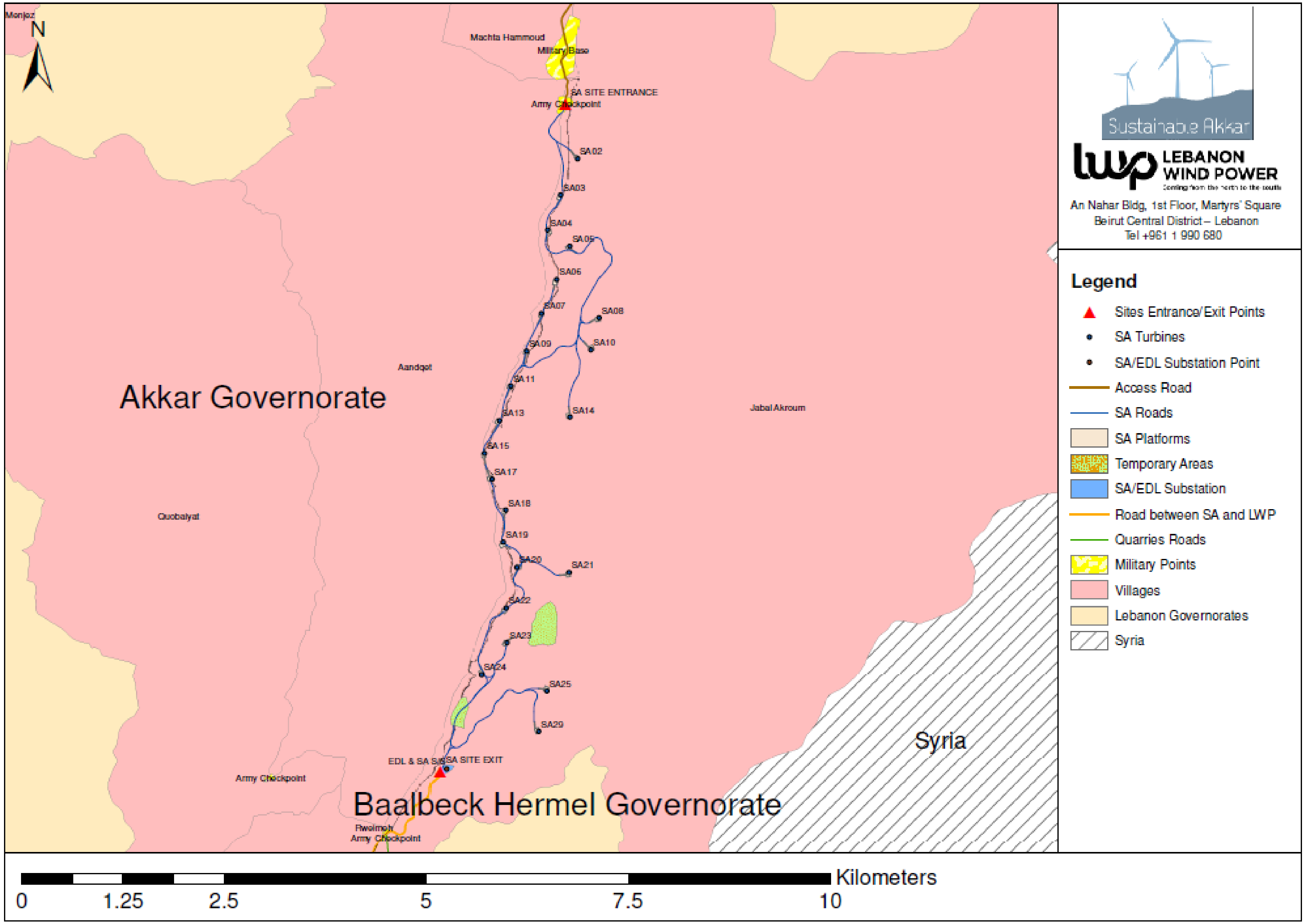
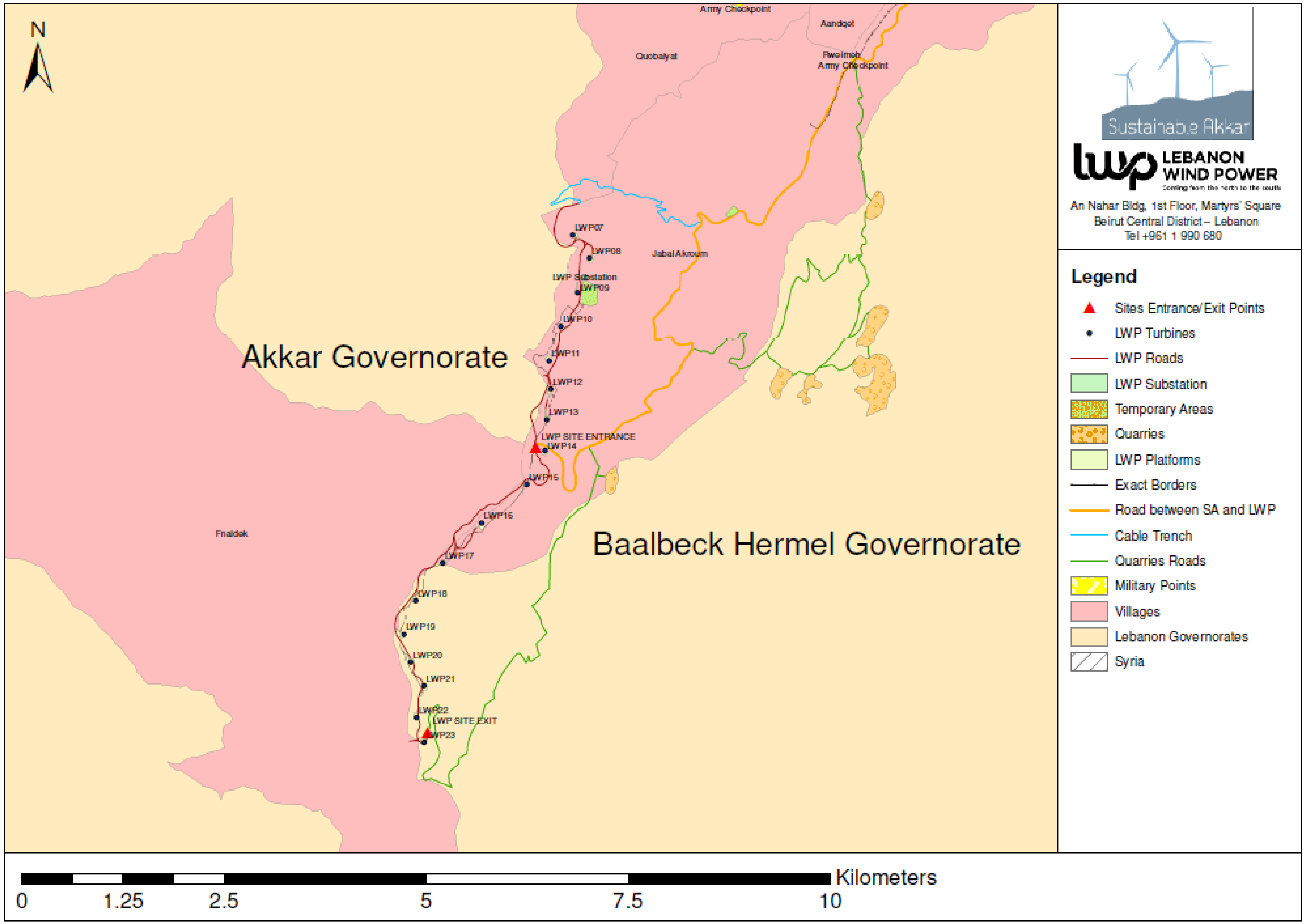


Figure 6-2g Villages Consulted Along the WTG Transport Corridor and Villages Near the Project



In addition, the visual impacts from key landscape units, protected areas and cultural/historical monuments were assessed as follows (refer to **Section 17 Community Health, Safety and Security**), as shown in **Table 6-1**:

Table 6-1 Visual Receptors

Landscape Units	Villages Where Turbines Will Be Clearly Visible	Cultural/Historical Monuments
• Agricultural Areas • Dense Abies Forests • Dense Pinus Forests • Dense Quercus Forests • Mixed Forests • Other Dense Leafy Forests • Rocky Land • Shrublands • Sparse Coniferous • Sparse Leafy Forests • Swamps • Urban Artificial • Urban Expansion	• Jouar el Hachich • Rweimeh Village • Qobaiyat Metraniyye • Qobaiyat Village • Es Sayeh Village • Fnaidek • Akkar El-Atiqa'a Village • Qammouaah Plain	• Al-Saifa Fortress (in Akkar El-Atiqa'a)

6.6. Public Participation Activities Undertaken to Date

The following sections describe the public participation activities undertaken to date. It is recognized that public participation is an on-going and continuous process, undertaken throughout all Project phases, inclusive of construction, operation and decommissioning.

6.6.1. 2017 Activities

6.6.1.1. Engagement with Family Leadership in Affected Communities

The Project developer began early engagement with family leadership of the Affected Communities in advance of the ESIA activities, as shown in **Table 6-2**. It is noted that, as the Lebanon Wind Power and Sustainable Akkar Wind Farms are adjacent, engagement was undertaken to support the planned development of both wind farms.

6.6.2. 2018 Activities

6.6.2.1. Meetings with Key Informants

Meetings were organized with key informants to discuss their opinions regarding the Project and to describe the household survey campaign to be implemented, as shown in **Table 6-3**. District level data regarding demographics, sources of income and cultural aspects was obtained during the meetings. The findings from the Key Informant Meetings are provided in **Section 16 Socioeconomic Conditions**.

Table 6-2 Face-To-Face Meetings with Family Leadership in Affected Communities

Name	Village Represented	Date
Abbas Jaafar, Kamel Jaafar, Mohamad Jaafar and Abdo Jaafar	Karm Chbat	2-Mar-17
Hussein Jaafar, Youssef Jaafar	Rweimeh	8-Mar-17
Hussein Ahmad Salah, Mohamad Ali Salah and Hussein Ali Salah	Kfartoun	27-Mar-17
Mohamad Khaled Abed Al Rahman and Ahmad Abed Al Rahman	Kfartoun	4-Apr-17
Mohamad Hussein Hussein and Khaled Mohamad Hussein	Kfartoun	18-Apr-17
Ahmad Ali Youssef Salah, Hasan Hasan Salah and Adnan Ali Salah	Kfartoun	9-May-17
Moustafa Hada	Kfartoun	9-May-17
Richdi Khaled Al Adraa, Hani Khaled Al Adraa and Mohamad Khaled Al Adraa	Kfartoun	24-May-17
Ahamad Ahmad Al Adraa and Hani Al Adraa	Kfartoun	6-Jun-17
Hani Al Adraa	Kfartoun	12-Jul-17
Ahmad Ali Daher	Kfartoun	12-Jul-17
Ahmad Abou Amcha, Hasan Khoder Abou Amcha and Mouhamad Hasan Abou Amcha	Kfartoun	14-Aug-17
Khaled Hasan Khoder	Kfartoun	1-Sep-17
Ali Jaafar, Toaan Jaafar and Noura Jaafar	Karm Chbat	11-Sep-17
Khoder Hussein Melhem, Urki Hussein Melhem and Jamil Hussein Melhem	Kfartoun	7-Oct-17
Hassan Jaafar, Ahmad Jaafar and Medhit Jaafar	Rweimeh	9-Oct-17
Riyad Jaafar, Imad Jaafar and Mohamad Jaafar, Ali Jaafar and Ajaj Jaafar and Rached Jaafar	Rweimeh	16-Nov-17
Maher Chawki Al Adraa, Ahmad Hasan Al Adraa and Ahmad Moustafa Al Adraa	Kfartoun	13-Mar-18

Table 6-3 Meetings with Key Informants

Name	Role	Date	Meeting Type
Ahmad Baarini	Mayor of Fnaidek	20-7-2018	Face-To-Face Phone Call
Omar Zahraman	Electrical Engineer at EDL	20-7-2018	Face-To-Face
Mohamad Salaheldin	Municipal Official Fnaidek	20-7-2018	Face-To-Face
Samira Tannous	Mayor Secretary Qobaiyat	25-7-2018	Face-To-Face Phone Call
Abdo Adbo	Mayor Quobaiyat	25-7-2018	Face-To-Face Phone Call
Ahmad Omar	Association for Development of Akkar	6-8-2018	Face–To-Face
Farah Sankary	Akkar Network for Development	6-8-2018	Face–To-Face
Dr Antoine Daher	Environmental Council	11-8-2018 20-10-2018	Phone Call Face-To-Face
Abdo Jaafar	Focal Point of Rweimeh Village	28-9-2018	Phone Call

6.6.2.2. Key Informant Surveys

As part of the ESIA, a combination of research methodologies were employed to collect data regarding socio-economic conditions of villages neighboring the Project, namely those of Aandqet, Qobaiyat, Akroum and Kfartoun, as follows:

- Desk Review: collect relevant data on the local communities directly surrounding the Project.
- Baseline Socio-Economic Conditions: conduct interviews and meetings with key informants, mainly with the leaders of local authorities (heads of municipalities) and other officials, in order to gather the information on the current socio-economic conditions and identify the village profile of the towns/villages in the vicinity of the Project area.
- Social Impact Assessment: carry-out a qualitative research, through face-to-face interviews with opinion leaders, to provide inputs and predictions of local communities regarding the social impact of the Project.

Through 25 in-depth, face-to-face interviews, it was possible to generate data concerning the demographics and socio-economic situation of the communities that may be directly influenced by the Project. In addition, information regarding the social impact assessment analysis of the Project and the identification of positive and/or negative, as well as direct and indirect impacts including externalities on various socio-economic factors were obtained.

The field surveys were conducted between 7 September and 2 October 2018 by experienced and specially trained experts, through utilizing two tailor-made technical tools:

1. Village Profile Checklist.
2. Qualitative Discussion Guide.

The face-to-face interviews, which included meetings and contacting several local authority representatives, was essential to understand the Project circumstances on the ground and enabled the analyst to produce the proper technical tools that correspond to the project objectives and status. **Table 6-4** provides a list of individuals interviewed.

Table 6-4 Interviews and Functions of the Interviewees in Villages Affected by the Project

#	Village	Name of Interviewee	Position of Interviewee
1	Qobaiyat	Abdo Makhoul	President of Municipality
2	Qobaiyat	Laurete Daher	Member of Municipal Council
3	Qobaiyat	Tony Baisary	Member of Municipal Council
4	Qobaiyat	Charbel Ghossn	Head of Municipality Research Committee
5	Qobaiyat	Elias Issa	Mayor (Moukhtar)
6	Qobaiyat	Elie Shidyaq	Mayor (Moukhtar)
7	Qobaiyat	Remon Fares	Mayor (Moukhtar)
8	Qobaiyat	Habib Issa	Previous Mayor
9	Qobaiyat	Tony Al-Saifi	Owner of Generator for Public Subscription
10	Akroum	Abdo Asaad	Vice President of Municipality
11	Akroum	Khaled Abdallah	Mayor (Moukhtar)
12	Akroum	Daher Diab	Mayor (Moukhtar)
13	Akroum	Mohamad Hussein Yehya	Previous Member of Council of Mayors
14	Akroum	Attef Abou Ali	Previous Mayor
15	Aandqet	Omar Masoud	President of Municipality
16	Aandqet	Marwan Joureij	Vice President of Municipality
17	Aandqet	Ibrahim Al-Rukawi	Mayor (Moukhtar)
18	Aandqet	Joseph Imad	Mayor (Moukhtar)
19	Aandqet	Ibrahim Al-Qadi	Mayor (Moukhtar)
20	Aandqet	Pamela Badawi	Municipality Clerk
21	Kfartoun	Ahmad Al-Zein	President of Municipality
22	Kfartoun	Anonymous	Member of Municipal Council and Owner of Landed Property at the Project Site
23	Kfartoun	Khaled Melhim	Mayor (Moukhtar)
24	Kfartoun	Malek Al-Adrouh	Mayor (Moukhtar)
25	Kfartoun	Khaled Al-Adrouh	Principal of Secondary School

6.6.2.3. Household Surveys

A household survey campaign was implemented to: 1) support the collection of social demographic data; 2) understand access to energy, consumption, and how the lack of a reliable energy supply may affect livelihoods; 3) attitudes of the local population (households and small to medium enterprises (SMEs)) toward the Project and expectations around better energy supply. The household survey targeted the surrounding villages of Qobaiyat, Fnaidek and Rweimeh Village. The targeted groups were village households and included interviews with the mayors of Qobaiyat and Fnaidek and SMEs operating in the villages.

A sample survey is provided in **Appendix F**. Quantitative and qualitative information was collated through primary data collection and analysis and reflection on the perceptions conveyed by the various residents pertaining to the Project and the current energy situation. Specifically, the survey focused on the following three information categories:

1. Social: The collection of social demographic data, including population, age, size of household, number of children, social composition, unemployment, employment by sector, distribution of labor force, income levels, house ownership, seasonal residency, population health profile and access to basic services.
2. Economics: The collection of data to assess household and SME energy consumption and expenditure, the background of each active business operating in each village, the nature of the supply of energy and current challenges associated with purchase and distribution of energy by subscribing to generators, the costs and burdens of energy and how it impacts the region and livelihoods, and how the economic situation in the villages will be affected by better energy supply, i.e. stimulation of the micro economy.

   The survey was designed to reflect the actual energy supply situation through a series of qualitative and quantitative questions covering many areas of the village and its socioeconomic situation. Due to lack of knowledge, certain technical questions were left unanswered by the respondents.
3. Technical and Energy Indicators: The collection of data to assess sources of energy and electricity, duration of electrification, the willingness of residents to connect and pay for electricity, household and SME's knowledge and the expectations from the Project and wind turbine technology, acceptance of this new source of energy or their indifferent feeling towards it, and lastly, what they anticipate as Project challenges.

The research team conducted a total of 408 surveys, divided between Fnaidek and Qobaiyat, with a total of 176 in Fnaidek (88 households out of a total of around 1,100 households in the village and 88 active SMEs) and 232 in Qobaiyat (180 households out of a total of 1,300 households in the village and 52 active SMEs). The total number of surveys is equivalent to 11% of the permanent households and 100% of active SMEs. The findings from the baseline social survey are provided in **Section 16 Socioeconomic Conditions**.

It is noted that El Rweimeh Village was not surveyed as planned, as the Project Team was advised by the local mayors and the focal point of El Rweimeh Village (Mr. Abdo Jaafar) that they must be accompanied by village leaders who were not available at the time of the visit. In addition, El Rweimeh Village does not have a permanent resident population and its houses are occupied on a seasonal basis by members of the Jaafar Family, with winter occupancy reduced to just 10% of the 120 households. As such, Mr. Jaafar provided high-level socioeconomic baseline data, including population, months that the village has its highest population, livelihoods, etc.

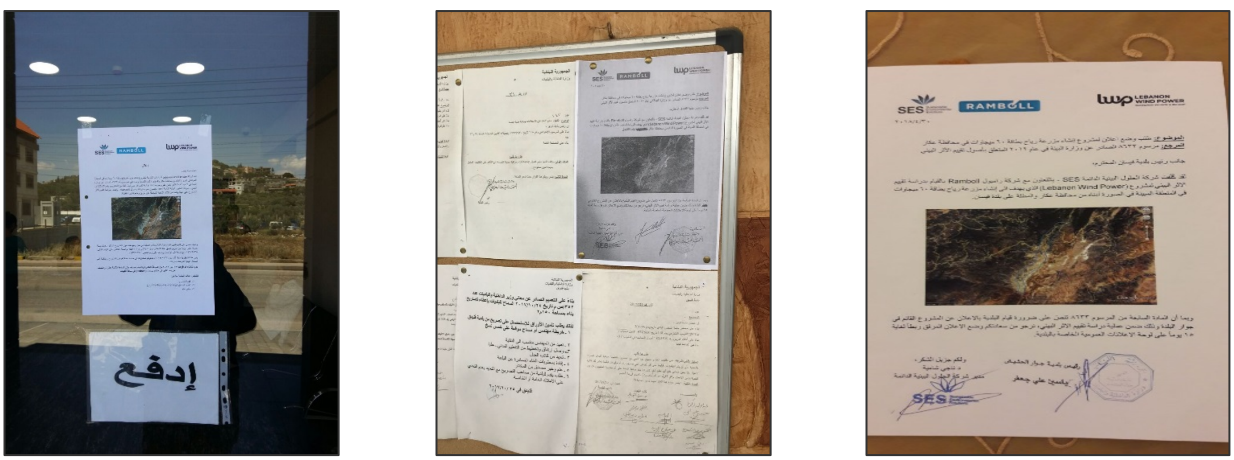
Mr. Jaafar has advised the Project Proponent that there are no objections to the Project by Rweimeh Village members, the construction of the substation in El Rweimeh Village, and/or the construction of the buried transmission line along the existing asphalt road and the existing track through Karm Chbat Nature Reserve.

6.6.2.4. Initial Public Disclosure Meeting

The Initial Public Disclosure Meeting took place on 15 May 2018. Announcements related to the Project were prepared and filed at the municipalities of the villages which own land in the Project area, namely Quobaiyat, Fnaidek and Rweimeh Village (includes Karm Chbat), and were posted on the municipal building entrance doors or information boards.

Rweimeh Village has no municipality; therefore, the announcement was placed at Jouar El Hachich, a nearby village as per the recommendation of a representative of the local people, as shown in **Figure 6-3**.

Figure 6-3 Placement of Public Announcements



a - Quobaiyat   b - Fnaidek   c - Jouar El Hachich

d – Public Disclosure Meeting

A copy of the announcement, formally registered invitation letters to the MOE, MOIM and MOEW, and list of attendants are also provided in **Appendix G**.

Project related discussions were undertaken with the Head of the Municipality of Fnaidek and the other meeting attendants. A seminar presentation was given by SES and included a description of the proposed project, the ESIA objective and scope and a summary of the major anticipated impacts and associated mitigation measures, also presented in **Appendix G**

The seminar was followed by a discussion whereby SES responded to the concerns raised by meeting attendants and committed to addressing them in the ESIA study. The discussions which took place during and after the meeting are summarized in **Table 6-4**.

Figure 6-3 shows photos taken during the meeting. Overall, a positive atmosphere prevailed and was encouraged by communicating:

1. The inclusion of environmental and social management measures during all Project phases.
2. The commitment of the Project Proponent to implement the latter measures.

Figure 6-4 Photographs of the Initial Public Disclosure Meeting






Table 6-4 Summary of Discussions During/Following the Public Consultation Meeting

Remark / Concern	Response
Mr. Majid Hachem, MOIM representative, was concerned about the status of the ownership of the parcels located at the top of the mountain i.e. whether they are public / municipal or private properties. He also advised that an official survey be implemented.	Mr. Ahmad Abdo Albaarini, Head of Municipality of Fnaidek, replied that these are municipal properties. He explained that Fnaidek municipality on the west side of the mountain ridge and Al Jaafar families from the east side have agreed on the border between their respective properties. It is the line separating the water catchments on the eastern and western slopes of the ridge. Mr. Jules Assi noted that the lands for the Project are not surveyed and have no title deeds. He added with the head of municipality of Fnaidek that they are going to proceed with علم وخبر with the help of the local head of municipalities and mayors (مخاتير) as well as a surveyor and the police, then the documents would be filed for certifying at the governorate of Akkar.
Mr. Majid Hachem noted that SES will be looking at the impact of the wind farm on the existing facilities without considering the depreciated value of surrounding land.	Dr. Abi Esber replied that there are 24 potential locations for the turbines and the latter will be compared to select the ones which will have the least adverse impact on the surroundings all while considering electricity production potential in the assessment; once selected the land(s) which will be leased for the turbines span up to 3,500m^2 around the turbine which increase the compensation potential for land owners. She finally added that the fact that most of the lands are publicly owned decreases the significance of the depreciation impact and make this area particularly attractive for the proposed development.
Mr. Jeff Gerges recommended that SES take into consideration the obligations of Lebanon under the international conventions (CBD and AEWA). He also added that the significance of the impact in terms of bird casualties needs to be evaluated in comparison to international guidelines which are available in this respect. He also enquired about the radar's mechanism and whether it can automatically shut down the relevant turbine	Dr. Abi Esber ascertained that all relevant signed / ratified conventions will be considered. With respect to bird casualties, Dr. Abi-Esber explained that Dr. Jaradi, who is the Project's avifauna expert, is training the ESIA project team on the identification of birds in the study area, which is instrumental for the implementation of monitoring activities during operation; the latter would identify any important bird casualties evidently considering the relevant international guidelines. Mr. Jules Assi replied that the radar will detect the birds' presence and flyways and based on the latter info, it will be determined when to shut off the turbines. Fast internet communication will be established between radar, the management team and the operation team (including representatives of the international turbine supplier) so that the command to shut off the turbine is quickly executed. A decision was made by the Lebanese Government to favor the shut-down of the turbines during migration periods. The decision stipulates that the Lebanese government will cover the financial losses from the shut off of turbines during migration periods in order to protect important migrating birds. Mr. Ahmad Abdo Al Baarini added that birds in the area commonly fly on the sides of the mountains, not on the top which is very high, and this should minimize any adverse impacts to birds.
Mr. Majid Hachem enquired about the number of turbines and the total production capacity.	Dr. Abi Esber replied that based on the final layout of favorable locations, the number and size of turbines will be decided; only large turbines will be used (3.8MW-5MW) to minimize the environmental footprint.
Mr. Majid Hachem asked whether it is possible to disclose free of charge the meteorological data collected by the met masts.	Dr. Abi Esber replied that the data are the property of the Project proponent and that access to data needs to be negotiated with them. Mr. Jules Assi added that not all types of meteorological data are collected, only those relevant for turbine operation, i.e. wind speed and direction, pressure temperature and humidity. Other essential meteorological data like rainfall and cloud cover are not being collected.
Mr. Jeff Gerges asked for more information regarding the de-icing mechanism of turbines.	Mr. Jules Assi mentioned that turbines which are located in snowy areas will be equipped with a de-icing mechanism which is more expensive but can ensure sound operation during snowy periods. Mr. Bachir El Marj said that the technology resembles that used in airplanes.
Ms. Nathalie Karam stressed that the ESIA study under preparation needs to consider the following: • SEA for the renewable energy sector. • The letter sent from MOE to MOEW concerning the scope of the ESIA of the three wind farms. • An assessment of bats in addition to birds. • An assessment of floral species in the area indicating those with high ecological value. • The decommissioning phase. • The extended producer responsibility concept to be included in contracts with turbine suppliers in case of broken parts.	Dr. Abi Esber replied that the preliminary studies done by Dr. Jaradi, the Project bird expert, has shown that there are no bats. She added that a complete site survey will be conducted where all kinds of fauna and flora will be recorded; the survey will be done when the layout of proposed sites is finalized. Mr. Jules Assi assured that any defect or broken items will be the responsibility of the operating company.
Mr. Jules Assi asked Ms. Nathalie Karam whether the Ministry would mind if the three ESIA consultants involved in the ESIA studies of the three proposed wind farms undertake a single cumulative impact study to avoid redundant efforts.	Ms. Nathalie Karam ascertained that this is not a problem as long as findings from the cumulative study are reported within the three ESIA studies.

6.6.2.5. Site Visit by LCEC/Family Leader Meeting

A Site Visit was undertaken on 4 June 2018, to provide LCEC with an overview of the Project site, potential turbine locations and the substation location, as shown in **Figure 6-5**. The site visit was followed by a meeting with the focal point of El Rweimeh Village (Abdo Jaafar), General Daher and the Aandqet Municipality Mayor.

Figure 6-5 Site Meeting with LCEC

6.6.2.6. Iftar for Affected Communities

A public participation dinner was prepared on Ramadan (7 June 2018) for several of the Affected Communities, including Akroum, Kfartoun and Rweimeh Village, as shown in **Figure 6-6**. The dinner was held to provide a better understanding of the Project design execution and the implications on the surrounding environment. Iftar is one of the religious observances of Ramadan and is often done as a community, with people gathering to break their fast together.

6.6.2.7. Land Rental/Ownership Impact Meetings with Officials

Discussions were undertaken with officials regarding land rentals and potential ownership impacts from turbines such as noise, shadow flicker and visual amenity as follows:

- 20 July 2018 - Meeting with Mayor of Fnaidek Ahmad Baarini.
- 20 July 2018 - Meeting with Municipal official Fnaidek Mohamad Aalah El Din.
- 25 July 2018 - Meeting with Mayor Secretary of Quobayat Samira Tannous.

Discussions included what job opportunities would be created by the Project, along with the general terms of the rental contract.

Figure 6-6 Iftar for Affected Communities

6.6.2.8. 2-Day Visit by Bank Audi/SLR

A 2-day site visit was undertaken by the Project Proponent with representatives of Bank Audi and their ESIA Reviewer, SLR, on 2 October 2018. The purpose of this visit was to provide an overview of the Project area, including the general physical environment, road development, power substation, transmission lines and operation buildings, and to discuss land ownership. In addition, meetings were held in Tripoli with the Mayor of Fnaidek, Mr. Ahmad Baarini and with Mr. Abdo Jaafar, focal point of the Jaafar Family to discuss the potential negative and positive impacts of the wind farms projects. The site visit was followed by a meal as shown in **Figure 6-7**.

On the second day (3 October 2018), several meetings were undertaken to discuss the potential negative and positive impacts of the wind farms projects as shown in **Figure 6-8**:

- A meeting with the Vice-Mayor of Aandqet, Mr. Marwan Greig.
- A meeting with a local NGO, the Environment Council in Quobaiyat.
- A meeting with General Khaled El Daher and representatives of the families of Kfartoun.

6.6.2.9. 2-Day Visit by International Lenders

The purpose of this 2-day visit 8-9 October 2018 was to have an overview of the Project, the physical environment, road development, land ownership, the substation location, the underground transmission line and the location of the operation buildings, as shown in **Figure 6-9**. International lenders Bank Audi, EIB, Proparco and Finance in Motion attended the site visit. In addition, the lenders met the mayor of Aandqet, Daher Family (General Khaled El Daher), and with the family of Jaafar, where representatives from all the communities of the project were invited, as shown in **Figure 6-10**.

Figure 6-7 Day 1: 2-Day Visit by Bank Audi/SLR

Figure 6-8 Day 2: 2-Day Visit by Bank Audi/SLR

Figure 6-9 Site Visit by International Lenders

Figure 6-10 Meeting with General Daher and Representatives of the Families of Kfartoun

6.6.2.10. Site Visit by Potential OEMs

A site visit was undertaken by the Project Proponent with representatives of three of the four potential OEMs, Siemens, GE and Nordex, on 12 October 2018, as shown in **Figure 6-11**. The purpose of this visit was to provide an overview of the Project area, including the general physical environment, road development, power substation, transmission lines and operation buildings, and to discuss land ownership.

Figure 6-11 Site Visit by Potential OEMs

6.6.2.11. 2-Day Visit to Lebanon by VESTAS

A site visit was undertaken by the Project Proponent with representatives of VESTAS on 24 October 2018. The purpose of this visit was to provide an overview of the Project area, including the general physical environment, road development, power substation, transmission lines and operation buildings, and to discuss land ownership. This was followed on the same day with a meeting between the VESTAS Head of Security and Amid Daher to discuss security conditions in the Project area, the VESTAS approach to security, and VESTAS' intent to employ locals. During the second day of the visit, the Vestas Head of Security met in Beirut with Mr. Abdo Jaafar (from the Jaafar Family) and Mr. Omar Massoud (the Mayor of Aandqet) to discuss security conditions in the Project area, the VESTAS approach to security, and VESTAS' intent to employ locals.

6.6.2.12. Focus Group Meetings

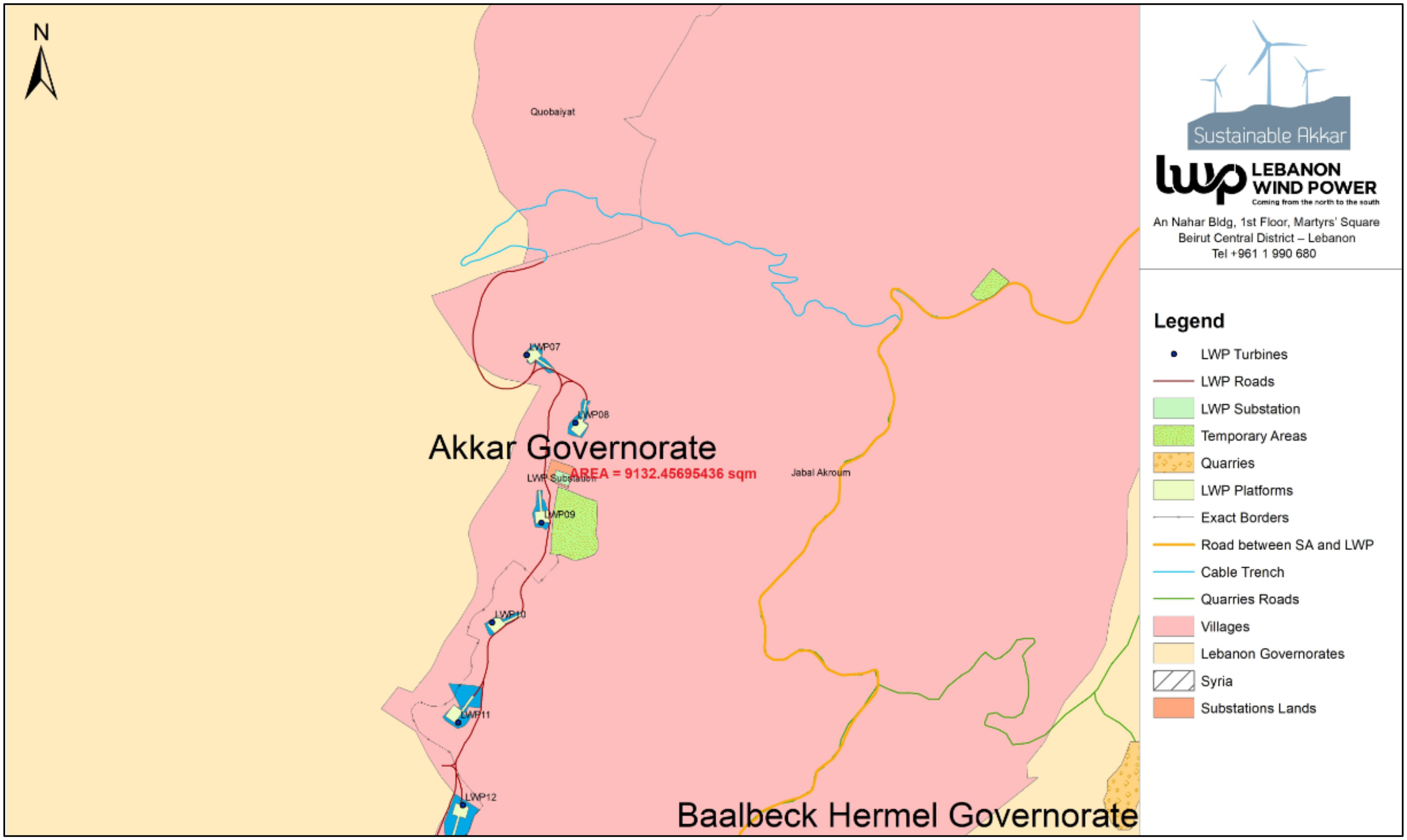
Two focus group meetings were organized on 2 and 4 November 2018, with a group of hunters who usually hunt in or in close proximity to the area where the Project turbines will be installed and a locally active non-governmental organization (NGO), the Environment Council in Quobaiyat (مجلس البيئة - القبيات).

After introducing the Project to both groups, feedback was collected regarding their knowledge of the wind energy technology and the proposed Project. Their perceptions regarding the Project and its effects, along with the management mitigation measures that the Project Proponent will be adopting to eliminate or reduce impacts were discussed, especially potential impacts to the natural reserve adjacent to the Project site. Photographs of the Focus Group Meetings are presented in **Figure 6-12**. The findings from the focus groups meetings are provided in **Section 16**.

Figure 6-12 Photographs of Focus Group Meetings

The hunters in attendance were specifically engaged regarding the use of one of the existing tracks used by hunters for construction of the underground transmission line between the Project and Lebanon Wind Power wind farm, as shown in **Figure 6-13** (Note: the hunters have requested anonymity). During the meetings, the hunters were advised they would be prohibited from using this track during installation of the transmission line. The hunters advised that the track is only one of many used by hunters, and that hunting only occurs as a hobby --- not for subsistence or to support livelihoods (refer to **Section 16 Socioeconomic Conditions**).

Figure 6-13 Existing Track through Karm Chbat Forest Reserve for Underground Transmission Line[1]



[1] Refer to Sections 5 and 6 for additional information regarding hunters and the use of existing tracks.

6.6.2.13. Visit to Turkish Wind Farms by Locals and EDL

A site visit to a wind farm in Turkey was undertaken on 21 November 2018, along with representatives of Sustainable Akkar, so that land owner representatives, the Mayor of Kfartoun, Ahmad el Zein, Kanaan Family representatives, Adraa Family representatives, and Daher Family representatives, could observe the operation of the wind farm and its potential negative and positive environmental effects, as shown in **Figure 6-14**.

Neighbors of the Turkish wind farm were visited and consulted regarding their opinion about wind farms.

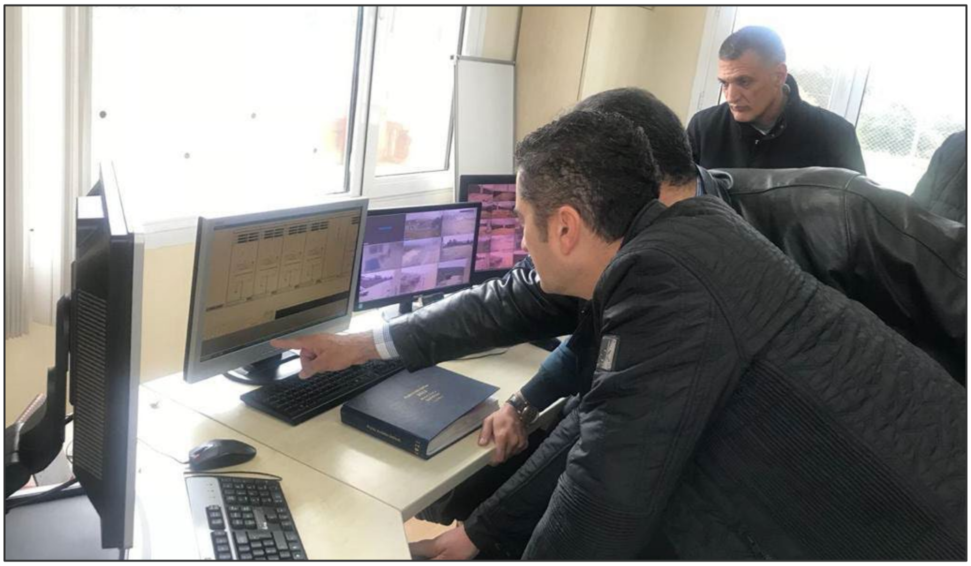
Figure 6-14 Visit to Turkish Wind Farms

On the same day, a team of seven EDL Heads of Units visited three wind farms in Turkey, along with representatives of the Sustainable Akkar and LWP team, to discuss the challenges they may face with the operators. The Turkish wind farm operators showed them the WTG performance monitoring system and SCADA data analysis, as shown in **Figure 6-15**.

6.6.2.14. November 2018 Hawa Akkar Public Meeting

Invitations to the villages were sent out 2 weeks prior to the public meeting undertaken by Hawa Akkar on 8 November 2018, in both written and oral form (i.e. with an official registered letter, or phone or personal communication/visit). The interest was low, as no one from the villages along the road corridor were noted in the attendees.

Figure 6-15 Review of WTG Performance Monitoring System and SCADA Data Analysis



6.6.2.15. Final Public Disclosure Meeting

A final public disclosure meeting took place on 1 December 2018 at the Qammouaah Plain in Fnaidek Village. Similar to the Initial Public Disclosure Meeting, announcements related to the meeting schedule and location were prepared and filed at the municipalities of the villages which own lands in the study area (refer to **Appendix F**) and were posted on the municipal building entrance door or on information boards. Two newspaper announcements were published twice on the most read newspapers in Lebanon (An-Nahar and L'Orient Le Jour) in addition to announcements of the social media and inside the villages of Fnaidek, Rweimeh Village, Qobaiyat, and Jouar El Hachih. Announcements regarding the meeting were also published in two popular local newspapers, Annahar and L'Orient Le Jour. The MOE, MOIM and MOEW were invited to the meeting through formally registered invitation letters.

A seminar presentation was given by SES and included a description of the proposed Project and a summary of the findings of the ESIA studies, including analysis of impacts and the proposed Environmental and Social Management Plan, the general findings of the ESIA study being conducted, and actions that were taken by the developer in order to mitigate any potential negative impact of the wind farm on the environment. The seminar was followed by a discussion whereby SES and the project developer replied to the concerns of the meeting attendants and committed to addressing them during project implementation and operation.

Overall, a positive atmosphere prevailed including lively discussions and exchange of ideas. The project developer committed to addressing all concerns and invited the attendants from the local public to apply for job opportunities offered by the project. **Table 6-5** summarizes the discussions which took place during and after the Final Public Disclosure Meeting.

Figure 6-16 shows photographs taken during the meeting.

Table 6-5 Summary of Discussions During/Following the Final Public Disclosure Meeting

Remark / Concern	Response
Mr. Mohammad Al Sayed, electrical engineer, was concerned about the accuracy of the deadlines. He said: since 2014 the Lebanese government was talking about the wind farms and promised renewable energy in 2018, now we are in December 2018 and the current deadline is 2020. He suspects that 4 months are not enough for project implementation, knowing that in Europe, the implementation of such wind farm needs up to 18 months.	Mr. Jules Assi, LWP Project Coordinator, advised that work on the wind farms could not be mobilized before November 2017, when LWP, Sustainable Akkar and Hawa Akkar signed the PPP agreement and they were allowed to start working. They have a 36-month term for the final delivery of the project.
Mr. Mohammad Al Sayed asked about the infringements made on the public power grid and what is the solution provided by LWP.	Mr. Jules Assi replied that the LWP agreement with MOEW includes producing electrical power and supplying it to the public grid. The solution for the infringements is not within the scope of the project developer.
Mr. Ahmad Zakaria, teacher holding a degree in the renewable energy domain, asked if the wind farms can provide enough electrical power to satisfy the commitment by the government to supply 12% energy demand through renewable energy sources. He also asked whether the implementation of the wind farms would cover the electrical power shortage.	Mr. Jules Assi replied that the planned 3 wind farms are able to satisfy a significant portion of the commitment, and that they will supply 25% of the shortage.
Mr. Mohammad Al Sayed asked where the remaining 75% of the shortage will be supplied from.	Mr. Jules Assi advised that this is a concern which needs to be taken care of by the Lebanese government.
Mr. Georges Ghattas, representative of the TBWA Agency, was concerned about the noise, knowing that at an air speed of 20 m/s makes a remarkable noise even without the existence of a wind turbine He also asked whether a study was made on the impact on any future buildings that are to be constructed around the turbines He asked who is going to recruit the HSE expert. He finally enquired about the wind speed at which there will be electrical energy production.	Mr. Jules Assi advised that the wind turbines will stop working at wind speeds exceeding 25 m/s which is a self-protection mechanism to maintain the integrity of the turbine. Dr. Layale added that noise next to the turbine may be more than 100dBA but will decrease substantially at a distance of 200m from the turbine and people should not consider building houses at a distance lower than this. She also added that a vast majority of the lands surrounding the turbines are public lands with no title deeds, and therefore with limited potential for investment in projects other than those supplying governmental services, a fact which decreases the significance of the latter noise impact. Mr. Jules mentioned that noise from any electrical appliance inside a house could be more than 60dBA. He also replied that LWP will recruit its own HSE expert who will be responsible for the follow up on environmental management at the Lebanon Wind Power wind farm. He advised that electrical energy production starts at a minimum wind speed of 5m/s.
Dr. Mohammad Nour EL Din Ali, lecturer at the Arab University, asked if the number of trees that will be cut was quantified. He also asked if the Ministry of Environment will monitor the project implementation and functioning He also enquired about the party who will monitor noise levels during the operation of the wind farm He finally asked about the fate of the 3 met masts present onsite whether other masts will be installed.	Dr. Layale advised that the number of trees present in the immediate construction zone were quantified and referred to the relevant tables about the matter in the presentation. Dr Layale also added that LWP is responsible for recruiting an HSE specialist who would need to properly implement all ESMP requirements. She also added that the Ministry of Environment would conduct inspections in the future to ascertain that the ESMP is implemented and that the latter inspections may involve actual measurements. Mr. Jules added that the lending banks also have third party auditing processes who would check for ESMP implementation and compliance with environmental standards before giving clearances to release payments to the project developer.

Remark / Concern	**Response**
	Mr. Jules also added that the 3 meteorological masts will stay until February 2019, and afterwards another 3 will likely be added by the turbine manufacturer all while keeping one of the old 3 met masts for calibration purposes. Mr. Jules advised that the Lebanese government will also be supervising their work.
Mr. Ahmad Khaled Zakaria, mechanical engineer, was concerned about the coordination between LWP and the municipality in the selection of turbine locations. He also asked who is going to benefit from the project? What is the approximate turbine size? And what is the turbine height?	Mr. Jules advised that once a turbine manufacturer is selected and the final places of the turbines are chosen, the municipality will directly be notified about the latter. In terms of benefits, Mr. Jules explained that there will be recruitment of up to 200 persons during construction from the local community in addition to several jobs during operation. He also added that the local municipalities and communities will benefit from road widening activities and the development of new roads. With respect to turbine size, Mr. Jules answered that it is not yet decided, but that the hub height will be approximately 105m.
Mr. Georges Ghattas was concerned if there is an impact on the groundwater	Dr. Layale explained that wind farms are not associated with a negative impact on the groundwater. She also added that the groundwater is very deep in the project area, and that WWTPs will be installed at wastewater generation points to ensure the safe treatment and disposal of wastewater.
Mr. Abed EL Ileh Zakaria, head of the union of the municipalities in El Kaytea, was concerned about the road to be taken when the construction starts. Is it going to be through Qobaiyat? He suggested a road from El Deniyyeh to Fnaidek.	Mr. Jules answered that the road to be taken starts from Tripoli port and continues to Minyeh, Abdeh, seaside road, Chadra, train railway, Wadi Khaled, Hawa Akkar site, Sustainable Akkar site, Rweimeh Village, then the Project site. He also added that the project developer does not mind discussing further the feasibility of the new proposed road with the municipality.
Mr. Ahmad Naaman, principal of Fnaidek public high school, was concerned about what parts of the turbine may present malfunctioning. He also asked about what can be done to help the locals, so they can have better chances to be recruited?	Mr. Jules answered that bad weather conditions, e.g. ice, very high wind speed may harm the turbine parts. He also added that the turbines have a de-icing mechanism when located at high altitude and will be stopped in extremely windy conditions. The monitoring and control of the turbines will be implemented by the turbine manufacturer in collaboration with a local control and support office. Mr. Jules also answered that there will be online and onsite training courses so that the chances of recruitment of the locals would be increased.

Figure 6-16 Photographs Taken During the Final Public Disclosure Meeting

6.6.2.16. Meetings with the Fnaidek Municipality

On 6 December 2018, several meetings were held between LWP Project Management Team and representatives of the Municipality of Fnaidek to discuss the terms of the rental contract between the two institutions. Fnaidek municipality was represented by the Mayor Mr. Ahmad Baarini and Dr. Mohamad Ali while SA/LWP was represented by Me. Adele Halabi (lawyer of SA/LWP), Mr. Jules Assi and Eng. Sarkis Farah.

The main topics discussed during the meeting included the following:

1. Duration of this contract?

28 years. The rental contract is divided into three phases:

- Phase 1: Study and construction: 2 years.
- Phase 2: Operation of the wind farm: 25 years.
- Phase 3: Decommissioning: 1 year.

2. Number of parcels to be rented for the Project?

The municipality suggested renting out all the ridge, instead of renting parcels where turbines will be placed, at the same price of 7,000$/ MW installed capacity.

3. Price clarification as suggested by the companies?

The municipality asked if the 7,000 USD/MW was per installed capacity or per produced. The companies replied that the suggestion is per installed capacity. Therefore, if the selected EPC ultimately chooses to install 20MW on their lands, the total rental value will be as follow:

- Phase 1: During Construction: 700$ x 20MW = 14,000 USD / year; installation phase.
- Phase 2: Following Erection of Turbines: 7,000$ x 20MW = 140,000 USD/year, plus a 2% escalation per year; operations phase.
- Phase 3: During Decommissioning of Turbines: the final escalated yearly rate, paid on a monthly basis until decommissioning is completed.

4. Will a copy of the Lebanon Wind Power ESIA be provided?

Once the study is completed, it will be published on all of the lenders' websites for comment, and therefore, Lebanon Wind Power will share it with the municipality.

6.6.3. 2019 Activities

6.6.3.1. Ramboll Meetings with Family Leaders and Officials

Between 19 and 21 January 2019, Ramboll conducted discussions with Mr. Abdo Jaafar (of the Jaafar Family), General Amid Daher (of the Daher Family), Mr. Ahmad Baarini (the Mayor of Fnaidek), and Omar Massoud, as shown in **Figure 6-17**. Ramboll provided an overview of the ESIA and sought feedback regarding the baseline environment, analysis of impacts and the preparation of Environmental and Social Management Plans. All three leaders communicated the full support by the communities they represent.

Figure 6-17 Ramboll Meeting with Omar Massoud

6.6.3.2. February 2019 Public Meeting for Hawa Akkar

Hawa Akkar held a Public Meeting on 15 February 2019. Attendance at the Hawa Akkar Public Meeting is relevant to Lebanon Wind Power, and presented herein, as both projects will share the same WTG transport route. Invitations were sent out 2 weeks prior to the public meeting in written form (official registered letters) and by phone calls. Again, interest was noted as low, with one representative of a Union of Municipalities noted in attendance. In addition, representatives from the following NGOs were invited to this meeting, along with leadership from the villages noted above, as shown in **Table 6-6**.

Two of the NGOs were interested in attending and requested information via email since they could not attend:

- **Committee of Employee Women Union – CEWU**
  Address: Halba, Main Road, center Fakhoury, Facing Auxilia – First Floor
  Tripoli,Al Maarad street ,Badi3 Najjar building near Crystal Marhaba-third floor
  Tel/Fax: +961 6 382 280
  Facebook Page: **Committee of Employee Women Union**
- **Society for the Protection of Nature in Lebanon (SPNL) who are associated with BirdLife International and represent BirdLife Lebanon**
  An MOU was signed between Hawa Akkar and SPNL earlier in 2012 for involvement and cooperation regarding bird watching and presence on-site , office for BirdLife within Hawa Akkar offices once project is operational, etc. Hawa Akkar met with SPNL in 2011, 2012 and 2019 for additional discussions, however they could not attend the February 2019 meeting.

Table 6-6 NGOs Invited to Hawa Akkar Public Meeting

NGOs	
Conseil De L'Environment - Qobaiyat*	Organization for Human and Social Services in North Lebanon
SPNL (Society for the Protection of Nature in Lebanon)	Committee for Conserving the Environment in North Lebanon
ALMEE (Lebanese Association for Energy Saving & for Environment)	Safadi Foundation
Wild Animals and Birds Research & Information Center	Committee of Employee Women Union in North Lebanon (CEWU)
Committee of Bentael National Park	North Lebanon Economic Development Agency (North LEDA)
Communal Council for the Development of Tannourine	Live Akkar
Conservation of Environment Committee-Besharry	Inmaa Koura Akkar
Association For Development In Akkar	Akkar Network For Development
Horizon of Cultural Development	Machta Hammoud Youth Group

* Present in previous public sessions in 2018 (9 June 2018 and 8 November 2018), but not on 15 February 2019.

6.6.3.3. Meeting with Lebanese Army Representatives

On February 7, 2019, Lebanon Wind Power and Sustainable Akkar team met with the Lebanese Army at the Chadra Military Base, as shown in **Figure 6-18**.

Mr. Jules Assi, Engineer Bachir El Marj and Engineer Sarkis Farah engaged in a general discussion about Project details with General Youssef Haddad, Army Regional Director in Chadra.

The main topics discussed during the meeting were:

- How Lebanon Wind Power and Sustainable Akkar benefit from the Lebanese Army presence.
- Facilitating the procedure of acquiring necessary permits from the Lebanese Army to visit the site, especially for international personnel.
- Discussing the main concerns of the Lebanese Army, which included the following:
  - The noise impact of turbines on their barracks and the distance that should be maintained between the barracks and the turbines.
  - Shadow flicker and the length of the effect that will be visible for receptors.
  - The transport of the turbines, when and how it will be conducted, during which hours and the duration.

At the end of the meeting, General Youssef Haddad appointed Captain Abdallah Al Zohbi as the contact person between the Lebanese Army and the Project, in order to help with day to day tasks that may arise and requests, i.e. short notice permits for international personnel visiting the site.

Figure 6-18 Meeting with the Lebanese Army

6.6.3.4. Consultation with Villages Along the Wind Turbine Component Transport Corridor

Consultation activities were undertaken on 19-20 February 2019 with mayors representing the villages along the WTG component transportation route, from Tripoli to Sahle, and included the following, as summarized in **Table 6-7**:

- Tripoli
- Al Beddaoui
- Deir Amar
- Al Minie
- Al Nabi Kzaiber
- Zoug Bhannine
- Al Mahmra
- Al Aabde
- Khane
- Harat Al Jdideh
- Al Hissa
- Hissa
- Tall Hmaire
- Aabboudiye
- Janine
- Noura-El Tahta
- Dabbabiyeh
- Fraidis
- Menjez
- Rmah El Nahriye
- Chikhlar
- Chadra
- Machta Hassan
- Machta Hammoud
- Khaisa

Table 6-7 Consultations with Municipalities & Governors

Name	Villages Represented	Date
Al Fayhaa Union of Municipalities	Tripoli, Al Beddaoui, Al Minie and Qalamoun	19-Feb-19
Deir Ammar Municipality	Deir Amar	19-Feb-19
Al Minie Municipality	Al Minie and Al Nabi Kzaiber Village	19-Feb-19
Zoug Bhannine Municipality	Bhannine	19-Feb-19
Al Mhamra Municipality	Al Mhamra	19-Feb-19
Talmaaiyan Union of Municipalities on behalf of the Akkar Countryside Municipalities	Talmaaiyan, Aarida, Knaisse, Massoudiyeh, Tal Bireh, Tal Abbas East, Hissa, and Abboudiyeh	20-Feb-19
Kobet Al Choumra Municipality	Kobet Al Choumra	20-Feb-19
Mqaible Municipality	Mqaible	20-Feb-19
Governor of the Akkar Region	Akkar Region	20-Feb-19
Qobaiyat Union of Municipalities on behalf of the North Akkar Municipalities	Qobaiyat, Chadra, Mashta Hassan, Mashta Hamoud, Aouinat, Rmeh and Aaydamoun	26-Feb-19
Governor of North Lebanon	North Lebanon	26-Feb-19

Al Fayhaa Union of Municipalities

On February 19, 2019, the Lebanon Wind Power and Sustainable Akkar team met with the mayors of the coastal line municipalities within the Northern Governorate, starting at the Al Fayhaa Union of Municipalities (representing Tripoli, Al Beddaoui, Al Minie and Qalamoun) to the Akkar Governorate limit, i.e. the Mhamra Municipality.

Eng. Bachir El Marj and Eng. Sarkis Farah met each of the 4 mayors of the Al Fayhaa Union during their weekly meeting, as shown in **Figure 6-19**. The meeting was constructive, many questions were asked about the timeline of the transport of WTG components, the schedule of each transport, potential obstacles on the road and potential traffic blockage.

Figure 6-19 Al Fayhaa Meeting with Mayors of Tripoli, Al Beddaoui, Al Minie and Qalamoun

The main concern of the Mayors was the timing of the transport. The Mayors advised to undertake transport after 12am, when the traffic is at its lowest, and to avoid transport on weekends as much as possible as many people travel north (including Akkar) to/from Beirut where they work during the week. The Project team answered the Mayor's questions as follows:

- Timetable: Between 12am to 4am.
- Timeline of transport: 2 times roundtrip per week during weekdays.
- Number of trucks per transport: Total of 11 trucks roundtrip per transport day / 2 days per week during weekdays = total of 22 trucks roundtrip per week.
- Number of trips: Maximum of 17 turbines at Lebanon Wind Power = 22 trucks roundtrip per week for total of 8.5 weeks.

The Project team also informed mayors that a communications protocol is being developed between the Project companies and the MOIM for the transport of the turbines from Tripoli to the Project site. Once this protocol is ready, it will be distributed to the Mayors two to three months prior to the start of the transport. At the end of the meeting, Mayors emphasized their willingness to provide further coordination across the municipalities and Project companies and assisting in accomplishing the Project as the fastest possible.

Deir Ammar Municipality

On February 19, 2019, the Project team met with Eng. Khaled Dhaybi, Mayor of Deir Amar, as shown in **Figure 6-20**. Deir Amar is located at the first Lebanese Army Checkpoint along the WTG transport corridor.

Figure 6-20 Deir Amar Meeting with Mayor Dhaybi

Mayor Dhaybi was welcoming and offered to assist the Project companies by providing a Municipal Police escort to facilitate the transport of the WTG components. The Mayor's main concerns regarded the provision of electricity in the northern region and if Deir Amar will benefit from the Project, as Deir Amar has an Electric Power Plant and is a link between the north and other Lebanese regions. The Project team explained the Project details, including the output of the Project in megawatts (68.3 MW for Lebanon Wind Power and 82.5MW for Sustainable Akkar), and explained that the Project boundary ends when the companies connect to EDL's National Grid.

Mayor Dhaybi also asked about the presence of pedestrian bridges in Deir Amar. The Project team assured the Mayor that no pedestrian bridges will be completely removed to accommodate transport of the WTG components; however, they will be elevated to achieve the needed height clearance of 5m. In addition, the Project team confirmed that costs associated with any road improvements will be borne by the Company.

<u>Al Minie Municipality and Al Nabi Kzaiber Village</u>

On February 19, 2019, the Project team met with the Mayor of the Municipality of Al Minie, Mr. Zafer Zrayka, as shown in **Figure 6-21**. The Mayor informed the Project team that Al Nabi Kzaiber Village does not have a municipality and is under Al Minieh's municipal authority.

Figure 6-21 Al Minie and Al Nabi Kzaiber Village Meeting

The Mayor welcomes the Project and gladly expressed that finally some investment will be coming to the north area of Lebanon --- after being left by the central government of Lebanon. Mayor Zrayka was friendly and willing to cooperate with the Project companies. During the WTG component transport phase, the Al Minie municipal police will provide an escort for the convoy.

The Mayor's only question regarded the speed bumps in the area. He expressed his opposition to removing them because there are many exits, and speed bumps are the only way to ensure the safety of the road. The Project team suggested replacing the asphalted speed bumps with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass. Mr. Zrayka welcomed the idea, especially since the Project companies will be responsible for the expense of removing and reinstalling the speed bumps.

<u>Zoug Bhannine Municipality</u>

On February 19, 2019, the Project team met with the Mayor of Bhannin, Mr. Abou Tala Webheh , as shown in **Figure 6-22**.

Figure 6-22 Meeting with Zoug Bhannine Municipality

The proposed plan for the transport of WTG components was explained, and the Mayor advised that he was fine with all aspects. However, he noted that the Bhannine Municipality does not have an available police force to assist with the escort. Mr. Webheh was also concerned about the speed bumps in the area, and the Project team proposed the same solution of replacing the asphalted speed bumps with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass.

The Mayor raised another concern regarding people going to and from Akkar during the WTG transport. The Project team informed the Mayor of the planned steps that the Project companies will be adopting to mitigate this potential negative impact, as itemized below:

- Transport Timetable: Between 12am to 4am.
- Announcements will be made along the WTG transport route (i.e. from Tripoli to the entrance of the Project site).
- A communications protocol is being developed between the Project companies and the Ministry of Interior for the transport of the turbines from Tripoli to the Project site. Once this protocol is ready, it will be distributed to the Mayors two to three months prior to the start of the transport.

Al Mhamra Municipality

On February 19, 2019, the Project team met with the Mayor of the Municipality of Al Mhamra, Mr. Abed Elkader Osman, as shown in **Figure 6-23**. The Mayor was aware of the Project as he had attended the Hawa Akkar Public Meeting on 15 February held in Machta Hassan. The concerns raised by the Mayor were very aligned with the other municipalities, with the addition of concerns regarding the Abdeh Roundabout.

Figure 6-23 Meeting with Municipality of Al Mhamra

The Project team informed the Mayor that some modification might be needed on this roundabout, but any modification will be discussed with the municipality as it is under their authority. The Project team concluded the meetings by confirming that the cost of any modification to the roundabout that might be needed will be borne by the Project companies.

Meetings with Akkar Countryside Municipalities

On February 20, 2019, the Project team met with all 8 mayors of Akkar countryside municipalities within the Akkar Governorate at the Talmaaiyan Union of Municipalities, based on a request to gather all municipal leadership in the area, as shown in **Figure 6-24**.

The Talmaaiyan Union of Municipalities is located next to Qlaiyaat Military Airport on the coastal countryside of Akkar, and includes the following:

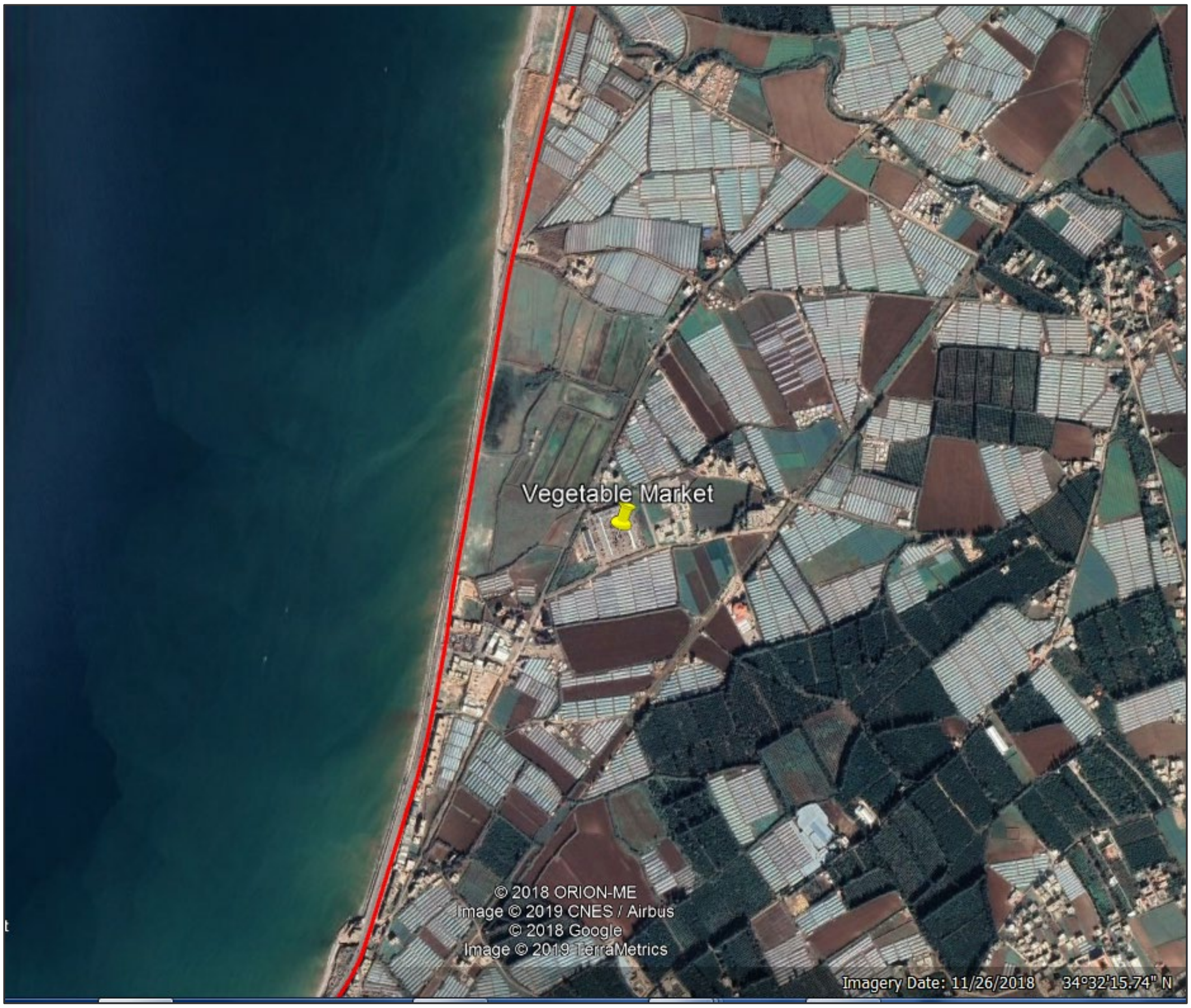
- Talmaaiyan (Mayor Mohamad Masri).
- Aarida (Mayor Ali Assaad Khaled).
- Knaisse (Mayor Khodor Idris).
- Massoudiyeh (Mayor Mohamad Ayash).
- Tal Bireh (Mayor Abd alhamid Saker).
- Tal Abbas East (Mayor Mohsen Saleh).
- Hissa (Mayor Mohamad Ali Hsein).
- Abboudiyeh (Mayor Mohamad Al Masoumaaii).

Figure 6-24 Meeting with the Talmaaiyan Union of Municipalities

The Project team introduced the Project and the purpose of the meeting. During the meeting, many questions were asked about the Project regarding electricity generation, road conditions, the timeline of the transport, the schedule of each transport, obstacles on the road and traffic blockage as follows:

- **Road conditions:** The road segment with the Talmaaiyan Union of Municipalities is only one lane in each direction, despite that it is the main road linking Akkar to the rest of Lebanon (as well as the main link between Lebanon and Syria). The following suggestions were made:
  - From Abde to Sheikh Ayash, widen the road by at least 1m on each side.
  - Improve the road quality by fixing potholes and maintaining the asphalt.
  - Put pressure on the government fund the Project with $800 million to widen the road.
- **Access to the Akkar Vegetable Market**: Farmers take their crops every day to the Akkar Vegetable Market, located ~0.35km east of the transport corridor between Al Aabde and Khane as shown in **Figure 6-25**, leaving at 2am and returning at 3am. It was suggested that the transport of Project trucks requires coordination with the Ministry of Interior as the Akkar countryside is the main supplier of vegetables to the northern territories and all of Lebanon. It is noted that access to the Akkar Vegetable Market is provided by other roads.

Figure 6-25 Location of the Akkar Vegetable Market



- **Transit:** The road is the main access for trucks going to and from the Lebanese-Syrian border; therefore, close coordination between the Ministry of Interior and Project companies in order not to affect the international trade between Lebanon and rest of countries.
- **Speed bumps:** Speed bumps should be replaced by rubber ones which can be removed and reinstalled after each transport.
- **Potholes:** Maintain the road and fix the potholes on the road from Abde to Sheikh Ayash.
- **Cars parked on the road:** This has to be coordinated with the Municipal Police prior to the beginning of each transport.
- **Electrical cables:** Cables lower than the clearance height should be replaced and increased to higher than 5.5m.
- **Electricity:** They urged to increase the electricity supply in Akkar countryside region, where many farmers need electricity to power water pumps to grow their crops.
- **Employment:** The Talmaaiyan Union asked the Project team to employ people from the Akkar countryside, noting the unemployment rate in this region as one of the highest in Lebanon.

- **Closing the Minieh-Abde exits:** Closing these exits will ensure that people won't crush the transport convoy by going against the traffic. This will ensure the safety of the transport.
- **Timetable and schedule of transport:** the transport will be two times per week from 12am to 4am. The convoy will consist of 11 trucks roundtrip per transport.

Kobet Al Choumra Municipality

On February 20, 2019, the Project team met with the Mayor of Kobet Al Choumra Municipality, Mr. Hussein Ali Ibrahim, as shown in **Figure 6-26**.

Figure 6-26 Meeting with the Kobet Al Choumra Municipality

In the meeting, the Mayor expressed his wish to cooperate with the Project's team to ensure the smooth transport within Kobet Al Choumra. The Mayor's main concern was the time of the transport; the Mayor advised to undertake transport between 12am and 3am to ensure that the Akkar Vegetable Market won't be affected by the convoy. The Mayor insisted on keeping the speed bumps on the 3km segment of road in Kobet Al Choumra, which is located at the exit of the vegetable market.

Mqaible Municipality

On February 20, 2019, the Project team met with the Mayor of Mqaible Municipality, Mr. Ali Hassan Alsaiid. The Mayor expressed his readiness to cooperate; however, he requested an accurate map of the access road from Mqaible to ensure that the road won't create any conflict between the communities. The Project team promised to give him the map(s) once it is finalized.

The Project team discussed the road condition in Mqaible, and the Mayor advised them to improve the quality of the road, i.e. use asphalt when opening the access to ensure better transport conditions from Mqaible to Akroum.

Akkar Governate

On February 20, 2019, the Project team met with the Governor of the Akkar Region in Halba, Mr. Imad Labaki, as shown in **Figure 6-27**.

Figure 6-27 Meeting with the Governor of the Akkar Region

The Project team provided an overview of the Project and technical information about the transport plan, timetable, schedule and number of trucks going from the Tripoli seaport to the site. The Governor appreciated the visit and offered help in any legal and technical issues which can facilitate the transport of the trucks.

North Akkar Municipalities

On February 26, 2019, the SA/LWP team met all seven mayors of North Akkar area based on a request to gather all municipalities in the area. The meeting took place in Qobaiyat Union of Municipalities. The Qobaiyat Union of Municipalities includes the following municipalities: Qobaiyat (Al Aabdeh), Chadra (Simon Hannah), Mashta Hassan (Mhamad Ahmad), Mashta Hamoud (Mhamad Khaled), Aouinat (Georges Wehbi), Rmeh (Georges Elias), Aaydamoun (CL. Youssef Abboud), as shown in **Figure 6-28**.

Many questions were asked about the project, electricity, road condition, timeline of the transport, schedule of each transport, obstacles on the road and traffic blockage. Below is a summary of the concerns and ideas that have been discussed during the meeting:

Figure 6-28 Meeting with North Akkar Union of Municipalities

- **Road condition:** The road was slightly better than the rest of the Akkar area, but it needs some improvement in order to successfully transport the turbines from the Tripoli Port to the Project site. The road needs some quality improvement by fixing potholes and maintaining asphalt in some section in Machta Hassan and Machta Hammoud area. Note: the internal roads of Machta Hassan and Machta Hammoud will not be used for transport.
- **Solar lighting poles:** When the team introduced the project, Qobaiyat and Machta Hamoud Mayors explained the issue of some renewable energy solution that been implemented in the area, such as solar lighting poles. The mayors explained the high maintenance cost of these poles, from the expensive batteries to transformers which have a life cycle of a maximum 2 years. The team explained the difference between solar and wind which does not require any storage system.
- **Quarry:** the road is main access of the trucks transporting rocks and gravel from Boustan area east-southeast of the Project site. The quarries are constantly maintaining the roads in the area in order to get support from the communities. The same maintenance activities have to be done by the Project Proponent.
- **Speed bumps:** Surprisingly, all mayors were against using speed bumps especially on Abboudiye-Rmeh highway. They have no problem at all with removing the speed bumps in this section of the road; however, they urged the Project team to keep the speed bumps in Machta Hassan and Machta Hammoud because it is a highly populated area and the roads are pretty narrow. Mayors told the team that the speed bumps should be built based on international standards: 3.75m long and 8cm in height. Note: the internal roads of Machta Hassan and Machta Hammoud will not be used for transport.
- **Potholes:** Maintain the road and fix the potholes on the road from Chadra to Machta Hammoud. Note: the internal roads of Chadra, Machta Hassan and Machta Hammoud will not be used for transport.

- **Electricity supply:** they urged to increase the electricity supply in North Akkar region because this area is the closest to the Project site and Qobaiyat has the main power plant which distribute the electricity to the whole region. The Mayors asked the Project team to put pressure on EDL to provide 24/7 electricity supply to the area, providing an example of the Shouff Area where a new landfill has been constructed there and the community put a pressure on EDL to provide 24/7 electricity supply to the area. The team explained that the municipalities in the area have to apply the pressure on the government and that the Project company has no right to change the electricity supply.
- **Employment:** the Union asked us to employ people from North Akkar area to work on the Project. The employment has to be divided equally on each municipality region. The Project team explained that the top priority is to employ people from the area surrounding the Project.
- **Chadra Roundabout:** Mayor Simon Hannah said that Chadra municipality paid around $50,000 to fix the Chadra entrance and createed a roundabout in order to facilitate the traffic flow from Machta Hassan and Machta Hammoud. If this roundabout is going to be removed during the transport phase, the Project team has to reconstruct it on its own expense. The team explained that based on the road survey study, the roundabout will not be removed.
- **Development:** the Project will contribute positively on the area, where people working on site will need accommodation, restaurants, and general services in the area.
- **Helicopter Option for Transport of WTG Components**: The Mayor of Machta Hammoud asked about using the helicopter option to transport the turbines to the site. The Project team explained that the road will be used for the transport of WTG components, noting that the Project company will maintain the road all the way from Tripoli Port to the Project site which will benefit the people using these roads.
- **Karm Chbat Nature Reserve:** The Mayor of Quobaiyat asked the Project team to put pressure on the government to declare the Karm Chbat Nature Reserve. Declaring the forest as a natural preserve will stop farmers from grazing goats there. Grazing is the main threat to the forest, where the goats constantly graze small trees; this is why there is only big trees in the forest and it is really rare to see newly trees growing. In addition to stopping the grazing, making the forest a natural reserve will stop people from the area from cutting tree just to use it as a heat source during winter.
- **Timetable and schedule of transport:** The transport of WTG components will be undertaken a maximum of two times per week from 12am to 4am. The convoy will consist of 11 trucks.

North Lebanon Governor

Eng. Bachir El Marj and Eng. Sarkis Farah met with the North Lebanon Governor (Ramzi Nohra) in Tripoli, as shown in **Figure 6-29**. The meeting was constructive, the team explained the transport plan, timeline of the transport, schedule of each transport, obstacles on the road and traffic blockage. The Governor was supportive and promised to facilitate any issue we will be facing before and during the transport.

Figure 6-29 Meeting with Governor of North Lebanon

Beirut Arab University

Eng. Jules Assi and Eng. Bachir El Marj presented the Project at the Beirut Arab University, Department of Mechanical Engineering, focusing on renewable energy and energy efficiency, as shown in **Figure 6-30**. The team introduced the Project to University staff and students. Students expressed happiness about the Project and asked about requirements needed to apply for a job during the construction phase. The team offered an internship program for students wiling to learn and get experience about wind farms.

6.7. Public Participation Outcomes

As indicated in the previous sections, extensive public participation activities have been undertaken since early 2017. Activities have included participatory planning, disclosure and dissemination of information, consultation & participation, an informal grievance mechanism (formalized herein as an outcome of the ESIA in the ESMP), and on-going reporting to local communities.

All affected communities have been engaged to: 1) support the collection of social demographic data; 2) gain an understanding of community access to energy, consumption, and how the lack of a reliable energy supply may affect livelihoods; 3) understand attitudes of the local population toward the Project and expectations around better energy supply. The prevalent response of those engaged has been extremely positive, with community leaders and members anxiously awaiting the construction and operation of the Project.

Figure 6-30 Project Presentation at Beirut Arab University

It is noted that Sunni and Shiite landowners in the Project area have historically disputed the division of land. After becoming knowledgeable about the Project details, the need for acquisition and leasing of land, and the Project's commitment to fairly distribute compensation through the location of wind turbines and substation, agreement concerning the division of land was reached over a short, 2-day period.

Project-related benefits have been expressed by community members as follows:

- Potential employment during construction and operations phases.
- Income generated by sale of land and land lease.
- Economic stimulus through provision of worker accommodation and meals at local hotels, apartments and restaurants.
- Provision of electricity to the grid to reduce or eliminate blackout periods.

There have been no objections raised by NGOs. The concerns expressed by stakeholders have been clearly documented and addressed as part of the decision-making process of the Project. Specifically, concerns have been incorporated into decisions regarding the following:

- Land rental agreements and compensation.
- Siting of wind turbines to avoid noise, shadow flicker and visual impacts to receptors.
- Road development, route selection and timing for the WTG components and construction materials.
- Employment opportunities.
- Maintaining access to hunting tracks and grazing areas.
- Minimizing impacts to the Karm Chbat Forest Reserve.
- Maintaining a buffer around the Lebanese Army Military Base.
- Common traffic management plan for Lebanon Wind Power, Sustainable Akkar and Hawa Akkar wind farms.
- Quantifying potential impacts to migratory birds.

High level meeting minutes from engagement with Akkar leaders is summarized in **Table 6-8**.

Though not present in the DAOI, particular attention was paid to vulnerable groups, i.e. Syrian and Palestinian refugees and the location of informal settlements, was considered. Based on the findings of the ESIA, vulnerable groups are not disproportionately affected by Project impacts (refer to **Section 16 Socioeconomic Conditions**).

Table 6-8 High Level Meeting Minutes

Mayor of Fnaidek , July 20, 2018 at 11:00 am:	
The meeting was to enquire about the Project, understand the position of the municipality and get some related information.	• **How many people are living in the village now?** It varies but approximately between 2,000 and 3,800 residents. • **Can you be specific?** I can't since we don't have any exact data of that but this from my knowledge • **Is the area still considered an agricultural village?** Yes, but not much since most work now outside the agriculture but some still care for their lands and some have leased it to others to care for it. We have about 4,000 farmers and 2,000 farmer residents working in farming on and off season . • **How many subscription generators are there?** I think 7 now and they are all managed by the owners of these generators. • **Are there companies and businesses that rely on the generators?** Yes, all of them, we don't get enough power, so we need to use generators. • **How about farmers?** Also, they rely on generators but depending on what they are doing since it is seasonal practice. • **Do you and the municipality welcome the idea of green energy?** Yes of course. • **Do you think that the supply of power from the windmill will help the area and its people?** Absolutely, it will enrich our struggling economy and support SMEs and households and it will bring contentment to people once they know they have power more. • **Do you think that SMEs and businesses here are effected by the cost of energy?** Yes of course, shops and companies that have high consumption from 50 to 100 and 150 Kw pay high. • **Do you think this will have a better economic impact once the project is operational?** Yes ,100% we are in a small village and central, if we have more electricity, shops will open longer and more often, and we will benefit from more trade and exchange of goods and sales. • **What do you know about green energy?** It is clean and effective way for getting electricity. • **What do you know about the windmill project and its energy ?** I know what we have been told about it and how effective it is for remote areas. • **Do you think your village is ready for such project?** Yes, we are ready. • **Do you think it will supply the village well?** Yes, if it is done well and if it is effective and cheaper than generators.

	• **What impact do you see it can bring on the residents, households and companies?** It will save them money. • **Do you prefer that the windmill be managed by the company?** Yes, and we are ready to assist in anyway. • **What are your expectations from this project and do you support and promote the idea?** The expectation is for sure positive and I do support and promote it. We are expecting that this supply of energy will increase commercial and touristic activities and have positive economic impact on the region and this is why I want this project strongly and I am willing to provide all support from the municipality since it is a project long been waited for and its benefits are plenty and inshallah it will have great economic and livelihood impact.
Meeting with Omar Zahraman, Member of Municipaal Council of Fnaidek, Electrical Engineer at the Electricité de Liban Akkar, 20/07/2018, at 12:30 pm	
The meeting was to enquire about the Project, understand the position of the municipality and get some related information.	**Are you aware of the Lebanon Windmill Projec?** Yes, of course. **Do you think it will happen?** Yes, and they are working on it. **What is in your technical opinion the level of consumption of electricity per household?** I pay, for example, around 100,000 lira per month for generators and around 50,000 for government electricity. It varies based on consumption, but the important part is that here the fees are 0.5 $ per KW and you have the monthly subscription of 25,000 lira. Generator owners do give less sometimes depending on the family but in general this is the charge. **What is the power outage in the area?** It also varies, but from 10 hours to 20 hours at times. **What are your thoughts on this project?** It is a great project for the region and we have long waited for it and wished for it to happen. It will definitely have positive impact on all sectors especially livelihoods since it will bring clean effective and affordable energy supply to the village and the region.
Meeting with Mohamed Salaheldine, Municipality Council Member, Fnaidek, 20/07/2018	
The meeting was to enquire about the Project, understand the position of the municipality and get some related information.	**Do you know about the project?** Yes of course, I believe the rumors have already spread about it and many know by now. **Are you personally supportive of this project?** Yes, for sure and especially the municipality. **What do you think about the project?** It is a good and if implemented and does not get any obstacles like other projects benefiting Akkar. **Any anticipated impact?** Saving money, increased supply of electricity, the whole region will be feeling better and of course better livelihood.

<table>
<tr><td colspan="2">Phone meeting with Dr. Antoine Daher, Environmental Counsel on 11 August 2018</td></tr>
<tr><td>The meeting was to enquire about the Project, understand the position of the municipality and get some related information.</td><td>Dr. Daher is fully aware of the project and all its details since he is part of the environmental counsel of Akkar. The phone meeting focused on his perspective and views on the project and the impact that it might carry on the region.

Dr Daher stated his support for this Project as he is a believer in clean effective alternative energy, but within this scope of green energy lies many environmental aspects that can be harmful to nature and is looking to see the Company’s feedback on the environmental assessment. For example, would the sound of the mills create noise and distortion on the households, what is the impact of the migrating birds flying at certain elevation?

Also, no technical awareness or publication has been posted to enlighten us about it, so we can support more especially that there are groups fighting this project in several villages and they are creating a negative lobby against it. Here it is the role of the company to engage us and allow us to better support them and present the facts concerning our environmental fears.

These lobbyists are the ones who will or did not get to benefit from the project financially and are spreading negative rumors and wrong facts about its impact.

More, we still need to know from the company what will be their plan of electricity supply and will effectively the Akkar villages will benefit or it will be as the rumors are saying that most of the electricity generated will go to support other regions outside the north and we will only get a fraction.

So overall, there are plenty of clarifications that are needed, and the company should be more proactive with us to make this project transparent and clear in terms of its objectives and goals.</td></tr>
<tr><td colspan="2">Ahmad Omar, Head of Akkar Development Association, 06/08/2018</td></tr>
<tr><td>The meeting was to enquire about the Project, understand the position of the municipality and get some related information.</td><td>He is in support of the project and aims that it will bring positive impact on the region since neighboring villages will also benefit. He also said that it will make the electricity burden less on households and improve overall livelihoods expressed in less spending and more saving.

Also, he wished that the Project will have also positive environmental impact and it will be far from houses. He is aware of the green energy solutions and knows about the project. His information regarding consumption and costs are similar to all answers obtained and his wishes was expressed that the project will eventually reduce the cost of energy and allow businesses to operate and work more since it will affect the positive chain or reaction effecting livelihoods.

He also indicated that women and kids are the primary target benefiting from the clean energy and the supply of electricity since they are the ones who spend most of their time at home. He also</td></tr>
</table>

	wished that the project as planned will provide consistent supply and not rationed supply and not benefit the region.
Mr. Abdo Abdo, Quobaiyat Municipality Mayor and Samira Tannous, Mayor Secretary of Quobaiyat -25 July 2018	
The meeting was to enquire about the Project, understand the position of the municipality and get some related information.	Mayor Abdo expressed that this project is a good project since it finally brings a viable solution that is not harmful to nature and it will bring effective and affordable energy to the region, however, he expressed concerns about the environmental pollution such as noise, birds, land use, and so on. He is supportive of the project and will do all it takes but he would like to see the engagement of the company also towards the citizens and enlighten them about the full scope and benefits of the project on Quobaiyat and other villages that shall benefit from the project. They are not interested in just being a land donor without enjoying the benefits of the project being installed on their land. As for Mrs. Samira Tannous, she also anticipates the financial and livelihood benefits the windmill shall bring and looking forward to seeing the impact as expected from this project especially when power outage has been a major livelihood problem across Lebanon and especially in rural areas.
Mr. Abdo Jaafar, Focal Point of Rweimeh Village Area, 27 July 2018	
The meeting was to enquire about the Project, understand the position of the municipality and get some related information.	Mr. Abdo expressed his full support from his side and he wishes that the project brings good and prosperity to the region and villages around especially in term of improving livelihood through more supply of electricity.

7. OVERVIEW OF STRATEGIC ENVIRONMENTAL AND ECONOMIC IMPACTS

It is understood that the Project will results in several site specific environmental and social impacts on various receptors throughout the Project phases to include planning and construction phase and operation phase. Such impacts are discussed in the subsequent chapters for each environmental receptor respectively and which include the following:

- Climate and Climate Change.
- Geology and Hydrology.
- Geophysical Ground and Seismicity.
- Air Quality.
- Transport and Traffic.
- Biodiversity.
- Bats.
- Ornithology.
- Socioeconomic Conditions (to include Land Use).
- Community Health, Safety and Security (to include Noise, Shadow Flicker, Visual Amenity and Traffic).
- Archeology and Cultural Heritage.
- Occupational Health and Safety.

Nevertheless, the Project will result in significant and crucial positive environmental and economic impacts on the strategic and national level given the current challenges the energy sector in Lebanon is facing which have serious implications on energy security as well as major economic burdens to the Lebanese economy. Such positive impacts are important to highlight, consider, and consider before investigating the potential negative environmental impacts anticipated from the Project, as discussed in the following sections. The anticipated positive environmental and economic impacts on the strategic level are discussed and highlighted below.

7.1 Lebanon’s Energy Sector

Lebanon still relies on fossil fuel, a non-renewable resource, for its energy consumption. Electricité du Liban (EDL) is the main public establishment responsible for the generation, transmission, and distribution of electrical energy in the country. Founded by Decree No. 16878 dated July 10, 1964, it currently controls over 90% of the Lebanese electricity sector. Unfortunately, due to decades of civil unrest and lack of political will, EDL is notorious for underserving the power demand of the country.

Overall, Lebanon relies on six principal sources of primary energy: 1) imported hydrocarbon fuels in liquid; 2) gaseous form; 3) imported electricity; 4) locally produced hydroelectricity; 5) biomass; and 6) alternative energy. In total, EDL is responsible for seven thermal power plants and three hydro-power plants generate electricity in the country with an installed capacity of 3,022MW, as shown in **Table 7-1**.

Table 7-1 EDL Generating Capacity in 2018

Thermal Power Plants		Capacity MW	Hydraulic Power Plants		Capacity MW	Total
Zouk	Onshore plant	805	Litani	Awali	108	
	Power barge	198		Joun	48	
Jieh	Onshore plant	408		Abdl Aal	34	
	Power barge	198	Bared	Bared (1)	13.5	
Sour		70		Bared (2)	3.7	
Baalback		70	Safa		13.4	
Zahrani		465	Nahr Ibrahim	Nahr Ibrahim (1)	15	
Der Ammar		465		Nahr Ibrahim (2)	12.5	
Al Hreesha		70		Nahr Ibrahim (3)	4.5	
			Kadisha	Balouza	8.4	
				Abu Ali	7.4	
				Mar Lichaa	3.1	
				Bsharre	1.6	
Total Thermal Capacity		**2,749**	**Total Hydraulic Capacity**		**273.1**	**3,022**

Source: Compiled from EDL (2018) and Fardoun et al. (2012).[1]

According to the 2016 NREAP, 68% the primary energy sources of Lebanon are generated through the power plants of EDL. The distribution network consists of 68 substations converting power from medium to low voltage and using more than 15,000 transformers to deliver electricity to every subscriber (EDL, 2018). The Quobaiyat Substation located 5km north of the Project (see **Figure 7-1**) and Halba Substation located 23 km northwest of the Project transmit and distribute electricity to Akkar Caza.

EDL's transmission network consists of many types of high voltage power lines including 66, 150, 220 and 400 kilovolt (KV) lines converting power from high voltage to medium voltage. In addition, the network includes more than 1,540km (1,336km of overhead lines and 178km of underground cables) of various voltages used for transmission and distribution.

Almost half the generation capacity of EDL (Zouk & Jiyeh Steam Plants) is nearing retirement while the operation of the other half (gas turbines) is sub-optimal since the plants run on gasoil instead of natural gas. Making the matters worse is the raising costs of electricity generation by the government, which has reached 0.17USD/kilowatt hour (KWH), while EDL insist on adopting a freezing tariff policy since 1994 (0.095USD/KWH for residential units, and 0.076USD/KWH for industries).

Approximately 7.5% of the total electricity production in 2009 was purchased from Syria (589GWH) and Egypt (527GWH) through regional interconnections. In addition to the deficit in electricity supply, the Lebanese electricity sector was facing several problems such as load shedding, technical losses, and the aging of power plants. This situation resulted in technical and financial impacts on customers, the Government, and the entire economy, and Lebanese end users were forced to rely on diesel generators to overcome the electricity shortages (MOEW/LCEC, 2016).

[1] Fardoun, F., Ibrahim, O., Younes, R., & Louahlia-Gualous, H. (2012). *Electricity of Lebanon: problems and recommendations*. Energy Procedia, 19, 310-320.

Figure 7-1 Quobaiyat Substation

As part of their effort to close the demand gap, the GOL has carried various actions including:

- For over two decades, the GOL has been purchasing electric power from Egypt and Syria through regional interconnections. In 2017, the GOL requested an increased electrical supply from Syria from 240MW to 300MW. This supply is usually accounted in the EDL official power generation records.
- The MOEW signed a contract in 2012 with the Turkish company Karadeniz Holding to provide power barges to serve as a stop-gap solution and supply 270MW into the national power grid. By June 2018, the contract was renewed for another three years under new terms; the company will provide Lebanon with more than 370MW by employing another power barge.[2]
- In 2017, the Lebanese government increased the power capacity of the Zouk and Jieh Power Plants through the addition of an installed capacity of 198MW in each plant, (EDL, 2017).[3] EDL is currently looking into the rehabilitation of the both power plants, in term of increased capacity, removal of obsolete material (asbestos), rehabilitation of soil, and even an overhaul of the Jieh Power Plant complete with dismantling of current units and construction of a new power plant (CDR, 2017).[4]

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[2] Azhari, T. (2018, June 17). EDL Extends Lease of Two Power Barges. *Daily star.* Retrieved from Dailystar.com.lb.
[3] EDL (2017) Enterprise Facilities. Retrieved from: http://www.edl.gov.lb/page.php?pid=37;
[4] Council of Development and Reconstruction (2017). Electricity. *Progress Reports October 2017.* Retrieved from www.cdr.gov.lb.

The country has yearlong power deficit that can reach up to 1,400MW during the summer. As of 2016, the peak power demand reached 3,594MW while the effective power production by EDL only reached 2,108MW[5], generating to 21 hours of electricity supply in Beirut and 14 hours outside of the capital. In response to the frequent power rationing by the government, local residents rely on private back-up generators.

As of 2010, private generators are satisfying 77% of the blackouts (LCEC, 2016).[6] Private generators operate using gas oil at notoriously low efficiencies rates, by comparison, the average generation efficiency of EDL from cradle to consumer gate is about 30% higher (MOE/UNDP/ECODIT, 2011);[7] thus, any given private generator is a wasteful and a major contributor to air pollution and costing the consumer 4.74 times more (per KWH) than government generated electricity.

In brief, Lebanon is plagued by chronic power rationing affecting economic growth and national satisfaction. This power production/generation deficit, the highest in the Middle East and North Africa (MENA) region (World Bank (WB), 2013)[8], is the result of three decades of technical and non-technical shortcomings including inadequate tariffs, misappropriation, war-related physical damages, ineffective regulatory framework, decrepit infrastructure caused by a dearth in investments, and the historic absence of a broad-based political commitment to resolve the energy crisis.

7.2 Energy Strategy for Lebanon

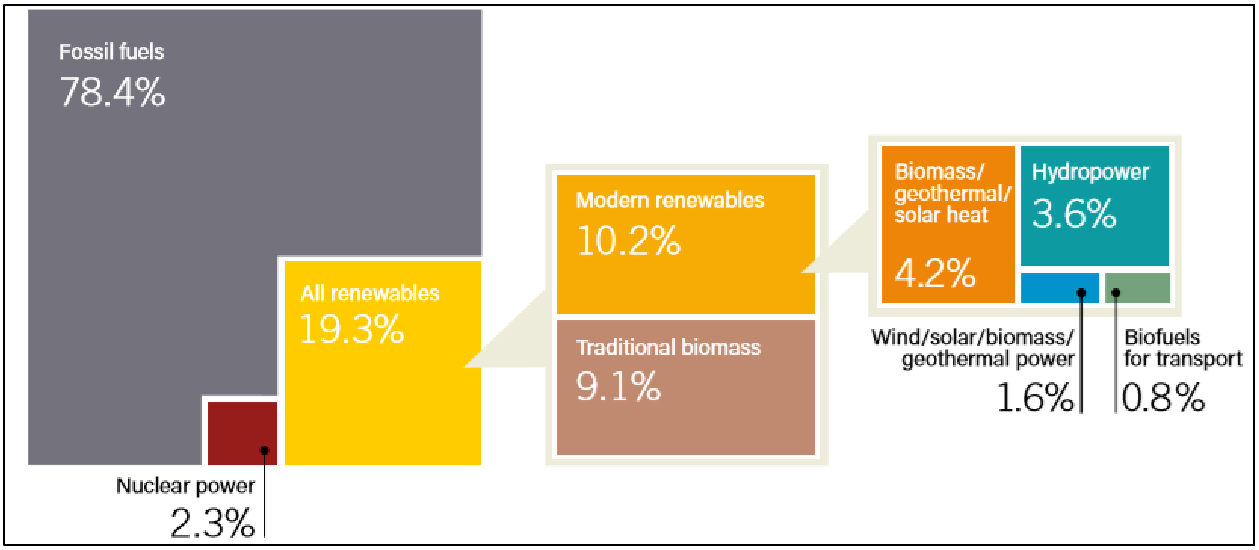
Clean renewable energy (RE) that comes from continually replenished resources such as sunlight, wind, rain, tides, waves and geothermal heat is becoming increasingly important as the world is facing the threats of climate change and depletion of fossil fuel reserves. Governments and world leaders started adopting laws and regulations to stimulate and commercialize RE sources.

Modern renewables have continued to grow strongly in all end-use sectors: power, heating, cooling and transport. In the power sector, renewable accounted for almost half of the estimated 921 gigawatts (GW) of electric capacity added globally during 2016. Wind and solar photovoltaics (PV) accounted for almost 47.8% and 33.65% respectively followed by the energy form biomass (~20%). Policymakers are increasingly aware of the wide range of benefits from renewables including energy security, reduced import dependency, reduction of greenhouse gas emissions, rural development and energy access.

By 2015, RE supplied an estimated 19.3% of global energy consumption (a 2.6% total increase from 2010); of which 10.2% derive from modern renewables such as hydropower (3.6%) and wind / solar / biomass / geothermal power (1.6%), as shown in **Figure 7-2**.

[5] Ashari, T (2018) Lights out as Demand surges for electricity. The Daily Star Published on 10 July 2018. Retrieved from: http://www.dailystar.com.lb
[6] LCEC (2016) The Second National Energy Efficiency Action Plan for the Republic of Lebanon [NEEAP]. Retrieved from http://climatechange.moe.gov.lb/viewfile.aspx?id=229.
[7] MOE/UNDP/ECODIT (2011) State of the Environment Report (SoER). [Chapter 9 – Energy Crisis].
[8] Enterprises Surveys. (2018). Infrastructure. World Bank Group. Retrieved from www.enterprisesurveys.org.

Figure 7-2 2015 Renewable Energy Share of Global Final Energy Consumption



Source: REN21 (2017)

In a bid to decrease the environmental footprint of its energy sector and align itself with the international efforts to reduce global Green House Gas (GHG) emissions, the GOL officially pledged to meet 12% of its energy consumption from RE sources by 2020 at the 2009 Copenhagen Climate Change Conference.

The Ministry of Energy and Water (MOEW) published the 2010 Policy Paper for the Electricity Sector that was approved by the Council of Ministers (COM) on 21 June 2010. In addition to proposing a strategic solution to the electricity sector in Lebanon, the Policy Paper built on the 12% commitment of RE by 2020 to propose some future milestones.

On the wind front, the MOEW published the *Wind Atlas of Lebanon*.[9] and a 2013 Request for Proposal (RFP) for developing the first utility-scale wind farm in Lebanon sparked private sector interest. At the U.N. Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015, the GOL also pledged to reach a 15% reduction in greenhouse gases (GHG) and 3% reduction in power demand by 2030 relative to a business-as-usual scenario:

- A 15% greenhouse gas (GHG) emissions reduction as unconditional, or 30% as conditional.
- A 15% of the power and heat demand in 2030 generated by renewable energy sources as unconditional, or 20% conditional.
- A 3% reduction in power demand through energy-efficiency measures in 2030 compared to the demand under the BAU as unconditional, or 10% conditional.

On the national level, several strategies and Action Plans have been put forth by different ministries to achieve these targets, most importantly the MOEW's 2010 Policy Paper for the Electricity Sector (PPES), the National Energy Efficiency Action Plan 2016-2020 (NEEAP), and the National Renewable Energy Action Plan 2016-2020 (NREAP). In detail, the PPES presents a detailed plan to revamp the electricity sector in Lebanon and aims to achieve 12% RE contribution to *"electrical and thermal*

[9] Atlas was produced in 2011 by CEDRO and funded by the UNDP.

supply" (PPES Section 5). However, the 12% RE coverage is an extremely ambitious goal especially for a country that has still to make important outlays to rehabilitate a deficient electricity sector. In energy terms, the current electrical energy demand is estimated at 16,400GWH; it is projected to reach around 20,000GWH in 2020 assuming a 3% yearly increase. Thus, by then, RE (hydro and non-hydro combined) should provide 2,400GWH of electrical energy to meet the RE target.

The NEEAP states 14 initiatives put together in compliance with the PPES to help Lebanon become an energy efficient country with a particular focus on renewable energy. The electricity generation from the wind power initiative aims to reach up to 200GWH per year by implementing small wind farms of capacity ranging between 60MW and 100MW.[10]

The NREAP considers four main technologies including eight energy sources in Lebanon to reach the projected 767 Kilotons of oil equivalent by 2020. The wind, solar, hydroelectric and biomass energy sources will account respectively for 2.05%, 4.05%, 3.24% and 2.5% of the total Lebanese energy produced. As of September, the GOL has launched bids for wind, solar, and is expected to launch bids for geothermal.

The current electrical energy demand is estimated at 16,400GWH, and is projected to reach around 20,000GWH in 2020 assuming a 3% yearly increase. Thus, RE (hydro and non-hydro combined) must provide 2,400GWH of electrical energy in order to meet the RE target. In February 2018, the minister of energy and power Cezar Abi Khalil signed the first power purchase agreement with companies of the private sector to build three wind farms of an individual capacity 200 MW.[11] The energy ministry's signing of the agreements represents Lebanon's first PPA with the private sector in electricity generation as part of efforts to close an estimated 1GW gap between current electrical supply and demand in the country.

7.3 Project Rationale

In assessing the feasibility, efficiency and cost effectiveness of the Project, wind resource potential, considering direction, speed and were considered. Wind resource potential was assessed using broad indicators sourced from existing information regarding wind activity, such as publicly available studies, the National Wind Atlas of Lebanon, historical measurements of wind speed and direction at various weather stations, etc. Wind potential data was also extrapolated from meteorological figures and wind data in nearby areas. Considering that energy generated by wind is proportional to wind speed, a localized 'wind atlas' of the planned wind farm was developed based on local wind speed data.

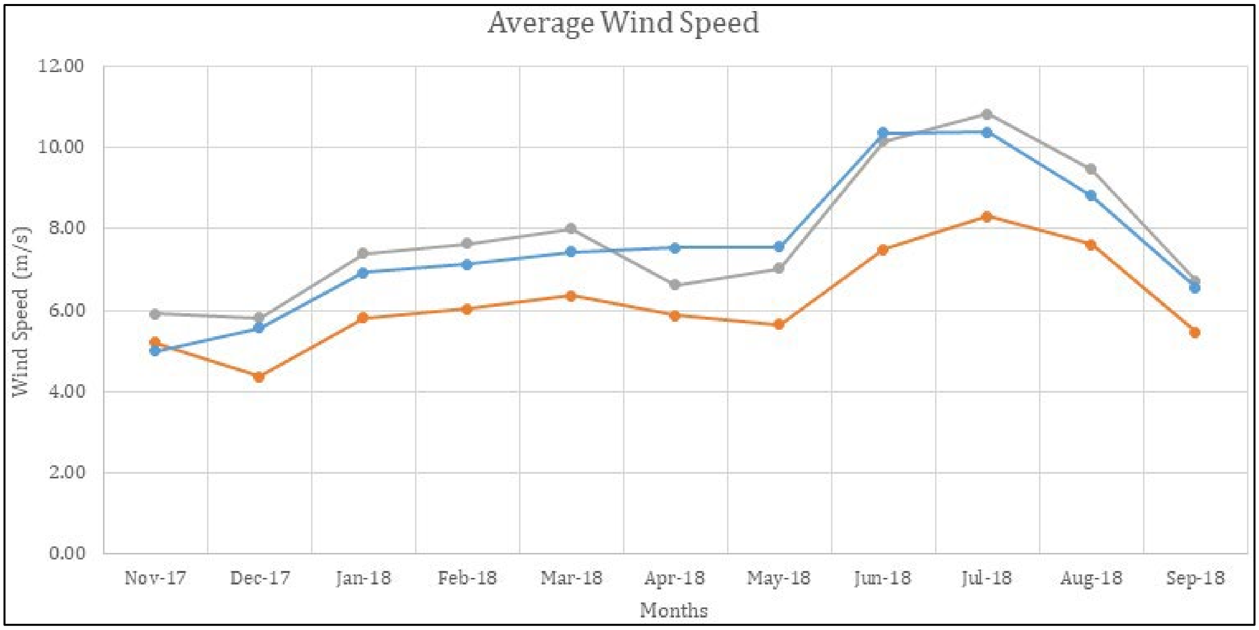
For more accurate and extensive assessment, three meteorological masts, MM1, MM2 and MM3 (Enisolar 80m and 60m models) were installed on site. The mast installations have been performed by ENISOLAR, and were supervised by LWP's third party wind expert, UL DEWI. In addition to an aviation light and a top lighting rod, each mast includes first class advanced top and low anemometers, wind vanes, a humidity and temperature sensor, an air pressure transducer, a data logger box. The data recorded by the mast is automatically sent twice daily to the Project team via internet. As is the case

[10] LCEC. (2011). The National Energy Efficiency Action Plan for Lebanon. Ministry of Energy and Water. Retrieved from www.rcreee.org

[11] LBCI. (2018). Lebanon signs wind Power Purchase Agreement. News Bulletin Reports. Retrieved from www.lbcgroup.tv.

across the Lebanese coastal zone, most winds blow from a westerly origin. Utility-scale wind power plants require minimum average wind speeds of 6 m/s (13 mph). The maximum recorded wind speed at site is 35 m/s, with the average wind speeds shown in **Figure 7-3**.

Figure 7-3 Average Wind Speed at Project Site



The measured wind direction and wind speed distributions for the masts for the highest measuring height are shown in **Figure 7-4** through **Figure 7-6**. The plots of the wind speed distribution show the parameters of the overall Weibull distribution (scale factor A, shape factor k) as well. The prevailing wind direction is west. The average wind speeds during the measurement periods are 6.3 m/s at MM1, 9.4 m/s at MM2 and 9.2 m/s at MM3.

An advanced time series correlation (MCP) was performed in order to extend the measured time series to a period of 1 year. The MCP-method applied has the added benefit of accurately predicting the wind distribution if sufficiently high quality data is available in both a high temporal and physical resolution. The entire correlation procedure is carried out depending on the wind direction, meaning that a relationship of the wind directions is calculated and that wind speed relationships are calculated for different direction sectors. These relationships are calculated for sectors, which are variable in size and depend on the amount of data in the sector.

To correct the short-term measurement to a long-term period, the monthly mean values measured at the Project site were correlated with the data from 10m SE (Damascus). **Table 7-2** presents the wind speed mean value for the short-term period and the resulting wind speed mean value for the long-term period. Wind turbine data from Vestas, Nordex, Siemens-Gamesa, GE and Senvion was then considered to calculate the resulting power curves in line with site-specific air density and the thrust coefficient.

Figure 7-4 Measured Wind Direction and Wind Speed Distribution at the Lebanon Wind Power Site – Mast 1

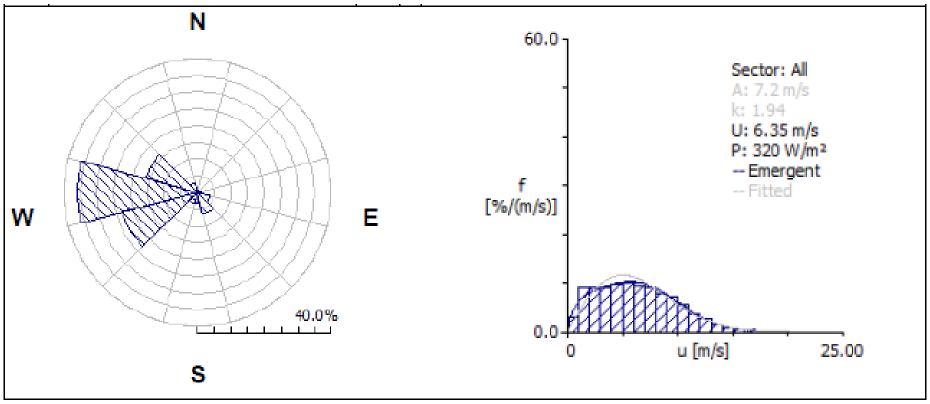


Figure 7-5 Measured Wind Direction and Wind Speed Distribution at the Lebanon Wind Power Site – Mast 2

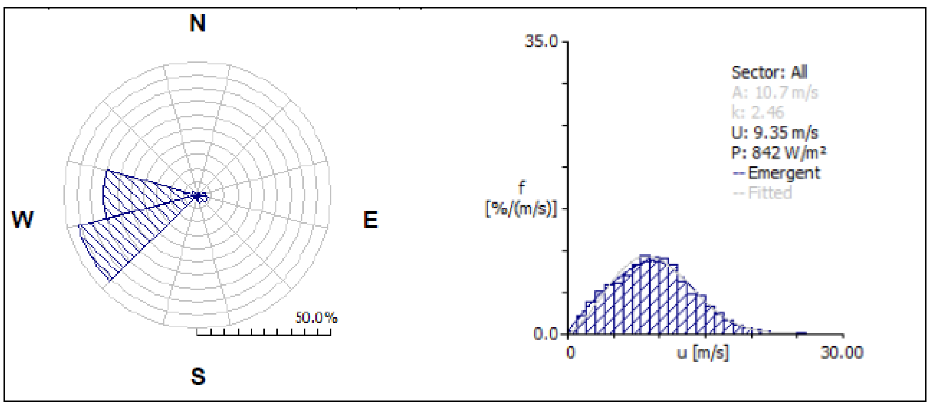


Figure 7-6 Measured Wind Direction and Wind Speed Distribution at the Lebanon Wind Power Site – Mast 3

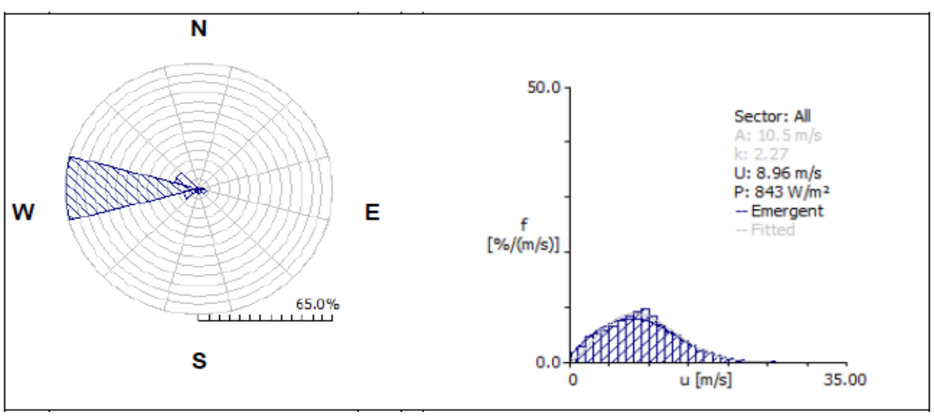


Table 7-2 Resulting Mean Wind Speeds and Scaling Factors for Long-Term Correction

Mast	MM1	MM2	MM3
Wind speed mean value for the 1-year period 2017-09-01 - 2018-08-31	6.01 m/s	7.82 m/s	7.68 m/s
Wind speed mean value for long-term period 2006-09-01 - 2018-08-31	6.00 m/s	7.81 m/s	7.67 m/s
Scaling factor for the site data to period 2006-09-01 - 2018-08-31	99.9 %		

Modeled Results

The following results are based on modeling the Project site meteorological mast wind data (corrected to the long-term average of 12-year (period 2006-09-01 - 2018-08- 31). The spatial variation of the mean wind speed for Lebanon Wind Power at the hub height of 110 m is depicted as different colors, as shown in **Figure 7-7**. The topography of the terrain is depicted as height contour lines. The positions of the reference points and of the wind turbines are marked in the map.

The gross energy yields were calculated by applying the power curves and thrust curves referenced above. The results are based on the site-specific time series using meteorological input data, calculated for each of the wind turbine positions. The results presented consider the potential farm losses caused by the adjacent Sustainable Akkar wind farm.

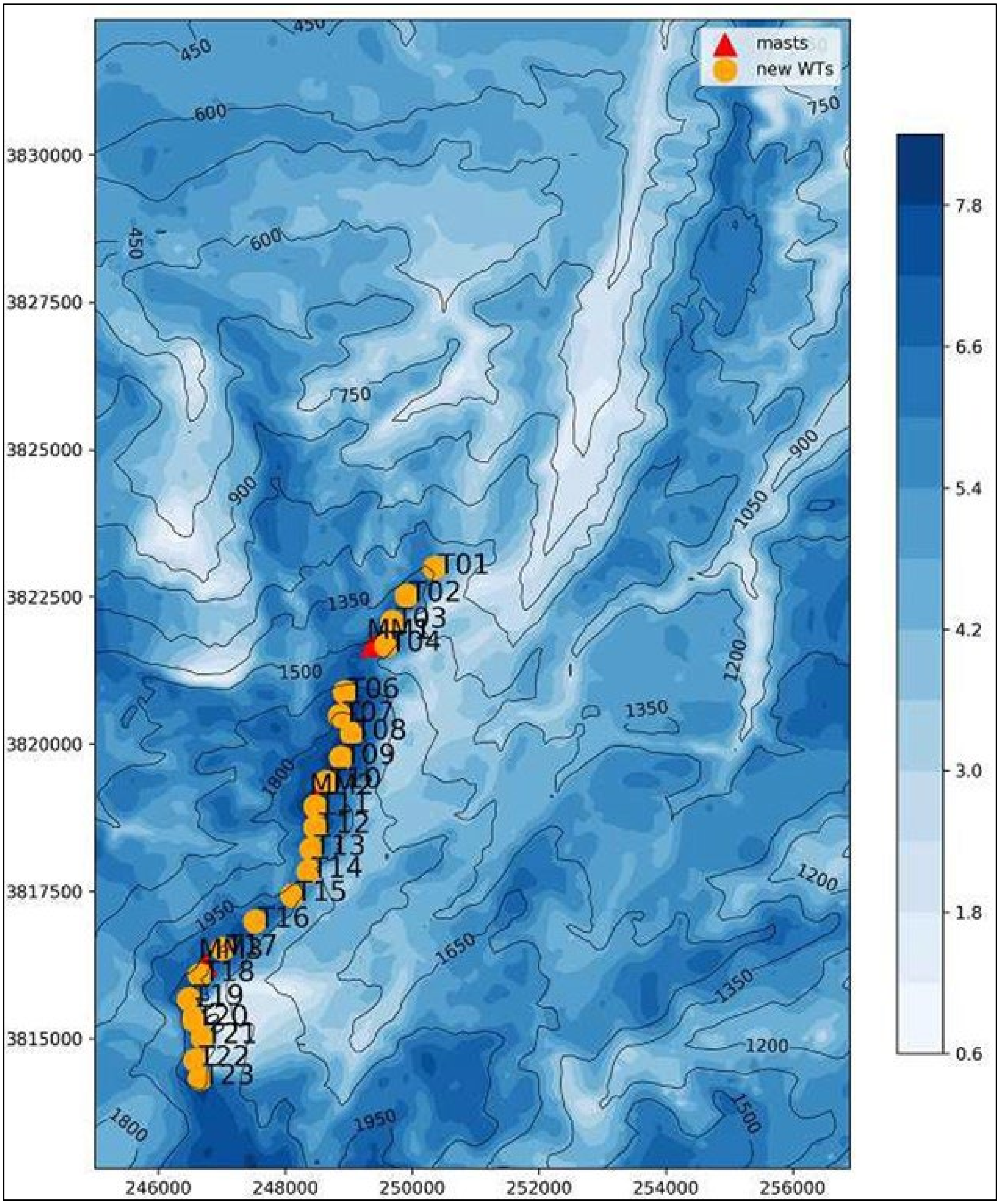
Table 7-3 summarizes the gross energy yield calculations for the entire Lebanon Wind Power wind farm, noting that all modeled capacities exceed 30%. It is noted that wind farm capacities above 30% are considered an economically viable project.

Table 7-3 Gross Energy Yield Calculations

WT-Type	Hub Height	Number of WTGs	Free Gross Energy Yield (entire farm)	Gross Farm Energy Yield (entire farm)	Gross Farm Energy Yield (per WT)	Farm Eff.	Average Wind Speed
	[m]		[MWh/a]	[MWh/a]	[MWh/a]	[%]	[m/s]
Vestas 4.2MW	105	16	234,405	228,381	14,274	93.2	7.1
SG 5.0MW	107	13	Calculations currently being undertaken.				
GE 5.3MW	101	11	186,678	181,819	16,529	93.2	7.1
GE 5.0MW	101	2	Calculations currently being undertaken				

Considering the above, the proposed Project is highly important for the region and is considered nationally significant as it will be one of the first grid connected wind power plants in Lebanon. Depending on the manufacturer selected, the Lebanon Wind Power Wind Farm will contribute the toward reaching Lebanon's RE target.

Figure 7-7 Mean Wind Speed (m/s) for Hub Height of 110m



7.4 Environmental Benefits

The negative environmental impacts from generating electricity through conventional fossil fuel burning at thermal power plants are very well known. This most importantly includes air pollutant emissions such as ozone, Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2), particulate matter, and other gases which are the cause of some serious environmental concerns such as smog, acid rain, health effects, and many others.

In addition, the burning of fossil fuels results in carbon dioxide emissions; a primary greenhouse gas emitted through human activities which contributes to global warming. The main human activity that emits CO_2 is the combustion of fossil fuels for electricity production and transportation. Concurrently, global climate change has become an issue of concern and so reducing greenhouse gas emissions have also emerged as primary issues to be addressed as the world searches for a sustainable energy future.

According the Biennial Update Report to the UNFCCC, published in 2017, Lebanon emitted 26,285 Gg CO_2eq. in 2013 with the most significant greenhouse gas being carbon dioxide, primarily produced from the burning of fossil fuels. The main contributor to greenhouse gas emissions is the energy sector (including transport) with 79% of GHG emissions, followed by industrial processes (10%) and waste sector (7%).

The emissions from Energy Industries, i.e. Electricité du Liban, is 7,392.08 Gg CO_2eq. representing 28% of the total for the production of 11,725 GWh in 2013, resulting in 630 t CO_2eq/GWh. CO_2 removals from the land use, land use change and forestry category amounted to 3,518.80 Gg CO_2, bringing Lebanon's net emissions down to 22,766 Gg CO_2eq.

Compared with the current conventional way of producing electricity in Lebanon through thermal power plants using heavy fuel oil and/or natural gas, generating electricity through wind power is expected to reduce consumption of fossil fuels, and will thus help in reducing greenhouse gas emissions, as well as air pollutant emissions. The Project will:

- Assist in solving the problem of electricity shortage on the local and national scales.
- Assist in achieving the commitment to 12% supply of energy through RE.
- Reduce GHG emissions since it will be displacing a largely fossil fuel-based electricity generating system, displacing metric tons of CO_2 annually.
- Saving millions of cubic meters of water per year in comparison to an oil-burning power plant which utilizes water for cooling.

8. CLIMATE AND CLIMATE CHANGE

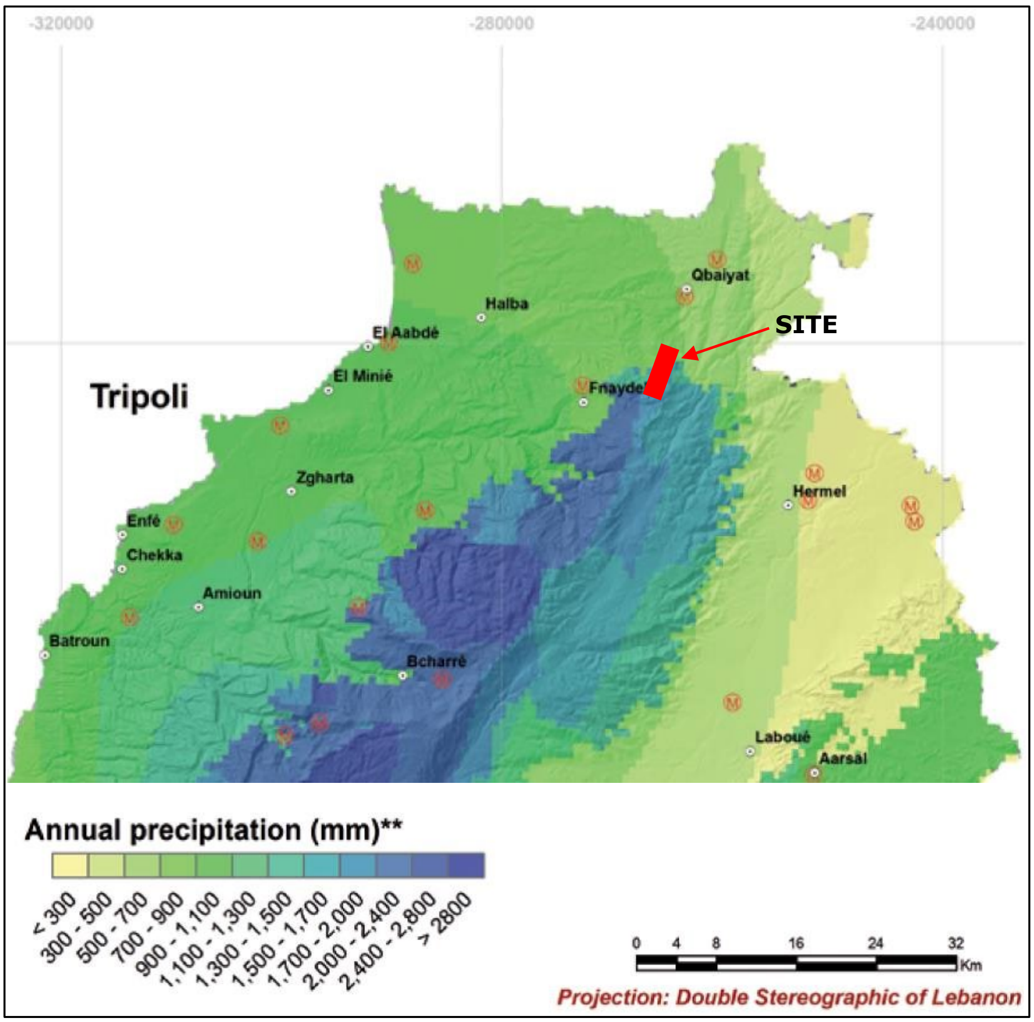
8.1 Baseline Methodology

No rain gauges were installed at the Project site. Climate and climate change conditions were obtained through literature review and assessment of data collected from three meteorological masts installed on site.

8.2 Baseline Findings

The climate in the study area is Mediterranean and is characterized by hot summers and relatively cold winters. The dry period extends from May to September whereas most rainfall occurs between December and January. A rainfall map of the region is provided in **Figure 8-1**.

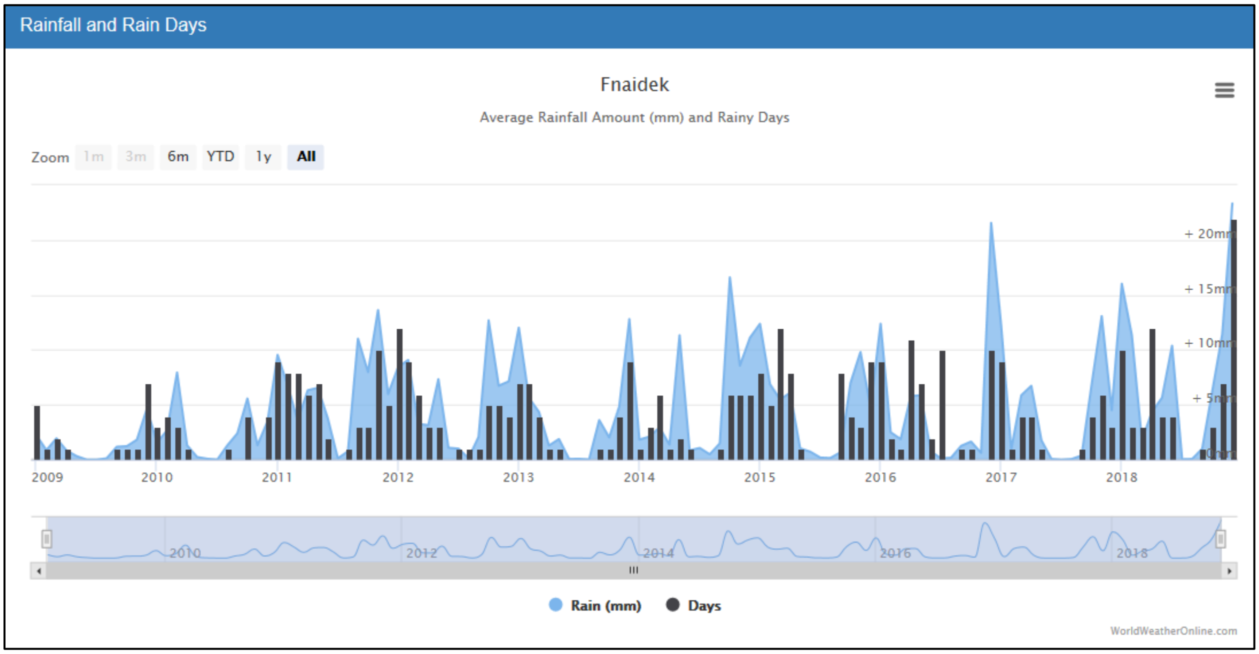
Figure 8-1 Annual Rainfall Map of the Region – 2011-2012



(MOE/UNDP, 2014)

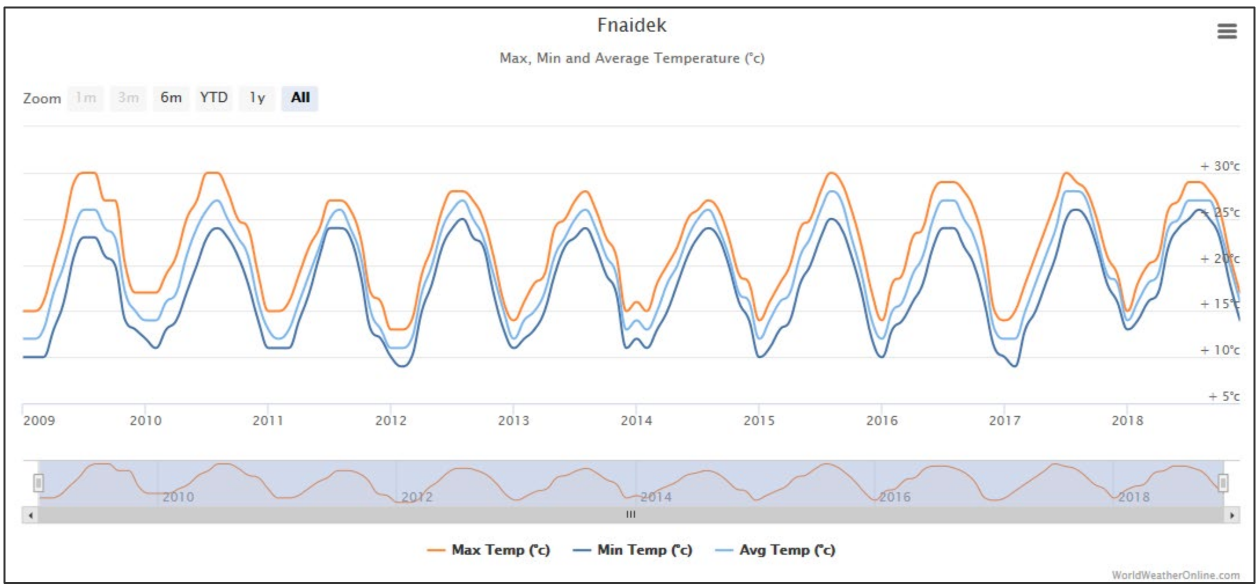
Annual rainfall measured in nearby Fnaidek (3km to the west) is shown in **Figure 8-2**.

Figure 8-2 Average Rainfall Amounts and Rainy Days in Nearby Fnaidek



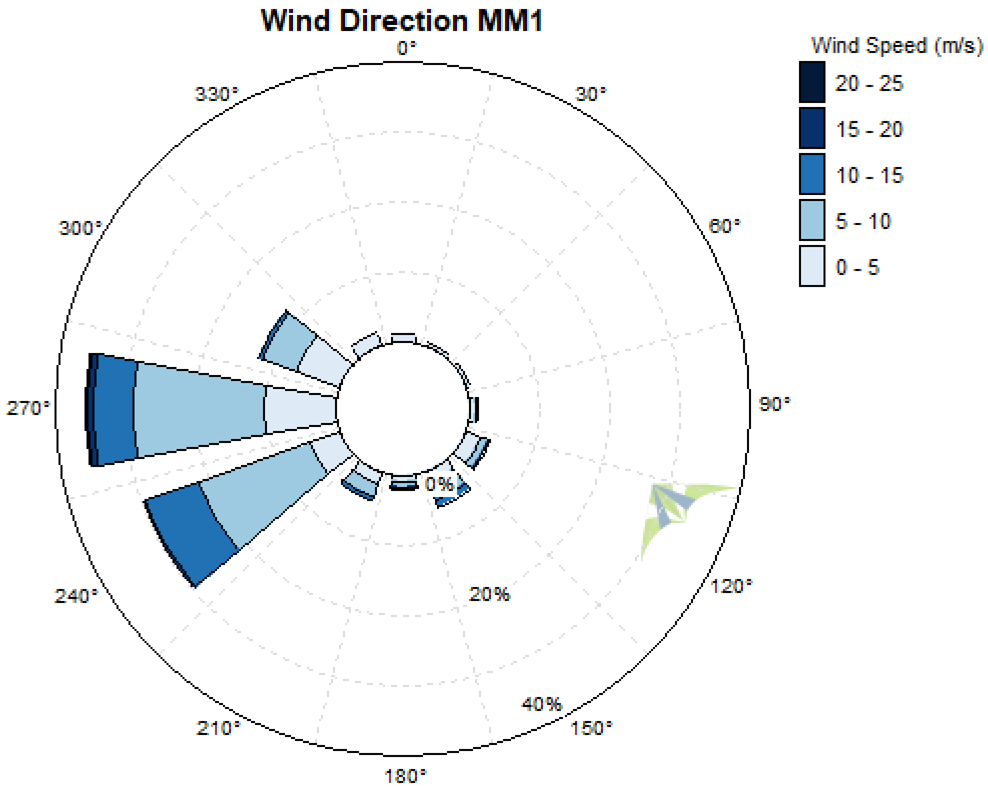
The average temperature measured in Fnaidek is shown in **Figure 8-3**.

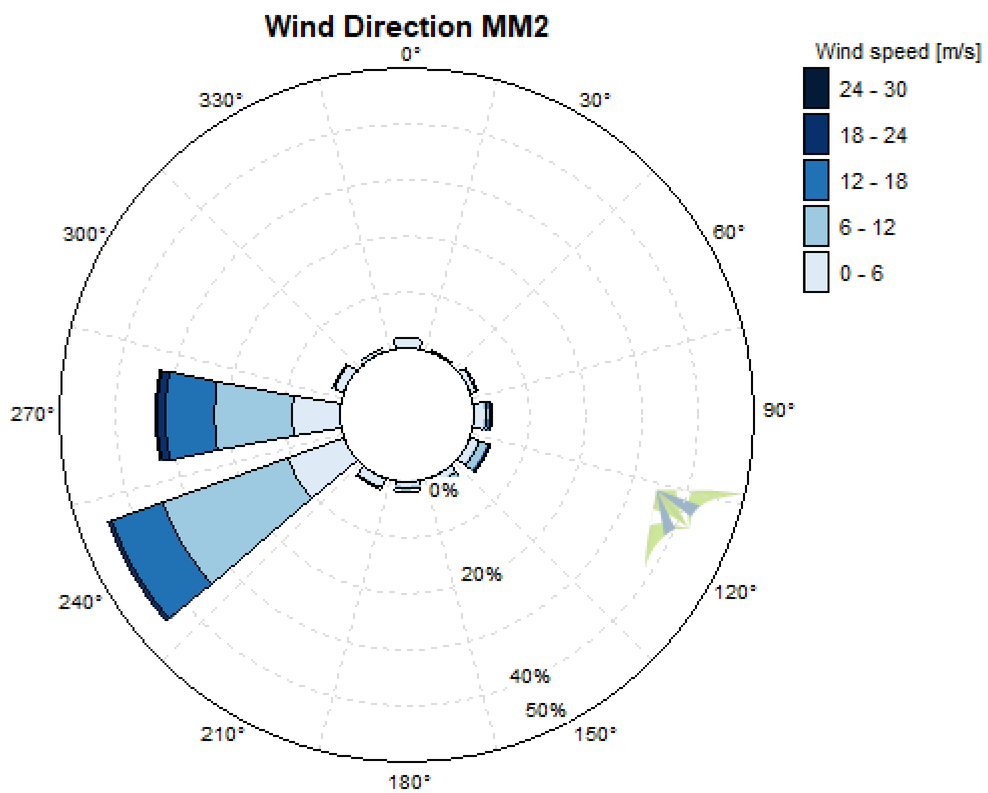
Figure 8-3 Maximum, Minimum and Average Temperature in Nearby Fnaidek

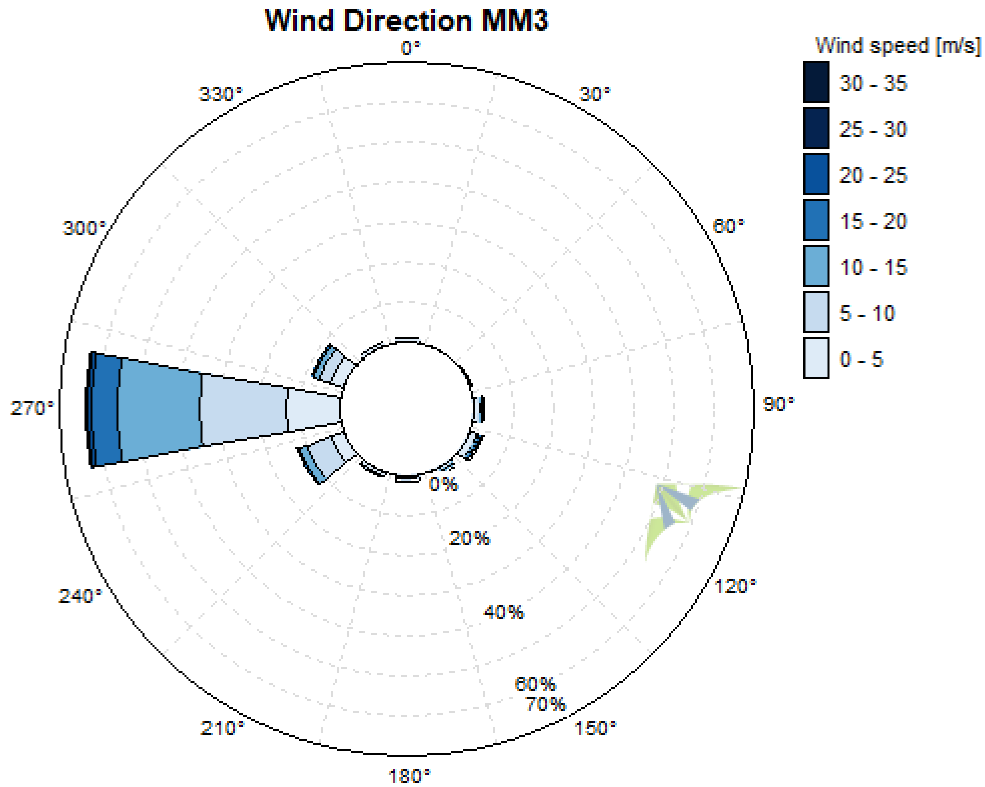


Wind conditions at the Project recorded by the site's three meteorological masts MM1, MM2 and MM3 are depicted in **Figure 8-4.** As is the case across the Lebanese coastal zone, most winds blow from a westerly origin. The maximum recorded wind speed at the Project site is 35 m/s.

Figure 8-4 Wind Speed and Direction at Three Meteorological Masts at the Project Site

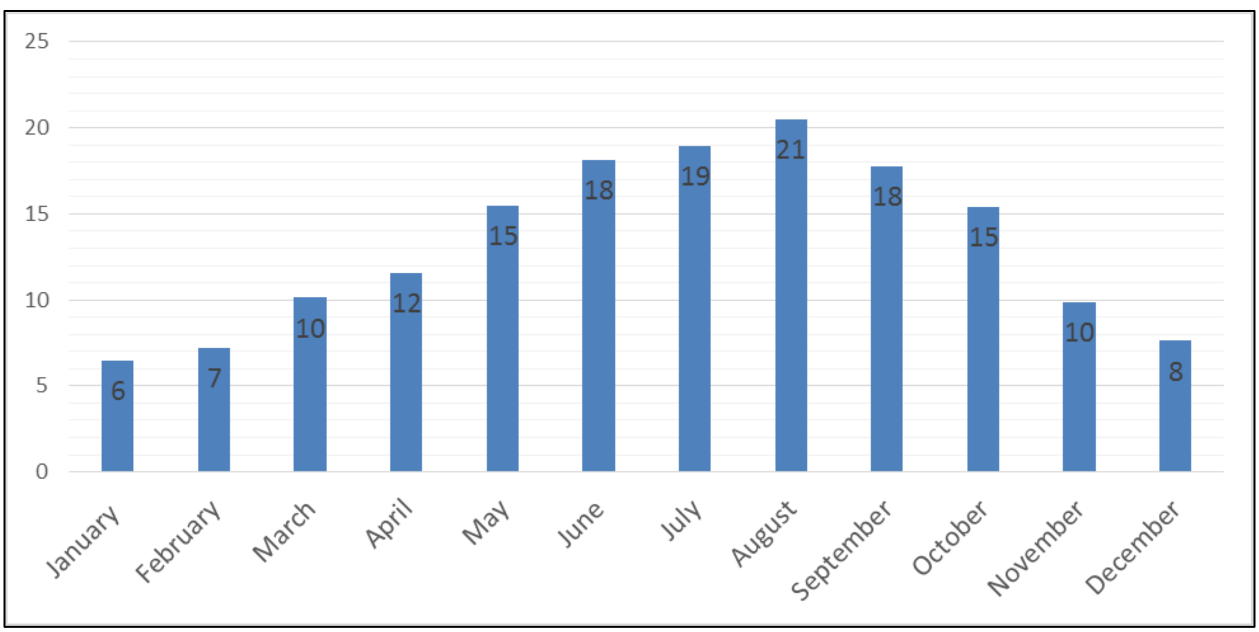




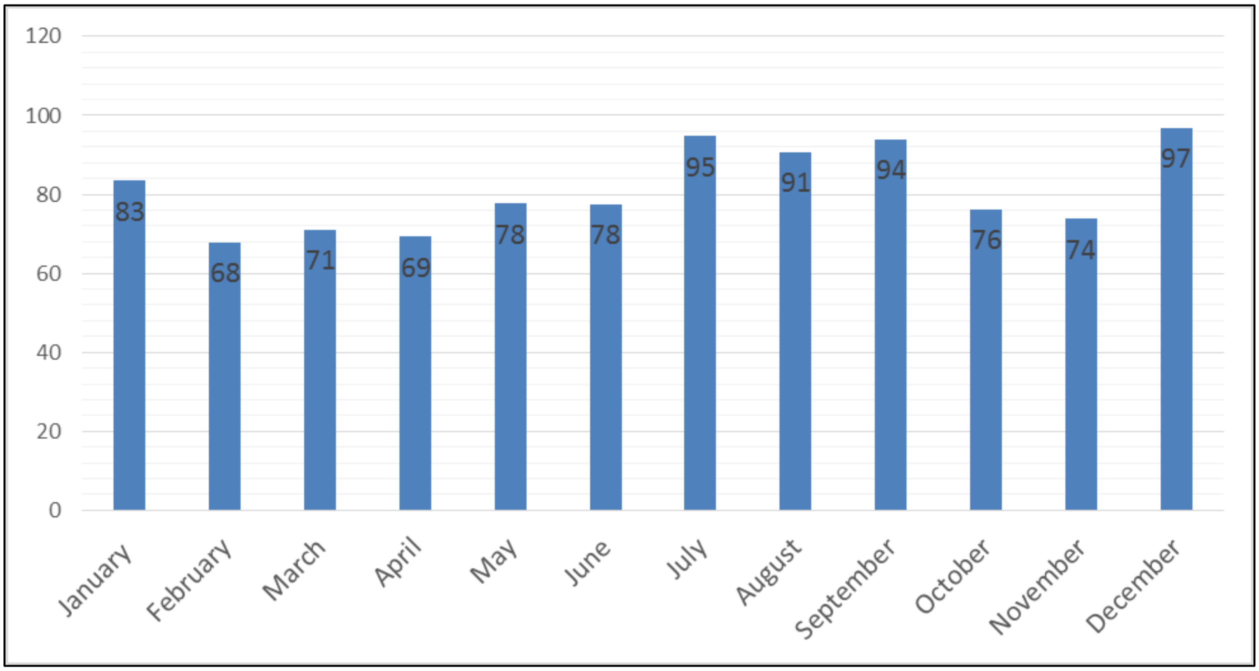


Year-round pressure, humidity and temperature data as measured year-round by a nearby meteorological mast located at the nearby Sustainable Akkar wind farm are provided in **Figure 8-5**.

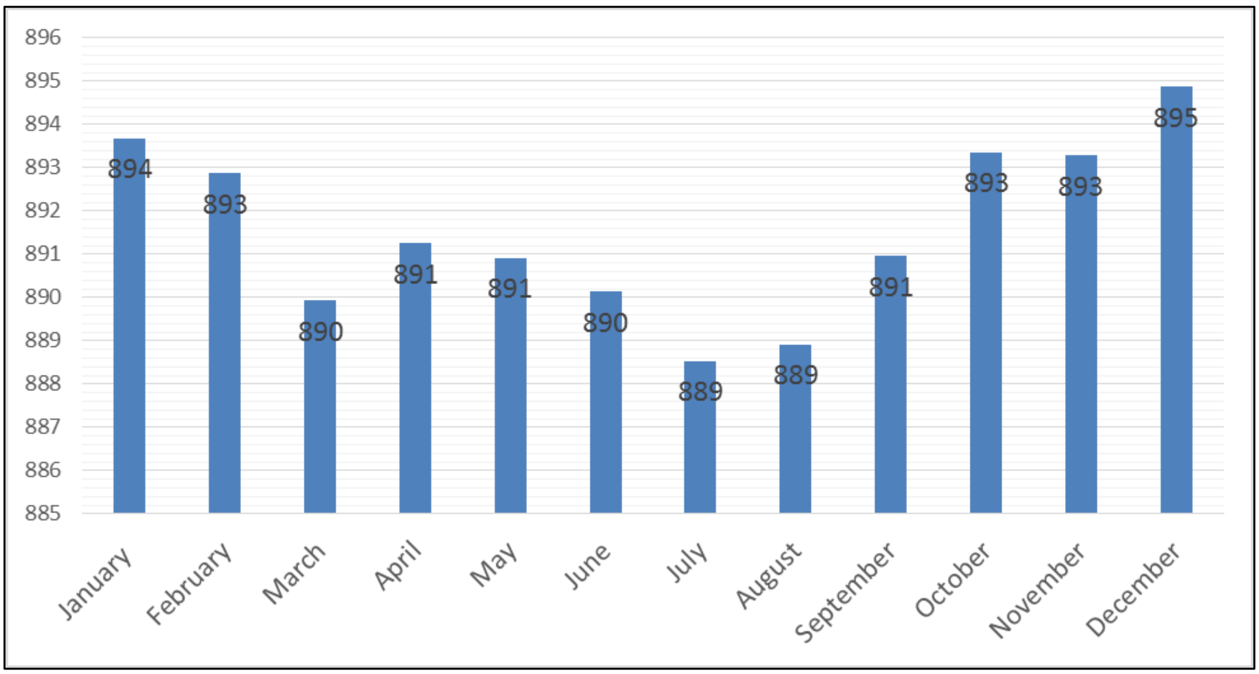
Figure 8-5 Average Temperature, Humidity and Pressure in Neighboring Sustainable Akkar Wind Farm for the Year 2014



a - Average Temperature (°C)



b- Average Humidity (%)



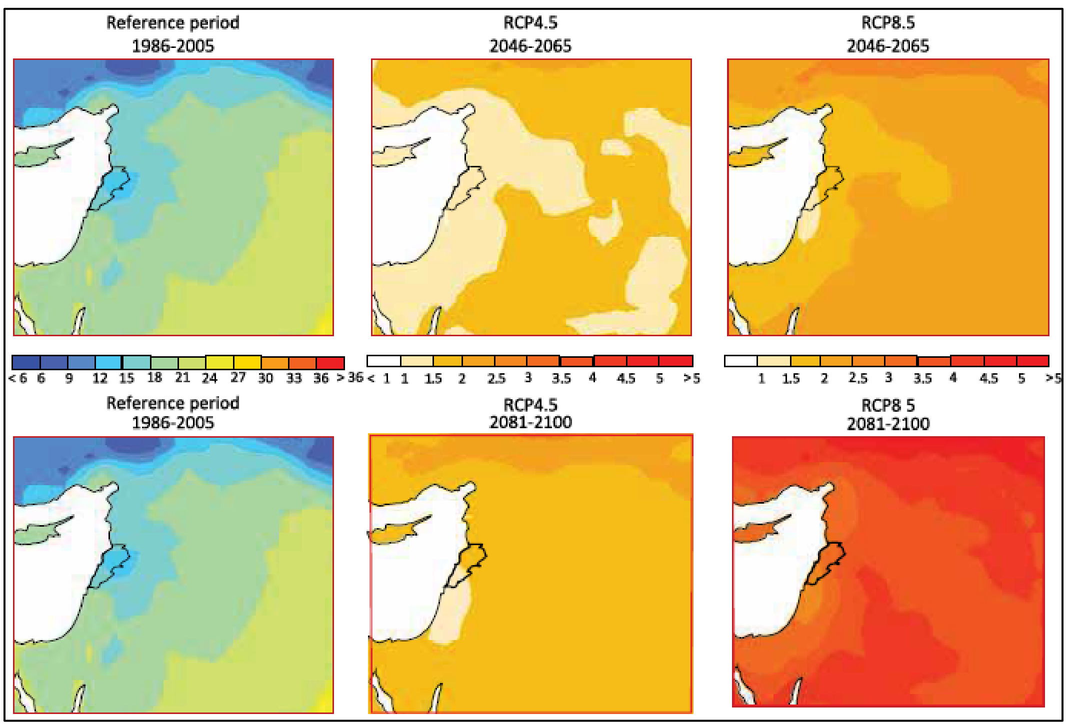
c - Average Pressure (hPa)

Climate change is expected to have the following effects in Lebanon:[1]

- Increases in mean annual temperatures between 1-2°C by mid-century and 3.5°C-5°C by the end of the 21st century.
- Decrease in annual average precipitation of 10-20% by 2040 and 45% by 2090.
- Reduced snow cover of 40–70 percent and decreased snow residence time from 110 days to 45 days by the end of the 21st century.
- Increased incidence of drought conditions by 9-18 days relative to present day by 2090.
- Increase in wildfire risk.
- Continued sea level rise, rising by a total of 30-6 cm in the next 30 years.
- Increased frequency of heat waves and decreased number of frost days.
- Less precipitation falling as snow, with snow line currently at 1,500m shifting to 1,700m by 2050, and to 1,900m by 2090.

A more recent ensemble of high-resolution regional climate model projections was developed under CORDEX (Coordinated Regional Downscaling Experiment; Gutowski, 2016) indicate an increase of 1.2°C-1.7°C in annual average temperatures in Lebanon by mid-century and an increase of up to 3.2°C by 2100 compared to the 1986-2005 baseline period, as shown in **Figure 8-6**. The range accounts for uncertainty in future increases in GHGs.

Figure 8-6 CORDEX Temperature Projections for the 21st Century for GHG[2]



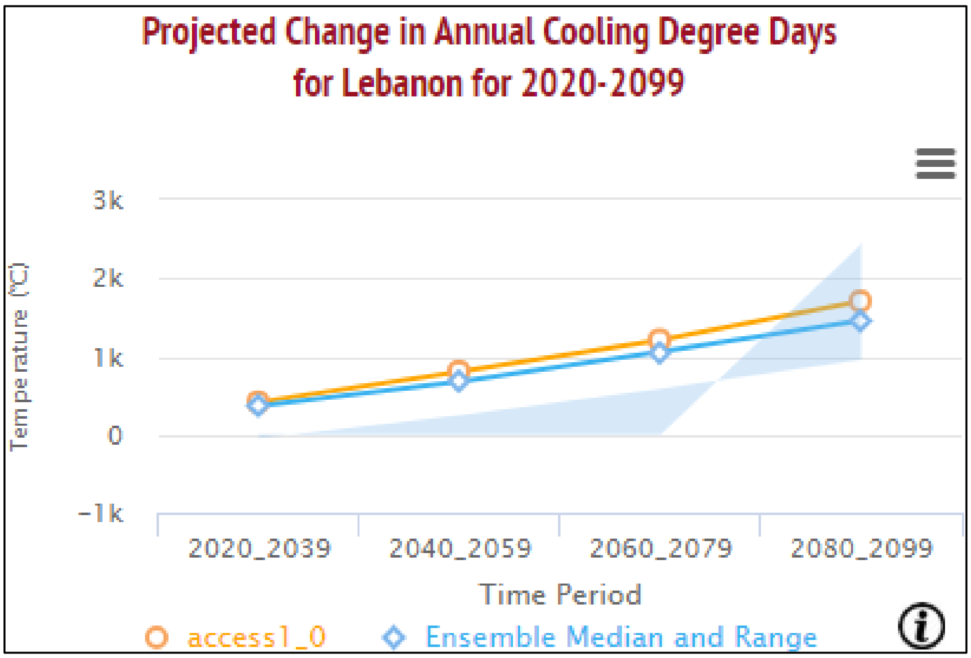
[1] MOE website on climate change vulnerability and adaptation http://climatechange.moe.gov.lb/vulnerability-and-adaptation http://climatechange.moe.gov.lb/vulnerability-and-adaptation

[2] Projected changes in temperatures in Lebanon, adapted from ESCWA, 2015, scenarios for Business as Usual (RCP 8.5) and GHG mitigation by mid-century (RCP 4.5).

Lebanon's 3rd National Communication to the UNFCCC (MOE, 2016) projects an increased demand for cooling due to rising temperatures. Increased demand for cooling is predicted to drive higher electricity consumption (1.8% for a 1°C increase in temperature, and 5.8% for a 3°C increase in temperature). The annual number of cooling degree days is an indicator of how much energy is required to cool buildings. This increased demand enhances the importance of the additional generating capacity of the Project.

Global climate model projections for changes in annual cooling degree days in Lebanon are shown in **Figure 8-7** and indicate a steady increase in cooling degree days during the 21st century.

Figure 8-7 Projected Trends in Annual Cooling Degree Days for Lebanon[3]



Projections are from 35 global climate models (GCMs) run for the IPCC 5th Assessment Report (Taylor et al., 2012). The blue line shows the median result among the 35 models and the blue shading shows the model range. Calculation uses reference indoor temperatures of 65°F. On a day when the average outdoor temperature is 85°F, reducing the indoor temperature by 20 degrees over 1 day requires 20 degrees of cooling multiplied by 1 day, or 20 cooling degree days. Utility companies use cooling degree days to estimate the annual amount of energy people will use to cool buildings.

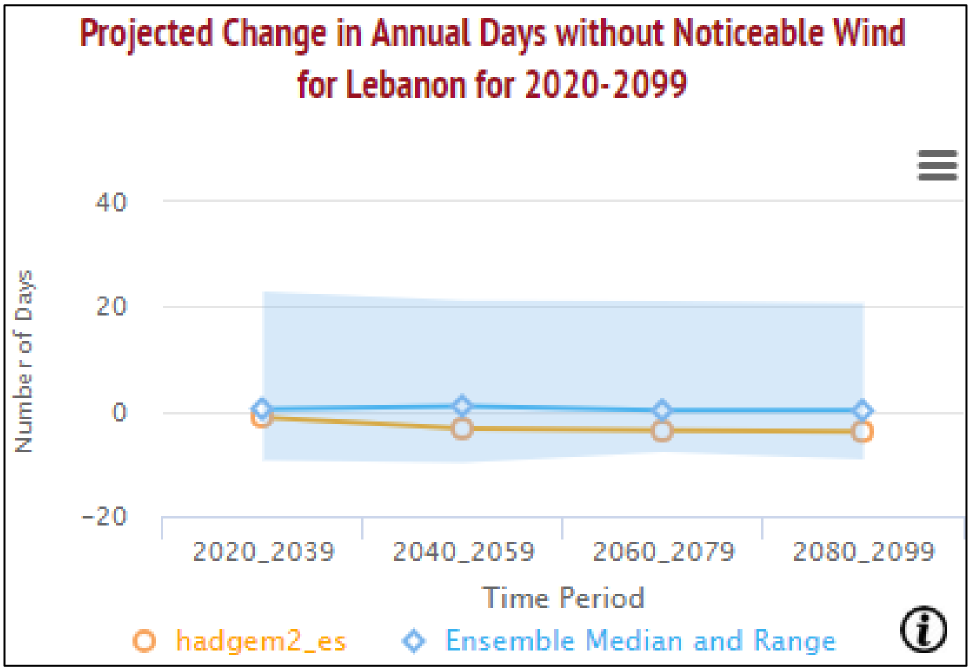
In addition to changes in temperature and rainfall, climate change may also affect winds. In order to run a WTG, a minimum wind speed is required to rotate the blade. This threshold wind speed allows us to estimate how many days in a year the mean wind in a location is likely below the level necessary to produce energy from wind. Climate model vertical grid cell sizes are too coarse to resolve the different wind speeds at the surface and the WTG hub, so the models near surface wind speed is used as a proxy for the hub wind speed.

[3] http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Middle%20East&ThisCcode=LBN#

The World Bank Climate Change Portal's 1 m/s threshold is likely lower than the wind speed required for WTG operation but serves as an indicator for changes in wind speeds during the 21st century. This indicates that the number of days available for generation of electricity from wind by the Project is expected to remain relatively stable.

Figure 8-8 indicates that climate projections show little change in the number of days per year without noticeable wind in Lebanon.

Figure 8-8 Projected Trends in Annual Days without Noticeable Wind for Lebanon[4]



Uncertainty in Climate Model Projections

The preceding discussion is based on projections of the future from climate models. While climate models are our best available tool for understanding future impacts from climate change, they have important limitations.

Several challenges introduce uncertainty into climate model projections of the future: 1) predictions regarding the future change in atmospheric GHG concentrations remain highly uncertain; 2) climate models are subject to limitations in resolution and skill in simulating processes that affect climate; 3) different global climate models may result in similarly valid projections for a given site yet with different outcomes (e.g. one model shows an increase in annual average wind speed while another model shows a decrease); 4) different downscaling methods may give different results when starting from the same global climate model simulation; and 5) the climate system has intrinsic natural variability that can be more influential than the climate change signal depending on the variable and time scale of interest.

[4] http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Middle%20East&ThisCcode=LBN#

The results described above are based on ensembles of climate model simulations and encompass a range of future GHG scenarios and downscaling methods. However, the results should be viewed with caution, and estimates of changes in winds have been shown to be highly model dependent (e.g. Pryor and Barthelmie, 2013), with the climate change signal often smaller than the natural variability of the winds.

In summary, WTGs are designed to be accommodate extremes in wind speed and temperatures and are expected to be relatively resilient to the changing climate (Pryor and Barthelmie, 2013). Increasing temperatures may increase demand for the energy the Project will generate and reduce the potential for ice formation on the WTGs. However, The Project is located well inland and is not exposed to rising sea levels.

8.3 Impact Analysis

8.3.1 Construction Phase

8.3.1.1 GHG Emissions

GHG emissions are estimated using the IPCC Tier 1 methodology (IPCC, 1997, 2000) using the quantity of fuel burnt by source for CO_2, CH_4, N_2O. Fuel consumption was estimated based on activity data presented in **Appendix H** for the three phases of the Project. The emission factors for each category are presented in **Table 8-1**.

Table 8-1 GHG Emission Factors

Source	Unit	CO_2	CH_4	N_2O
Transport – Diesel	g/L	2,652.42	0.1498	0.06656
Transport – Gasoline	g/L	2,287.15	0.6675	0.01997
Energy - Diesel	g/L	2,645.60	0.1082	0.02155

To calculate the CO_2eq. emissions, a Global Warning Potential (GWP) of 1 was used for CO_2, 21 for CH_4 and 310 for N_2O.

Table 8-2 shows the quantities of GHG emissions during the construction, operations and decommissioning phases of the Project.

Table 8-2 GHG Emissions During the Construction Phase

Phase	CO_2 em. (kg)	CH_4 em. (kg)	N_2O em. (kg)	CO_2eq. em. (kg)
Construction	1,763,657	106	38	1,777,547
Operation (1yr)	168,357	26	2	169,378
Decommissioning	151,051	14	3	152,403

The GHG emissions showed that the main GHG from the Project is CO_2 with the construction phase being again the highest emitter. The assessment of impacts was therefore based on the construction phase, representing the worst-case scenario.

The impact severity was considered Low, and the sensitivity of the receptor considered Medium, resulting in a Minor impact as shown in **Table 8-3**.

Table 8-3 GHG Assessment for Construction Phase (Worst-Case Scenario)

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

8.3.2 Operations Phase

8.3.2.1 Flood Risk

While global climate model projections for precipitation extremes indicate that the Project area is not expected to experience increase flood risk,[5] heavy rainfall could create a potential risk of local flood hazard within the Project site during rainy season, including flash flood events. Such risks must be taken into consideration throughout the detailed design of the Project, as they could inflict damage to the Project and its various components.

Mitigation Measures

The following identifies the mitigation measures that must be considered by the selected OEM/EPC Contractor at a later stage:

- The selected OEM/EPC Consultant will undertake a flood risk assessment to investigate such risks. The assessment should be on study of the catchment area's rainfall, runoff and flood flow.
- It is recommended that the selected OEM/EPC Contractor, as part of the detailed design prepared for the Project, avoid locating any of the Project components within the buffer distances developed under the flood risk assessment to eliminate any risks for flood.

[5] http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_future_climate&ThisRegion=Middle%20East&ThisCcode=LBN

- A detailed hydrological study must be undertaken to identify and determine the required engineering structures to be considered as part of the detailed design for new asphalt and gravel road segment and internal tracks (e.g. drainage structures, culverts).

Following the implementation of these mitigation measures, the impact severity is considered Slight, and the sensitivity of the receptor as Medium, resulting in a residual impact categorized as Negligible as shown in **Table 8-4**.

Table 8-4 Flood Risk Assessment

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	**Negligible √**	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

8.3.2.2 Wildfire Risk

Increasing temperatures and decreasing precipitation may also increase the potential for wildfires, which could affect the Project infrastructure and/or interrupt access to the site. Such risks must be taken into consideration throughout the detailed design of the Project, as they could inflict damage to the Project and its various components.

Mitigation Measures

The following identifies the mitigation measures that must be considered by the selected OEM/EPC Contractor at a later stage:

- It is recommended that the selected OEM/EPC Contractor, as part of the detailed design prepared for the Project, avoid locating any of the Project components within the buffer distances (if any) developed for the Karm Chbat Nature Reserve.
- The selected OEM/EPC Contractor must identify and determine the required fire detection and protection equipment to be considered as part of the detailed design.

Following the implementation of these mitigation measures, the impact severity is considered Low, and the sensitivity of the receptor as High, resulting in a residual impact categorized as Moderate as shown in **Table 8-5**.

Table 8-5 Wildfire Risk Assessment

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High √**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor	**Moderate √**
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

8.4 Carbon Payback Period

It is noted that the assessment did not consider the offsetting beneficial impact of generating clean energy through the operation of the wind farm. The Carbon Payback Period (P), measured in days, is defined as the time needed to generate the emissions from the turbine's life cycle when using the fossil fuel electricity mix of the national electricity company EDL.

Therefore, a life cycle assessment was undertaken to calculate the GHG equivalent to CO_2. It comprises all phases of the Project, i.e. the manufacturing, shipping, construction, operation, decommissioning, shipping for disposal, recycling and landfilling.

Since the OEM/EPC Contractor is not yet determined, several assumptions were made to calculate the *approximate* Carbon Payback Period. These assumptions are presented in **Table 8-6**.

The expected energy output from LWP is 341.1 GWh/year resulting in 6,828 GWh over 20 years. The total emissions from the LCA (lifespan 20 years) results in 48,742.03 tons of CO_2eq, as shown in **Table 8-7**.

Since the EDL emission rate is 630 t CO2eq/GWh, the carbon payback period is 83 days, which is expected when compared to the literature.

Table 8-6 Assumptions for Calculation of GHG for the Project LCA

Manufacturing			
Item	**Material**	**Share of Total Weight**	**Emission Factor (t CO_2eq/t of Material)**
Nacelle (share normalized to 1)	Steel	0.806	2.49
	Copper	0.082	6.60
	Aluminum	0.031	3.47
	Glass	0.010	0.57
	Iron	0.071	1.35
Generator	Steel	0.800	2.49
	Copper	0.200	6.60
Blade	Fiberglass	0.600	1.39
	Epoxy resin	0.400	3.98
Tower	Steel	1.000	2.49
Above assumptions from: Smoucha EA, Fitzpatrick K, Buckingham S, Knox OGG (2016) Life Cycle Analysis of the Embodied Carbon Emissions from 14 Wind Turbines with Rated Powers between 50 Kw and 3.4 Mw. J Fundam Renewable Energy Appl 6: 211. Other assumptions: • Number of Wind Turbines: maximum of 16 • Weight of Nacelle considered: 80 tons • Weight of Generator considered: 68 tons • Weight of Blade considered: 22 tons for one blade, 66 tons in total (33 blades) • Weight of Tower considered: 315 tons			
Shipping to Lebanon			
Assumptions: • From EMEP/EEA 2016: General cargo, fuel consumption 204 g/kWh (50% Medium speed diesel, 50% Slow Speed Diesel), Main engine 2,555 kW, Auxiliary engine 588 kW, Cruising only considered, speed 23 km/hour, Fuel type: Bunker Fuel Oil • Travel distance: 10,000 km • Number of ships: 5 • Emission factors: IPCC (1996, 2000)			
Construction - Calculated in Climate Change paragraph			
Operation - Calculated in Climate change paragraph for 1 year, lifespan 20 years			
Decommissioning -Calculated in Climate change paragraph			
Shipping - from Lebanon same as Shipping to Lebanon			

Recycling			
Material	**Share Recycled**	**Share Landfilled**	**Emission Factor for recycling (t CO_2eq / t of material recycled)**
Steel	0.90	0.1	1.819
Aluminum	0.95	0.05	0.738
Copper	0.95	0.05	3.431
Iron (considered same as iron)	0.90	0.1	1.819
Other	0	1	0
Above recycling data from: Kabir MR, Rooke B, Dassanayake M, Fleck BA (2012) Comparative life cycle energy, emission, and economic analysis of 100kW nameplate wind power generation. Renew Sustain Energy Rev 37: 133-141.			
Landfilling			
All material, Emission factor regardless of material type: 0.0009 t CO_2eq / t of landfilled material			
Above landfilling data from: Kabir MR, Rooke B, Dassanayake M, Fleck BA (2012) Comparative life cycle energy, emission, and economic analysis of 100kW nameplate wind power generation. Renew Sustain Energy Rev 37: 133-141.			

Table 8-7 CO_2eq Emissions from the Project Wind Turbine Life Cycle

Stage	**Emissions CO_2eq (t)**
Manufacturing	22,241
Shipping to Lebanon	4,295
Construction	1,778
Operation	3,388
Decommissioning	152
Shipping from Lebanon	4,295
Recycling	12,592
Landfilling	2
Total	**48,743**

9. GEOLOGY AND HYDROLOGY

9.1 Baseline Methodology

Information regarding the Project site geology was obtained through literature review.

9.2 Baseline Findings

9.2.1 Geology

The study area falls on a Middle Cretaceous formation (Sannine Maameltein, C4-C5), characterized as thinly bedded to widely exposed and highly karstified limestone overlying pale gray fractured fine and thick bedded limestone, as presented in **Table 9-1**.

Table 9-1 Formations Encountered in Project Area

Formation Name	Code	Description
Maameltein	C5	Massive to thinly bedded white gray limestone and marly limestone.
Sannine-Maameltein	C4-C5	Combining the above limestone formations to create one of the major water towers in Lebanon, widely exposed and highly karstified, with major recharge coming from snow.
Sannine	C4a, C4b, C4c	Pale gray fractured fine and thick bedded limestone and marled limestone with geodes and chert.

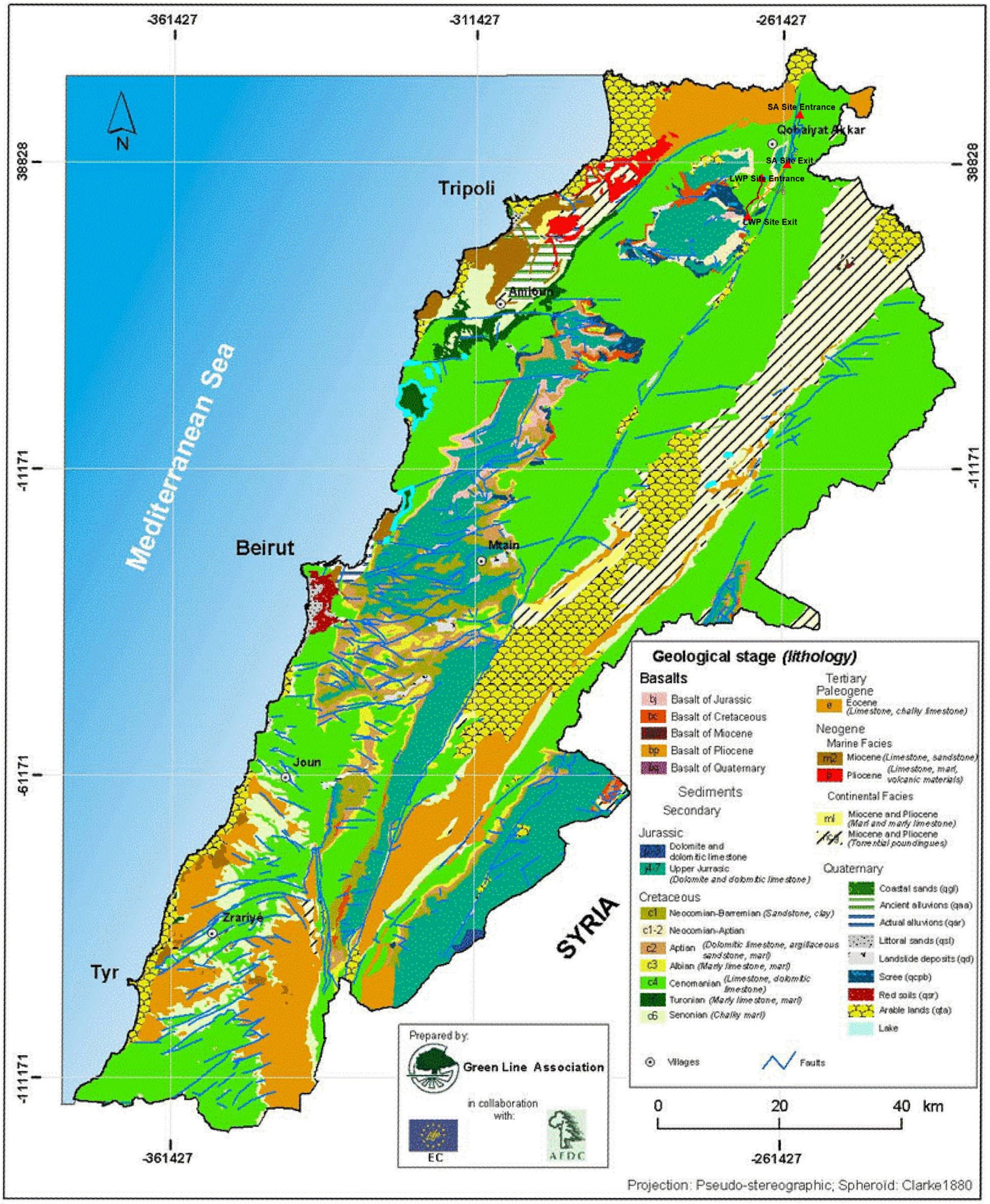
The structural features were shaped by the major tectonic events recorded in the geological history of Lebanon and have an impact on controlling the groundwater flow directions --- serving as a preferential pathway or as a flow-restricting boundary.

The primary structures are divided into: 1) primary faults Yammouneh, Rashaya, Hasbaya, Roum and Serghaya; 2) primary folds North Mount Lebanon Anticline, Barouk-Niha Anticline, Bekaa Syncline/garben, North Anti-Lebanon Anticline and Mount Hermon Anticline; and 3) platforms (Akkar, Tyr and Saida-Damour.

The secondary structures are divided in to secondary faults, which are trending in a NW-SE, NE-SW, ENE-WSW and E-W and secondary folds, mainly trending in a NNE-SSW direction parallel to the primary faults.

The geological map of Lebanon is shown in **Figure 9-1**. A cross-section of northern Lebanon is shown in **Figure 9-2**.

Figure 9-1 Geological Map of Lebanon[1]



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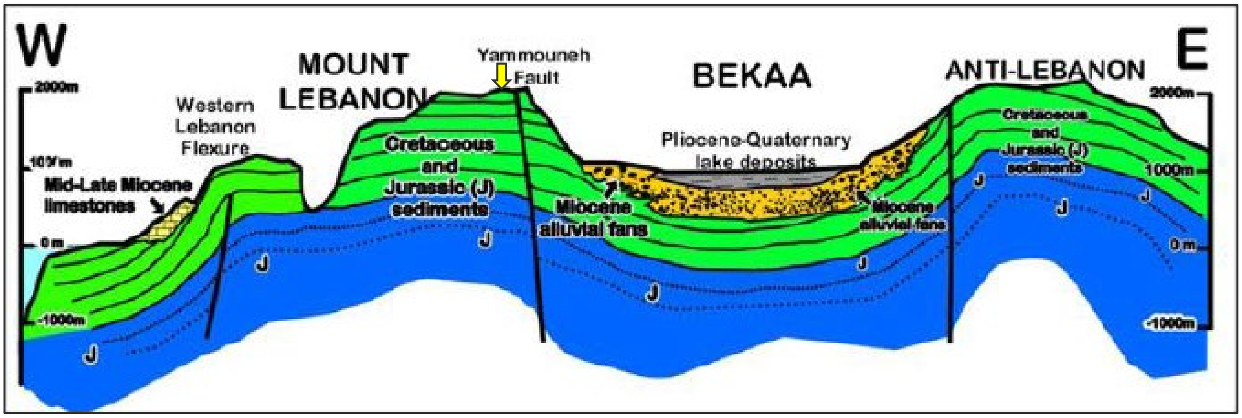
[1] Geological map of Lebanon, Dubertret, 1955.

Figure 9-2 Cross-Section of Northern Lebanon[2]



Onsite observations confirmed the prevalence of limestone rocks in the Project area, as shown in **Figure 9-3a and 9-3b**. The Project site is situated west of the Yammouneh Fault, as shown in **Figure 9-2** and **Figure 9-4**. Topography is presented in **Figure 9-5**.

Figure 9-3a Limestone Outcroppings in the Project Area

Figure 9-3b Limestone Outcroppings in the Project Area

[2] Ground Study Report, Lebanon Wind Power Project, Akkar Region – Southern Ridge, Lebanon, 2018.

Figure 9-4 Faults of Lebanon

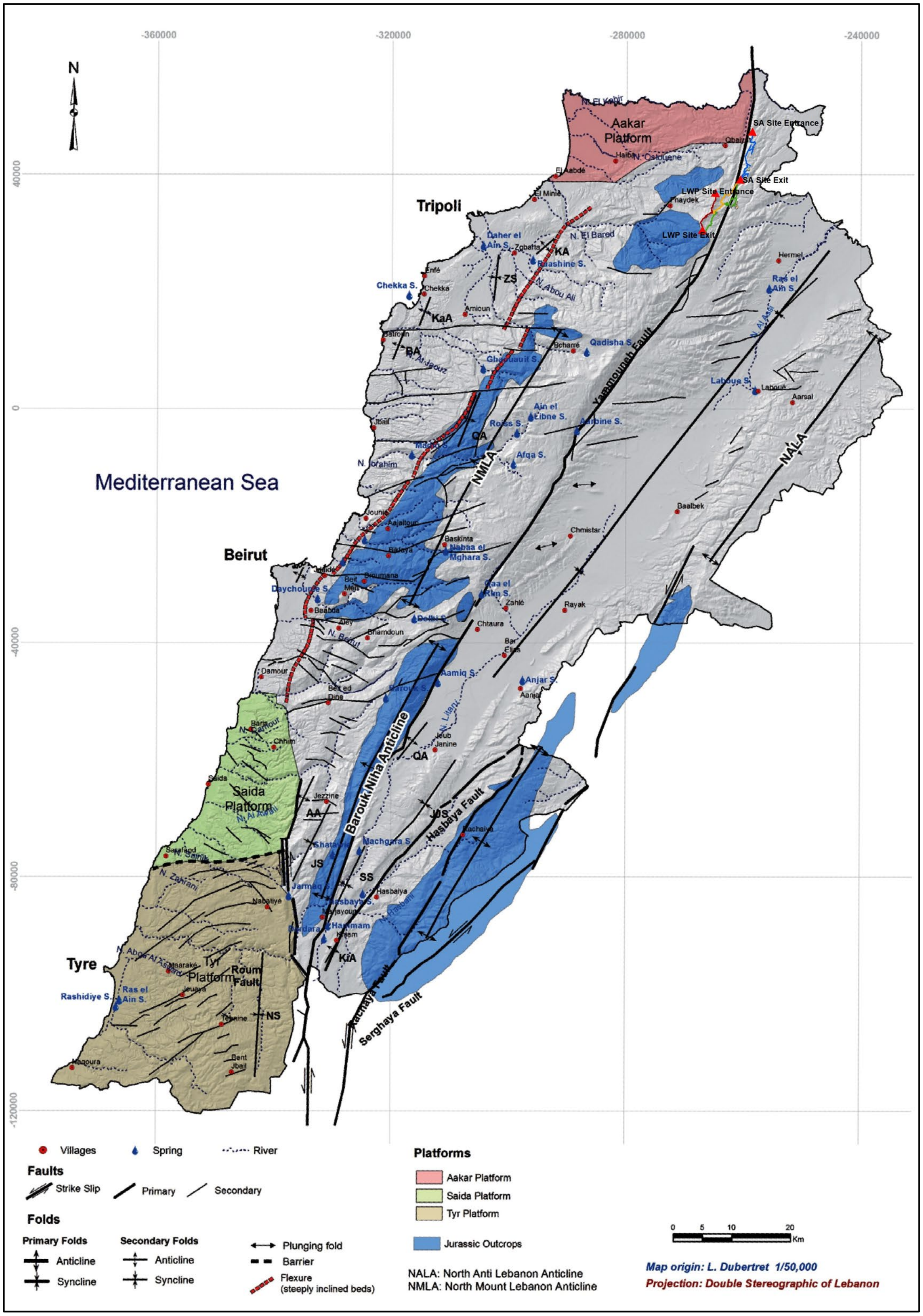
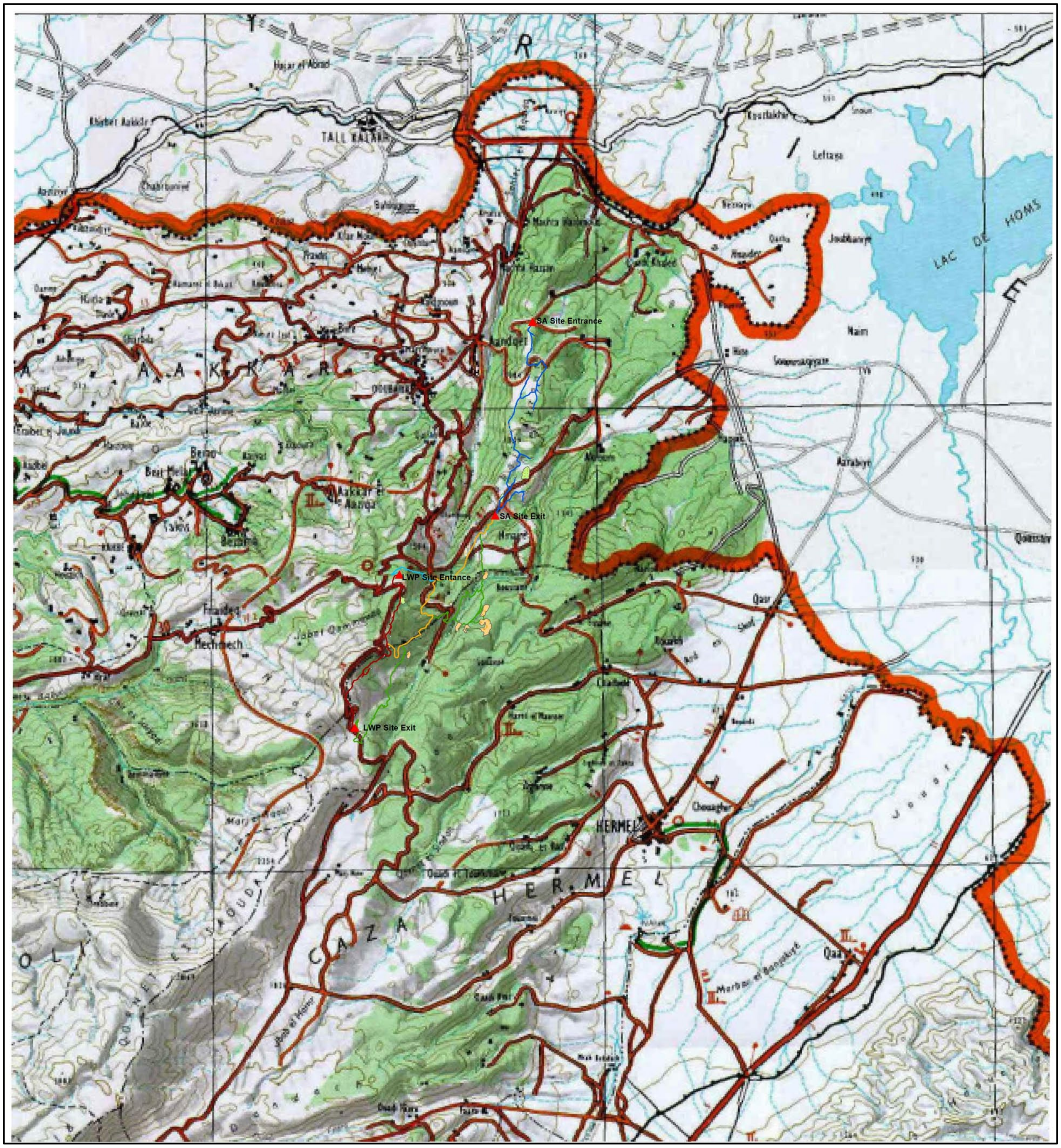


Figure 9-5 Topography of Northern Lebanon[3]



[3] Vidiani, 2019.

9.2.2 Groundwater

9.2.2.1 Hydrostratigraphy

The relationship between stratigraphy and hydrostratigraphy is shown in **Figure 9-6.**

The main aquifer underlying the Project site is the Sannine-Maameltain Aquifer, which is lithologically composed of karstic limestone, i.e. soluble rock where voids, caverns, open fractures, and caves have formed due to weathering by aggressive water. Combining these two formations creates one of the major water towers in Lebanon. The Project site is situated west of the Mediterranean-Interior Province Divide in the Qammoua Groundwater Basin. Major recharge of this aquifer is from snow and groundwater is stored and transmitted in fractures and conduits and is not an area that is recharged by natural and/or wastewater sites, as shown in **Figure 9-7.**

Shallow and deep groundwater flow in the basin is shown in **Figure 9-8** (as indicated by small and large blue lines). According to the UNDP Groundwater Resources Report, the aquifer is not under stress as shown in **Figure 9-9**.

The recharge potential of the groundwater basin underlying the Project site is shown in **Table 9-2**. The hydrochemical composition is Ca-Mg-HCO_3, with a shift toward salt water intrusion, as shown in **Table 9-3**.

Table 9-2 North Lebanon Cretaceous Basin Recharge Potential[4]

GW-BASIN	VOLUME OF POTENTIAL RECHARGE (MCM/YEAR)		TOTAL VOLUME OF POTENTIAL RECHARGE (MCM)	% OF ARTIFICIAL RECHARGE TO NATURAL RECHARGE	% OF ARTIFICIAL RECHARGE TO NATURAL RECHARGE
	NATURAL SOURCES	WASTE-WATER EFFLUENT		(2010-2011)*	(2011-2012)*
North Lebanon Cretaceous Basin (Basin 18)	10.5 - 20.9	0.5 - 0.6	11 - 21.5	4.1 - 8.1	2.6 - 5.1

Table 9-3 North Lebanon Cretaceous Basin Hydrochemical Composition[5]

GW BASIN NO	NO. OF SAMPLES	FACIES FROM PIPER	GW BASIN NO.	NO. OF SAMPLES	FACIES FROM PIPER
Mediterranean Province					
18	3	Ca-Mg-HCO_3 With shift towards salt water intrusion for SS2 values	19a	6	Ca-Mg-HCO_3

[4] Ground Study Report, Lebanon Wind Power Project, Akkar Region – Southern Ridge, Lebanon, 2018.
[5] Ground Study Report, Lebanon Wind Power Project, Akkar Region – Southern Ridge, Lebanon, 2018.

Figure 9-6 Stratigraphy and Hydrostratigraphy

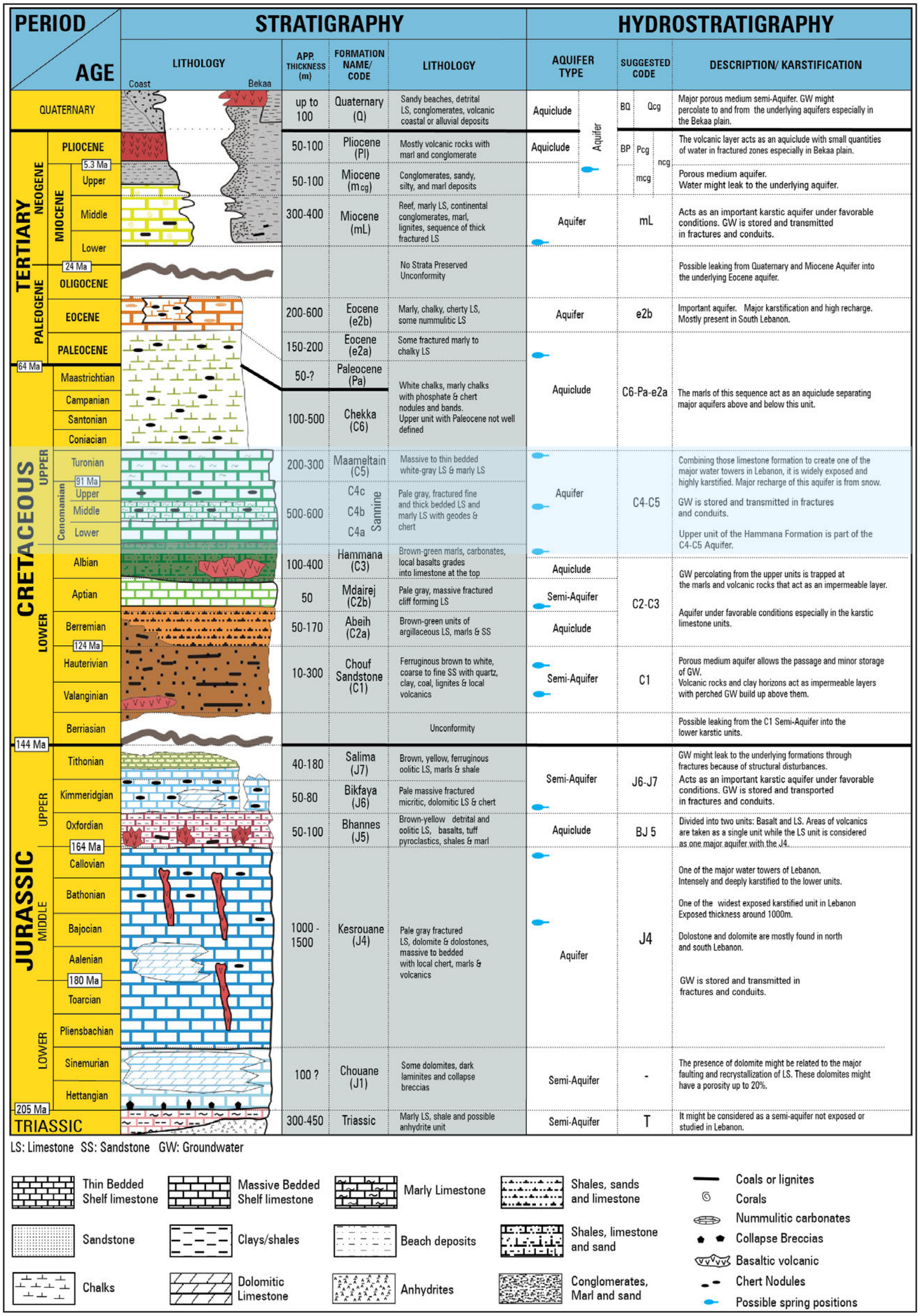


Figure 9-7 Hydrogeology Map

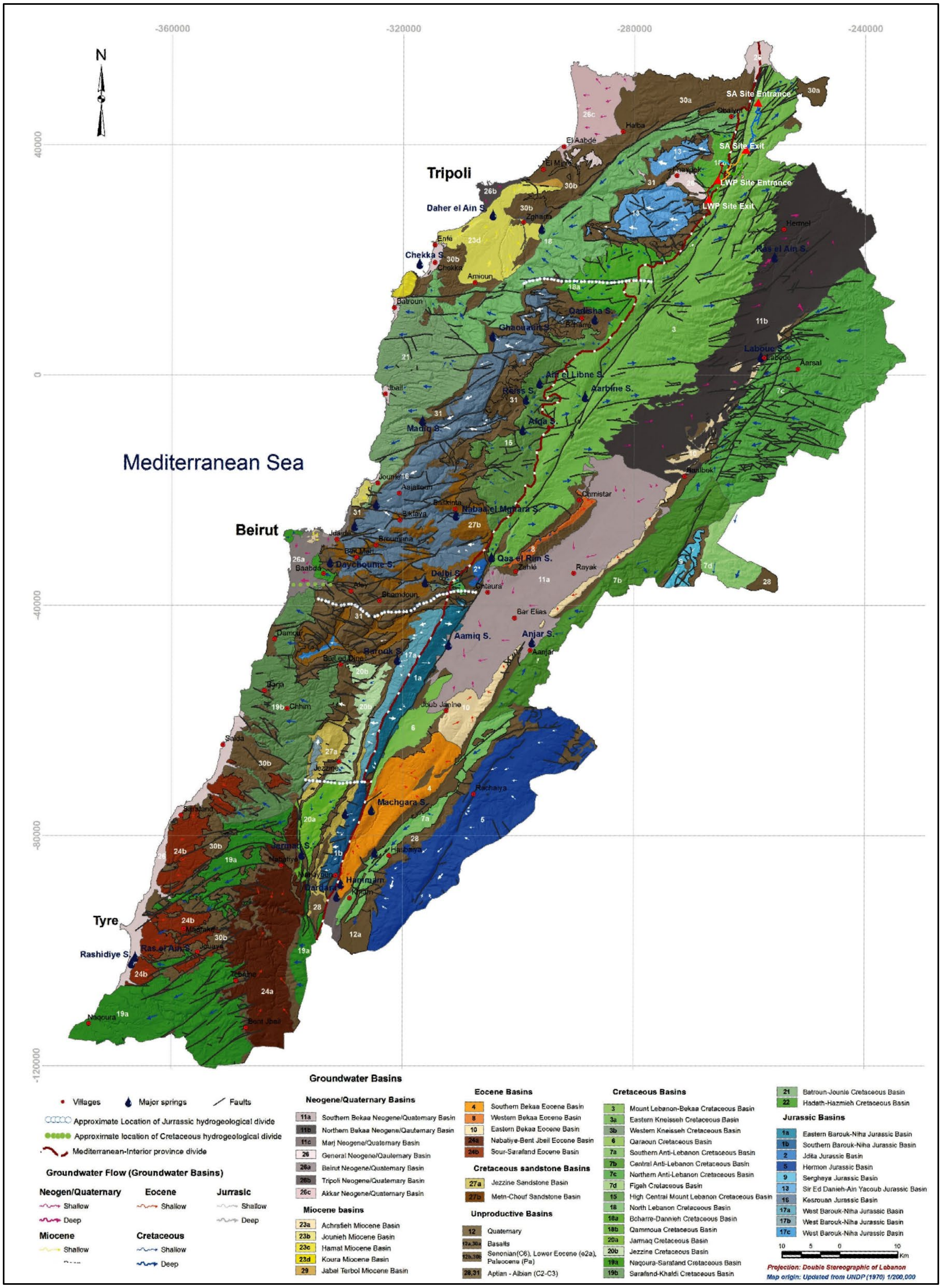


Figure 9-8 Shallow and Deep Groundwater Flow Direction in the Basin

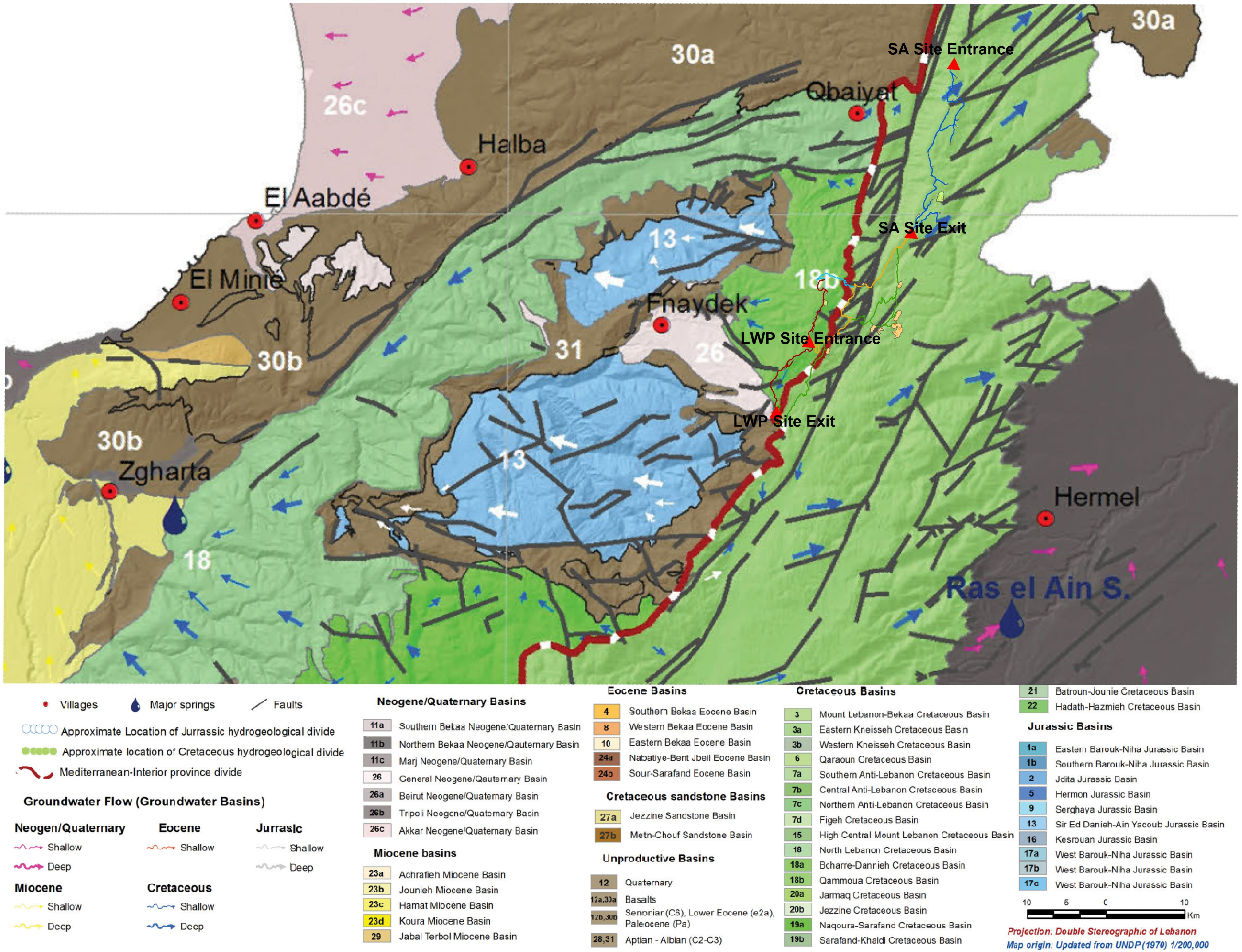
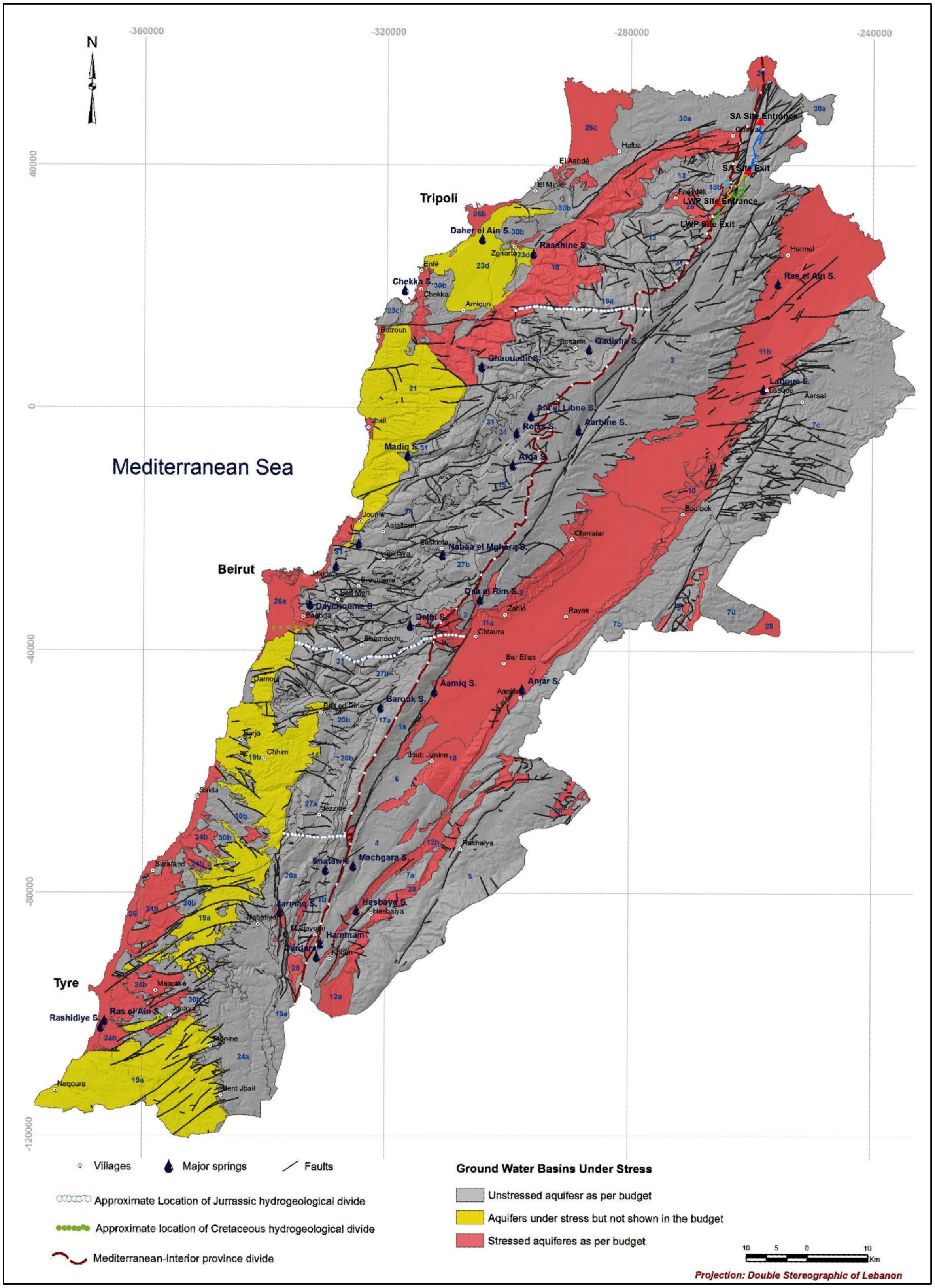


Figure 9-9 Groundwater Basins Under Stress



9.2.2.2 Groundwater Extraction

The 2014 UNDP Study summarized the public well survey conducted between November 14, 2011 and February 13, 2012. The survey revealed the presence of 841 public wells in the country, as shown in **Figure 9-10**, out of which 44 wells are abandoned and 68 are non-operational. Flow meters were installed in 287 public wells. The survey showed that the operational public wells are exploiting the various aquifers at an estimated rate of about 248.7 million m^3/year.

Additional survey work is currently being undertaken by the Developer to identify the number and location of public wells near the Project. The findings will be incorporated into mitigation for the Project.

As indicated in **Figure 9-10**, the Project site is located within Lebanese Water Establishment **NLWE**, of which 27% is abstracted from the C4-C5 Aquifer. The number of public wells, piezometers and total extraction rates by Water Establishment is summarized in **Table 9-4**.

Table 9-4 NLWE Water Establishment Wells and Extraction Rates[6]

ESTABLISHMENT	TOTAL NO. OF WELLS SURVEYED IN THE FIELD	TOTAL EXTRACTION (rate m^3/day)	TOTAL EXTRACTION RATE (million m^3/year)	TOTAL NUMBER OF PIEZOMETERS
BMLWE	218	193,642	71	38
BWE	209	90,422	33	42
SLWE	277	309,128	113	7
NLWE	137	88,383	32	25
Total	841	681,576	249	112

9.2.3 Water Sources

9.2.3.1 Surface Water

Lebanon has 28 rivers, 22 of which originate on the western face of the Lebanon range and run through the steep gorges and into the Mediterranean Sea, the other 6 arise in the Beqaa Valley. Although the country is well watered and there are many rivers and streams, there are no navigable rivers, nor is any one river the sole source of irrigation water. Drainage patterns are determined by geological features and climate. Although rainfall is seasonal, most streams are perennial.

The five rivers that flow within the North Lebanon Governorate (Mohafaza) are: Al Kabir River (Nahr Al Kabir), Oustuene River, Al Bared River (Nahr Al Bared), El Jaouz River (Nahr El Jaouz) and Abou Ali/Kadisha River (Nahr Abou Ali), as shown in **Figure 9-11**.[7]

According to **Figure 9-12**,[8] the Project lies in a water vulnerable zone.

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[6] Ground Study Report, Lebanon Wind Power Project, Akkar Region – Southern Ridge, Lebanon, 2018.
[7] Shared Water Reources of Lebanon, Amin Raban, 2017.
[8] DAR-IAURIF, 2005.

Figure 9-10 Public Well Locations

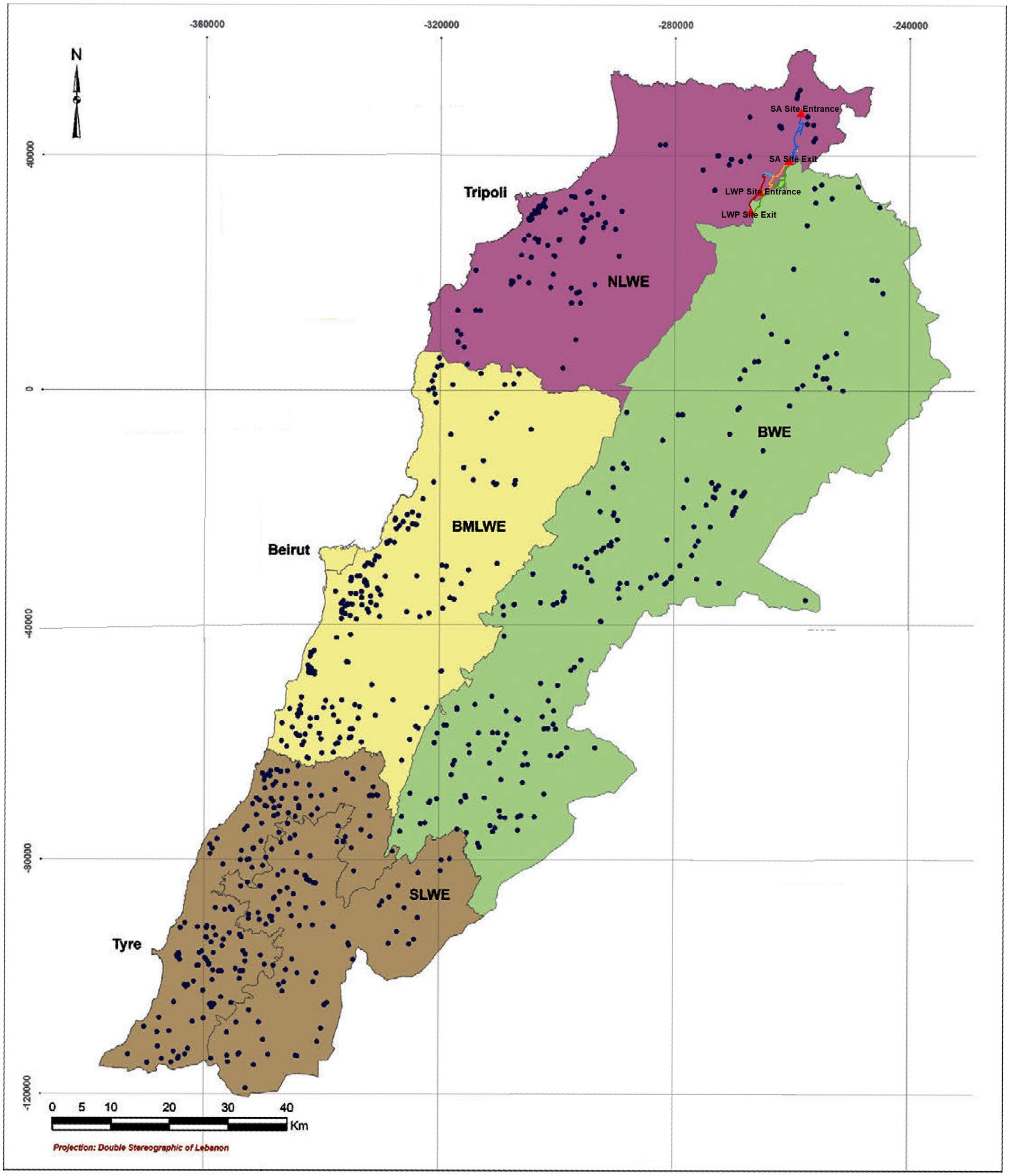


Figure 9-11 Lebanon River Locations

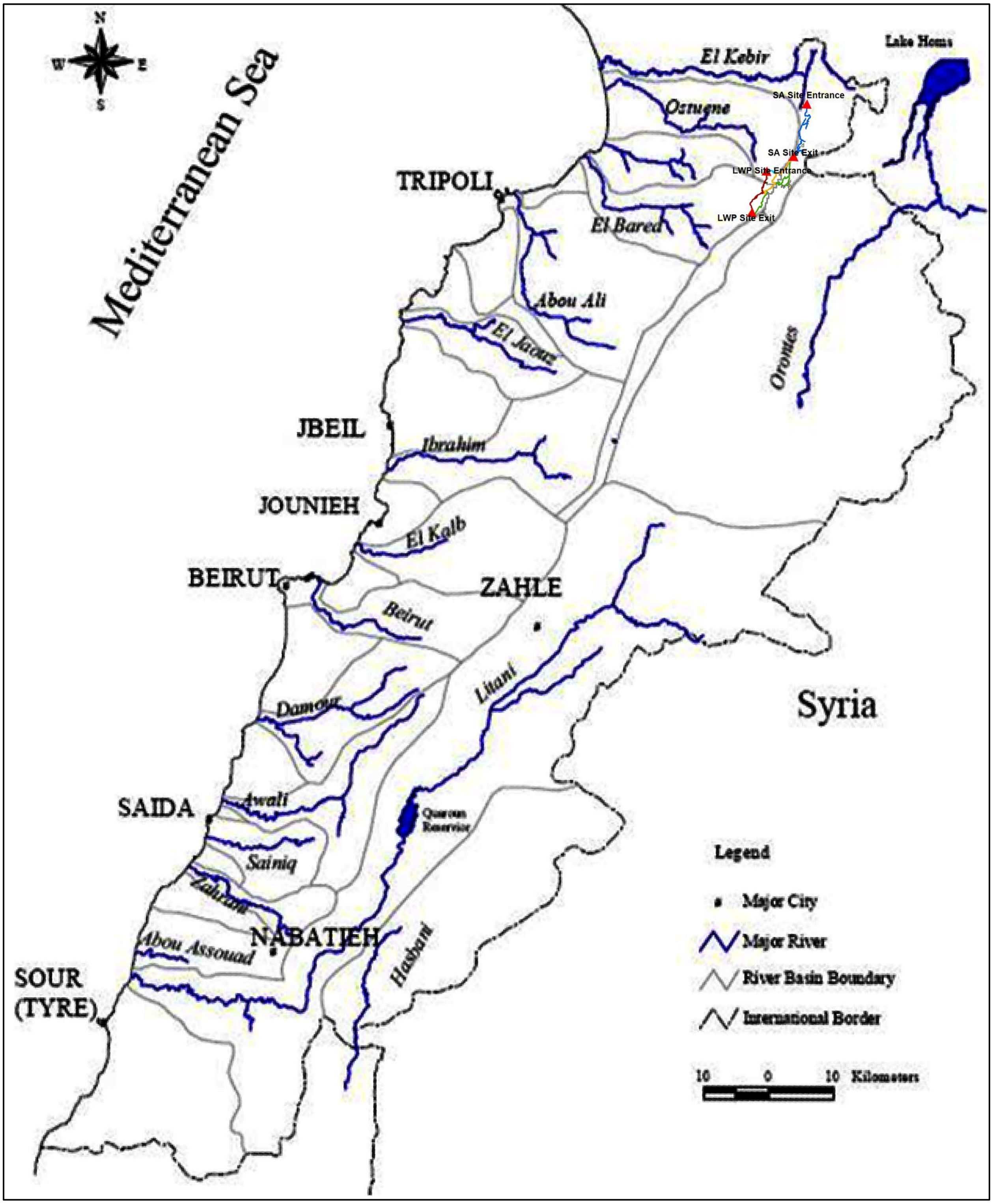
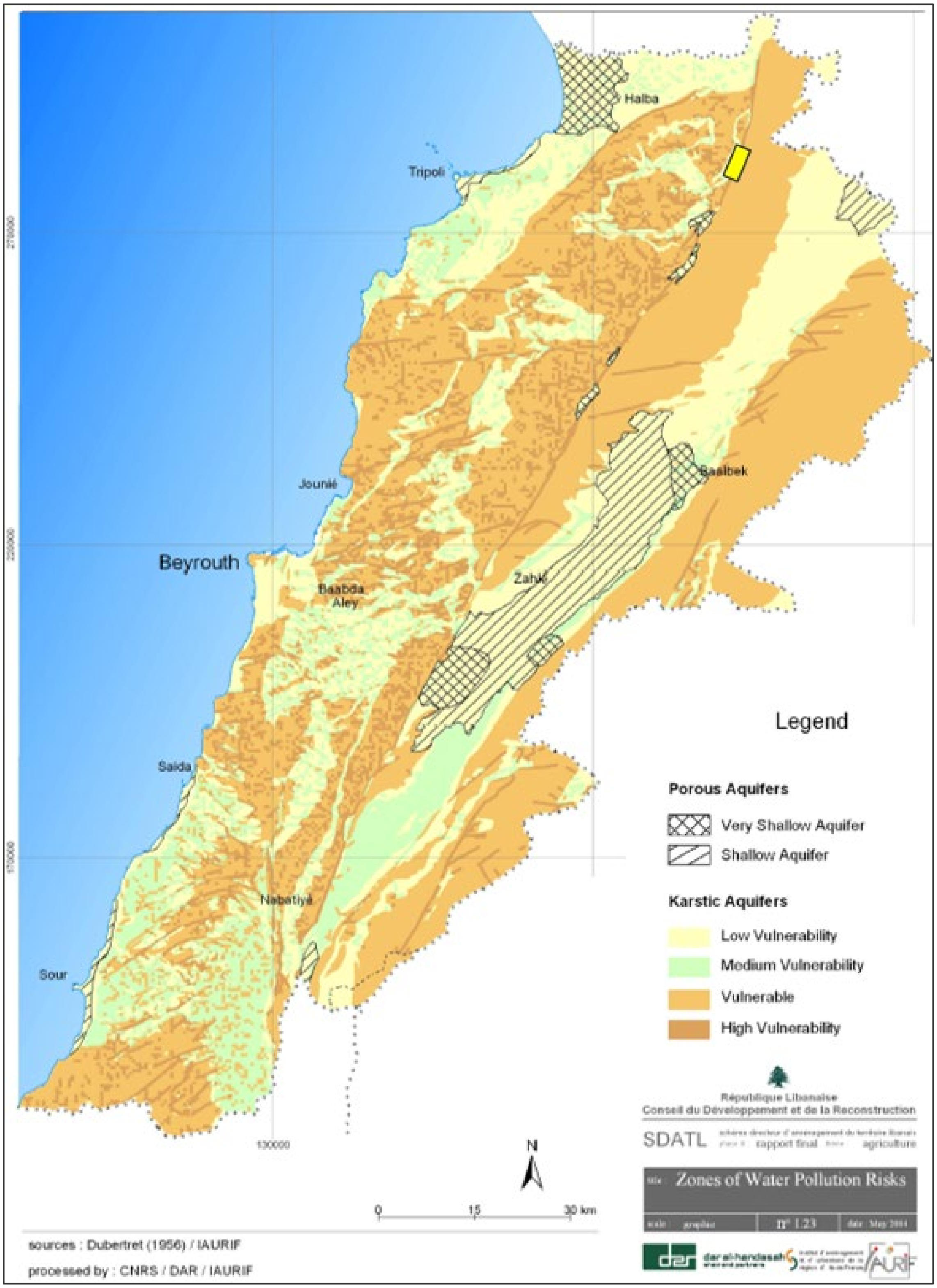


Figure 9-12 Water Resource Vulnerability Map of Lebanon



Akkar is generally rich in water resources. The Al Kabir is the main river in the area that extends along 58 km, noting that the villages of Aandqet, Quobaiyat, Chadra, Machta Hammoud and Machta Hassan form part of its drainage basin or watershed. **Figure 9-13**[9] shows the villages in the Project area and Al Kabir River passing through Chadra and Machta Hassan.

The El Kabir River has an average flow rate of about 9.13 m^3/s, with a minimum and a maximum of 1.42 m^3/s and 190.8 m^3/s, respectively. The river, as many others in the country, suffers from pollution. **Table 9-5**[10] shows some indicative pollutant values in the Al Kabir, Al Bared and Abou Ali/Kadisha Rivers in North Lebanon. These values were taken during the dry season, namely during the months of July, August and September of 2004.

Table 9-5 Parameters for Selected Main Rivers in North Lebanon in the Dry Season

Parameter	Al Kabir River / Nahr Al Kabir	Al Bared River / Nahr Al Bared	Abou Ali River / Nahr Abou Ali	Limit Value
BOD_5 (mg/l)	14.4	28.2	39.3	Nil*
NO_3 (mg/l)	3	2.8	3.4	50*
TDS (mg/l)	270	225	280	600*
SO_3 (mg/l)	20	28	22	250*
Total Coliforms (TC) (c/100ml)	300	610	26,500	500**
E. coli (c/100ml)	20	17	300	100**

* WHO (2006) standards for drinking water
** MOE Decision 52/1-1996: requirement for bathing water quality including sea, rivers and lakes.

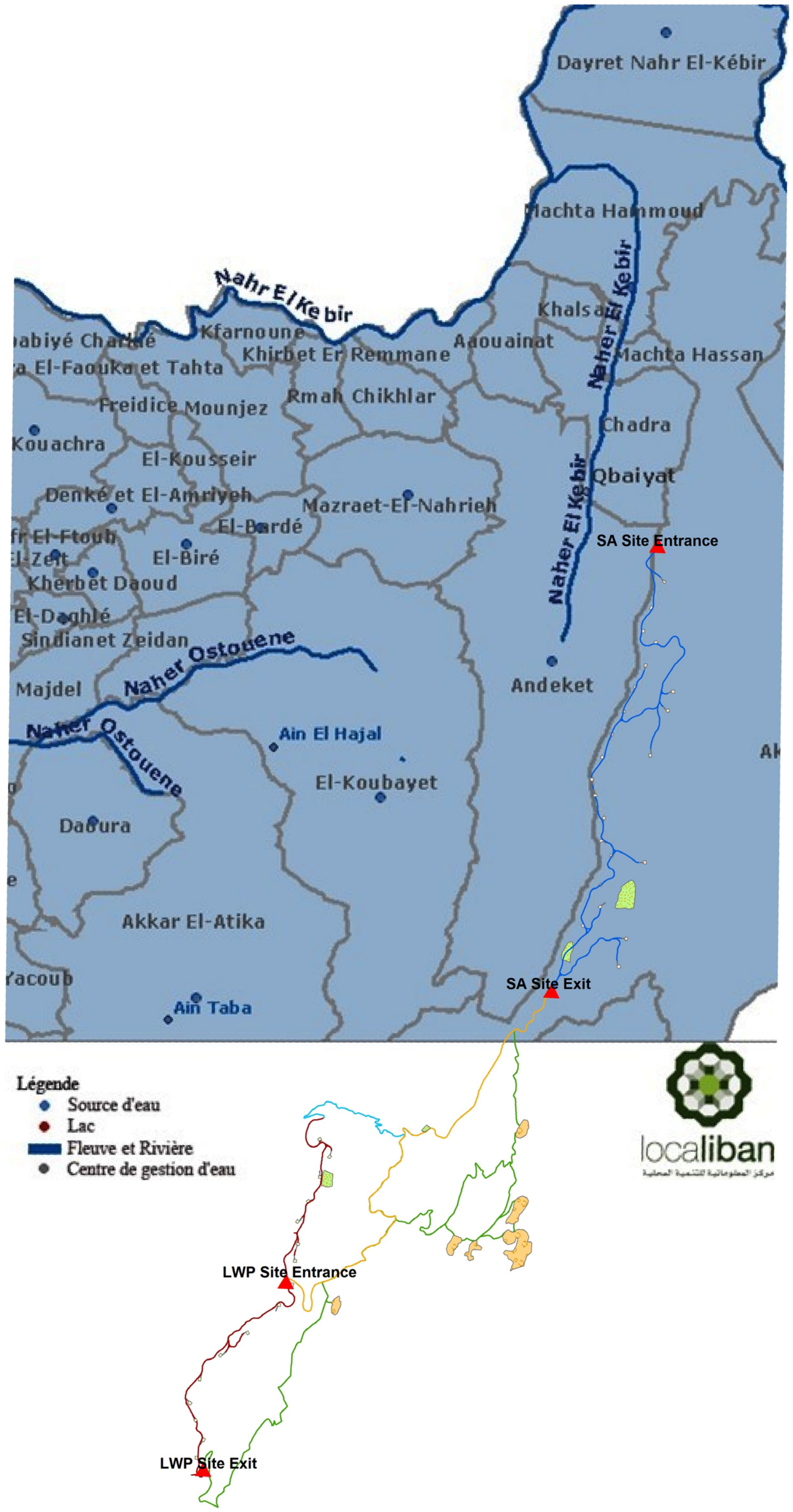
9.2.3.2 Springs

Approximately 5,050 springs are depicted in the 1:20,000 topographic maps of Lebanon. 409 springs distributed throughout the 51 GW basins have some reliable discharge flow data. Only 9 springs are currently being monitored on a regular basis. A 2014 spring assessment by the UNDP categorized and classified springs into types (based on emergence mechanism) and classes (based on discharge flow rates), in addition to analyzing hydrographs of springs with continuous data.

About 81 major springs, with sufficient reliable information, were categorized into 9 types. Each type is characterized by its specific emergence mechanism which includes a combination of spring hydrodynamic characteristics (i.e. draining flow, overflow, artesian, or a combination of two of these flow types) and geological controlling features (i.e. structural and stratigraphic control/barriers).Only 5 springs were found to belong to Class 2, which is characterized by a discharge rate ranging between 1 to 10 m^3/s.

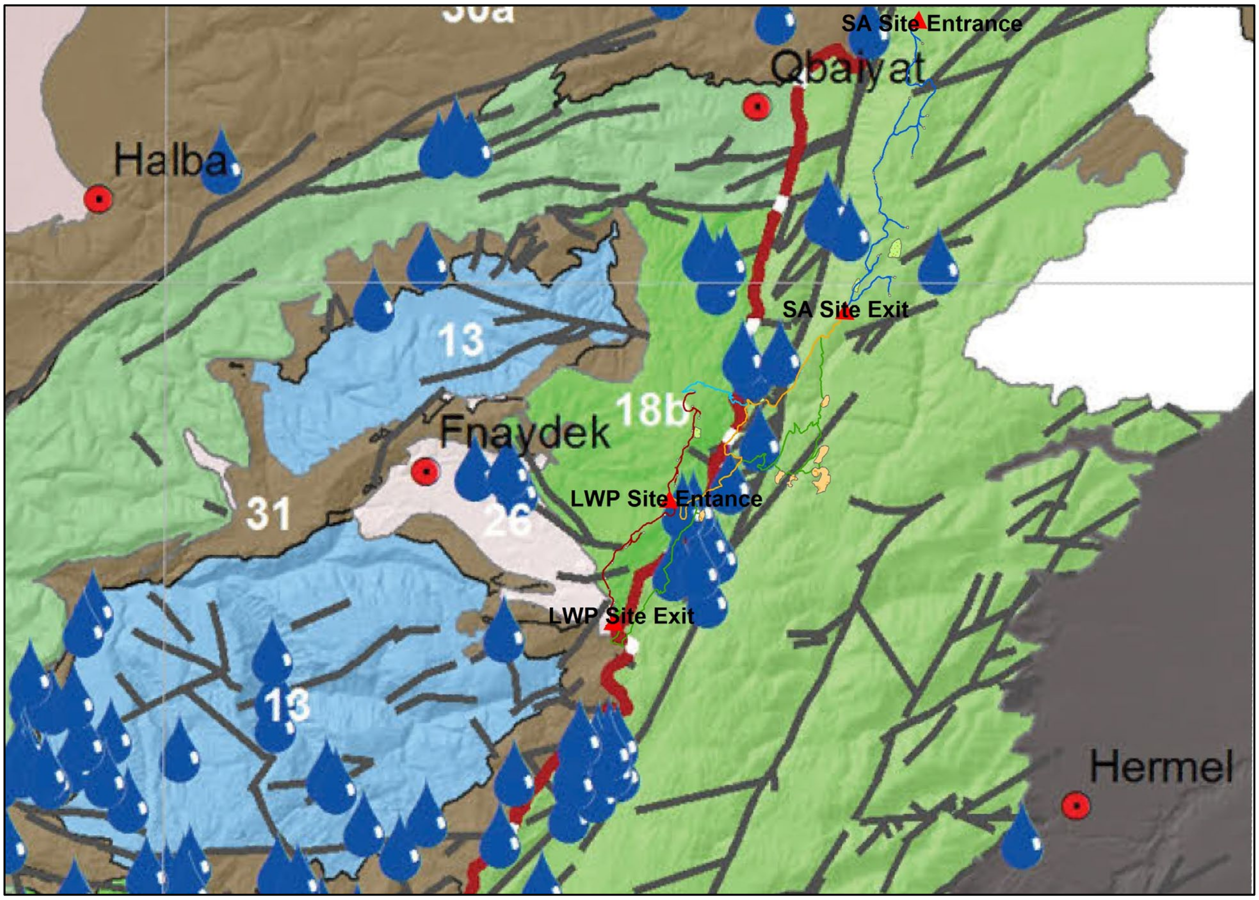
[9] LocaLiban, 2012.
[10] MOE, 2010.

Figure 9-13 Water Resources Map of the Project Area



There are no major springs in the study area, with the closest being the Ras El Ain Spring in Hermel, as previously shown in **Figures 9-7** through **Figure 9-9**. There are, however, several small water springs as depicted in **Figure 9-14**.

Figure 9-14 Minor Spring Locations



9.3 Impact Analysis

This section identifies the anticipated impacts to soil and groundwater from the Project activities during the construction, operation and decommissioning phases. It is noted that the selected OEM/EPC Contractor will undertake planned survey / monitoring (i.e. surveying of major karstic features, groundwater mapping, water quality monitoring of groundwater, local springs, etc.) to inform detailed design and address adverse impacts during construction.

9.3.1 Potential Impacts from Improper Management of Waste Streams during Construction and Operation

The generic nature of the impacts for the construction and operation phases of the Project include potential impacts from improper housekeeping practices (e.g. improper management of waste streams, improper storage of construction material and of hazardous material, etc.). Improper housekeeping practices during construction and operation (such as illegal disposal of waste to land) could contaminate and pollute soil which in turn could pollute groundwater resources. This could also indirectly affect flora/fauna and the general health and safety of workers (from being exposed to such waste streams).

Generally, such impacts can be adequately controlled through the implementation of general best practice housekeeping measures as highlighted throughout this section, and which are expected to be implemented by the selected OEM/EPC Contractor throughout construction and operations phases.

The potential impacts from improper management of waste streams could be of a long-term duration throughout the construction and operations phases. Such impacts are considered of low magnitude as they are generally controlled through the implementation of general best practice housekeeping measures. The receiving environment is considered of medium sensitivity. Following the implementation of the mitigation measures highlighted throughout this section, the residual significance can be reduced to not significant.

9.3.1.1 Solid Waste Generation

Solid waste is expected to be generated from construction and operational activities. Solid waste generated will likely include construction waste (such as debris) and municipal solid waste (during construction and operation such as cardboard, plastic, food waste, etc.). Municipal and construction waste generated will likely be collected and stored onsite and then disposed to the closest municipal approved area for disposal.

The mitigation measures to be applied by the OEM/EPC Contractor during the construction and operations phases include the following:

- Coordinate with the appropriate Municipality or hire a competent private contractor for the collection of solid waste from the site to the municipal approved disposal area.
- Prohibit fly-dumping of any solid waste to the land.
- Distribute appropriate number of properly contained litter bins and containers properly marked as "Municipal Waste".
- During construction, distribute a sufficient number of properly contained containers clearly marked as "Construction Waste" for the dumping and disposal of construction waste. Where possible, the OEM/EPC Contractor must seek ways to reduce construction waste by reusing materials (for example through recycling of concrete for road base course).
- Implement proper housekeeping practices on the construction site at all times.
- Maintain records and manifests that indicate volume of waste generated onsite, collected by contractor, and disposed of at the landfill. The numbers within the records are to be consistent to ensure no illegal dumping at the site or other areas.

9.3.1.2 Wastewater Generation

Wastewater is mainly expected to include black water (sewage water from toilets and sanitation facilities), as well as grey water (from sinks, showers, etc.) generated from workers during the construction and operation phase. Wastewater quantities are expected to be minimal. It is expected that wastewater will be collected and stored in fully contained septic tanks and then collected and transported by transportation tankers to be disposed at an appropriate wastewater treatment plant (WWTP).

The following mitigation measures are to be implemented by the selected OEM/EPC Contractor during the construction and operations phases:

- Coordinate with Akkar Water Directorate to hire a private contractor for the collection of wastewater from the site to the appropriate WWTP.
- Prohibit illegal disposal of wastewater to the land.
- Maintain records and manifests that indicate volume of wastewater generated onsite, collected by contractor, and disposed of at the WWTP. The numbers within the records are to be consistent to ensure no illegal discharge at the site or other areas.
- Ensure that constructed septic tanks during construction and those to be used during operation are well contained and impermeable to prevent leakage of wastewater into soil.
- Ensure that septic tanks are emptied and collected by wastewater contractor at appropriate intervals to avoid overflowing.

9.3.1.3 Hazardous Waste Generation

Hazardous waste is expected to be generated throughout both the construction and operation phase to include consumed oil, chemicals, paint cans, etc. Given the nature of the Project, hazardous waste quantities are expected to be relatively low. Nevertheless, hazardous waste generated will be collected and stored onsite and then disposed at an appropriate hazardous waste treatment facility.

The following mitigation measures are to be implemented by the selected OEM/EPC Contractor during the construction and operations phases:

- Coordinate with the MOE and hire a private contractor for the collection of hazardous waste from the site to the hazardous waste treatment facility.
- Follow the requirements for management and storage as per hazardous waste management and handling of the MOE.
- Prohibit illegal disposal of hazardous waste to the land.
- Ensure that containers are emptied and collected by the contractor at appropriate intervals to prevent overflowing.
- Maintain records and manifests that indicate volume of hazardous waste generated onsite, collected by contractor, and disposed of at the hazardous waste treatment facility. The numbers within the records are to be consistent to ensure no illegal discharge at the site or other areas.

9.3.1.4 Hazardous Materials

The nature of construction and operational activities entail the use of various hazardous materials such as oil, chemicals, and fuel for the various equipment and machinery. Improper management of hazardous material entails a risk of leakage into the surrounding environment either from storage areas or throughout the use of equipment and machinery.

The following mitigation measures are to be implemented by the selected OEM/EPC Contractor during the construction and operations phases:

- Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another.
- Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for.
- Incorporate dripping pans at machinery, equipment, and areas that are prone to contamination by leakage of hazardous materials (such as oil, fuel, etc.).
- Regular maintenance of all equipment and machinery used onsite. Maintenance activities and other activities that pose a risk for hazardous material spillage (such as refuelling) must take place at a suitable location (hard surface) with appropriate measures for trapping spilled material.
- Ensure that a minimum of 1,000 litres of general-purpose spill absorbent is available at hazardous material storage facility. Appropriate absorbents include elite, clay, peat and other products manufactured for this purpose.
- If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste.

9.3.2 Potential Impacts to Related Infrastructure and Utilities

9.3.2.1 Potential Impacts on Water Resources during the Construction and Operation Phases

It is expected that the Project throughout the construction and operation phase will require water for potable usage (drinking, personal cleaning, etc.) and non-potable usage (e.g. cleaning of turbines). The water requirements throughout the construction phase will be required temporary (for construction period only) and are considered minimal and not significant.

Calculations of potable and non-potable water use are currently being undertaken by the Developer.

Water will be required during the operation phase and mainly for drinking and other personal use of onsite staff (around 3 personnel). During operation, water will also be required for the cleaning of the blades. It is expected that the cleaning will take place once every 3–5 years, thus amounting to 5–9 times during the lifetime of the Project. The amount of water required per wash is around 48m^3 (equivalent to around 1m^3 per turbine, i.e. for a maximum of 16 turbines X 3 blades per turbine); thus, the maximum amount of water required during the lifetime of the Project is around 336m^3 (assuming 7 washes are undertaken).

The anticipated impacts on the local water resources and utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operation phase. Such impacts are expected to be of low magnitude and of low sensitivity given the minimal water requirements of the Project. To this extent, the impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor should coordinate with the Akkar Water Directorate to secure the water requirements of the Project.

9.3.2.2 Potential Impacts on Wastewater Disposal Utilities during the Construction and Operation Phases

The Project is expected to generate wastewater during both the construction and operation phases to include black water (sewage water from toilets and sanitation facilities) and grey water (from sinks, showers, etc.). Wastewater quantities generated are expected to be minimal and not significant at all during both phases of the Project and are likely to be easily handled.

Generally, the approximate estimated wastewater to be generated from the Project can be accounted as follows. Throughout the construction phase, 150 construction workers are anticipated, whereas during the operation phase 3 workers are anticipated. The water requirements per capita during the construction and operation are currently being calculated by the Developer. The wastewater generated will most likely be collected by tankers from the Project and disposed offsite at a wastewater treatment facility. Such wastewater generated from the Project during the construction and operation phase reveals that such quantities are negligible.

Taking all of the above into account, the anticipated impacts on wastewater utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operations and maintenance phase. Such impacts are expected to be of low magnitude given the minimal wastewater quantities generated, and of low sensitivity as they will be easily handled. Given the above impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must coordinate with the Akkar Water Directorate to obtain list of authorized contractors for disposal of wastewater.

9.3.2.3 Potential Impacts on Solid Waste Disposal Utilities during the Construction and Operation Phases

The Project is expected to generate solid waste during both the construction and operation phases to include construction waste (i.e. dirt, rocks, debris, etc.) as well as general municipal waste (such as food, paper, glass, bottles, plastic, etc.). Solid waste quantities generated are expected to be minimal and not significant at all during both phases of the Project and are likely to be easily handled as either municipal waste and/or construction debris. Such quantities are negligible when compared to the total volume of solid waste received by such facilities daily.

The anticipated impacts on solid waste utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operations phase. Such impacts are expected to be of low magnitude given the minimal solid waste quantities generated, and of low sensitivity as they will be easily handled by the landfill. Given the above impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must:

- Undertake discussions with the appropriate municipal landfills to determine where there is sufficient capacity to easily handle construction debris generated from the Project.
- Coordinate with the appropriate municipality or hire a competent private contractor for the collection of construction waste from the site to the approved landfill.
- Coordinate with the appropriate municipality or hire a competent private contractor for the collection of solid waste from the site to the approved landfill.

9.3.2.4 Potential Impacts on Hazardous Waste Disposal Utilities during the Construction and Operation Phases

The exact quantities of hazardous waste that will be generated from the Project are not determined; however, given the nature of construction and operation they are expected to be minimal. Such hazardous waste streams include simple types of waste such as oil, chemicals, and fuel for the various equipment and machinery. Hazardous waste quantities are likely to be easily handled by the hazardous waste treatment facility.

Taking all of the above into account, the anticipated impacts on hazardous waste utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operations and maintenance phase. Such impacts are expected to be of low magnitude given the minimal hazardous waste quantities generated, and of low sensitivity as they will be easily handled appropriately by the hazardous waste treatment facility. Given the above, the impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must coordinate with the MOE to hire a competent private contractor for the collection of hazardous waste from the site and disposal at the hazardous waste treatment facility.

9.3.3 Impact Assessment Summary

Table 9-6 Impact Assessment for Improper Management of Waste Streams

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High √**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor	**Moderate √**
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

10. GEOPHYSICAL GROUND AND SEISMICITY

10.1 Baseline Methodology

A geophysical ground investigation was implemented in April-June 2018 to determine the engineering parameters for the wind turbine and plant foundations, platforms and roads to be constructed, as presented in the Terifrom Ground Study presented in **Appendix I**.

A 12-channel DOREMI engineering seismograph recorder was used for the MASW studies. It consists of a tablet PC for system records, a sensor for detecting seismic tracks, a trigger, a sledgehammer, 12 vertical geophones (4.5 Hz geophone) and special connection units, as shown in **Figure 10-1**.

Figure 10-1 Seismic Device

A total of 506 Multichannel Analysis Surface Waves (MASW) measurements were taken in the field and 2D-3D models and evaluations were used in the analysis of S-type seismic velocity (Vs) among other parameters. The resulting Vs30 measurements characterize the Ground Groups encountered at the data point, as shown in **Table 10-1**, indicative of the stability of soils.

Table 10-1 Vs30 Values and Corresponding Ground Groups

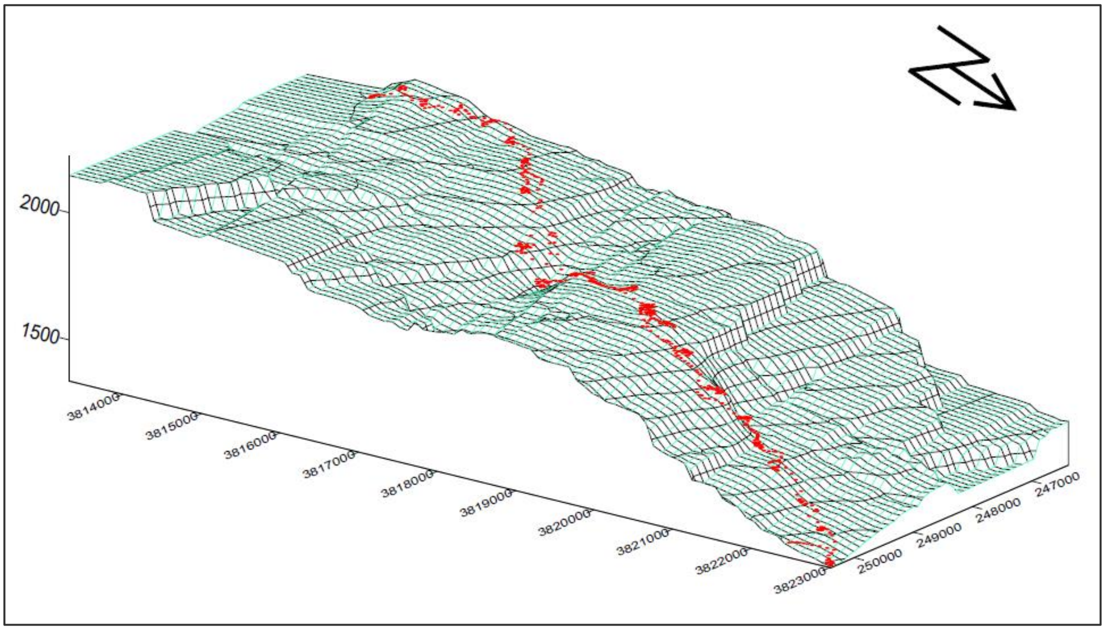
Vs30 Value (m/sec)	Ground Group	Definition
Vs30 > 800	A	Rock or other similar formations
Vs30 > 360, but < 800	B	High hard sand pebbles very hard clay
Vs30 > 180 but < 360	C	Tight to medium tight sand, gravel or hard clay
Vs30 < 180	D	Cohesionless ground from loose to medium tight

Measurements were collected at each of the wind turbine locations under consideration at the time of the survey. Depending on the ground conditions observed at each turbine location, differing numbers of measurements were collected to provide recommendations for excavation prior to construction in suitable soils with appropriate bearing capacity.

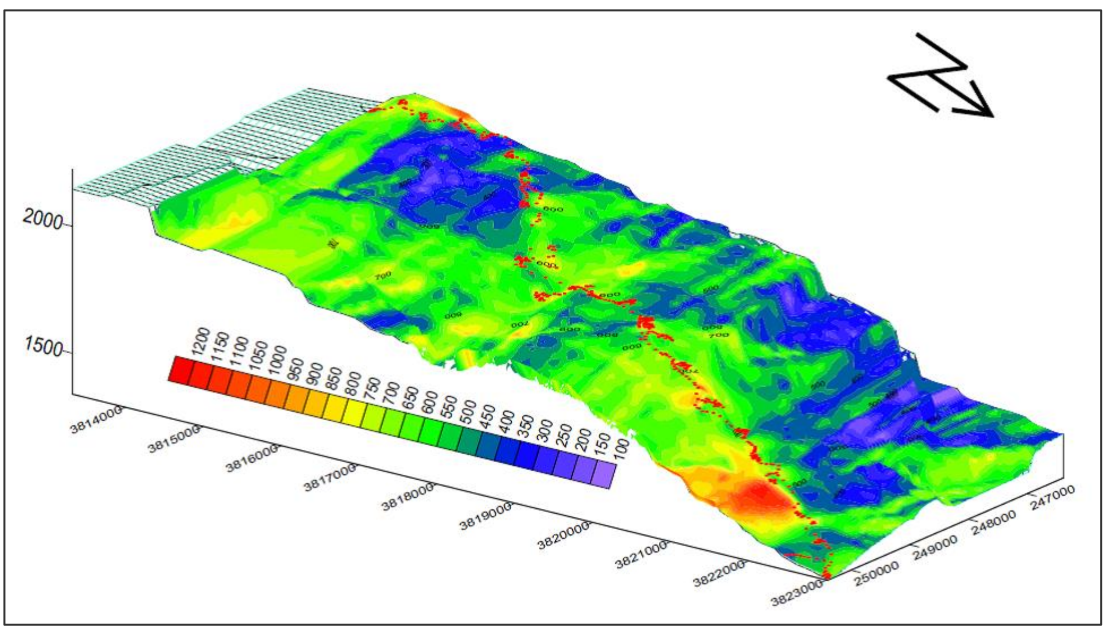
10.2 Baseline Findings

Measurement points and findings in terms of Vs30 dispersion map are provided in **Figure 10-2**. Overall, Ground Groups of A through C were encountered at most locations; it is noted that no Vs30 values lower than 200 recorded and very few locations recorded Vs30 values lower than 300, indicating relatively hard formations. The profile measured at each potential turbine location, the soil conditions encountered at each turbine location, and the recommendations provided for excavation ahead of construction are provided in **Appendix I**.

Figure 10-2 MASW Measurements



a - Measurements Points

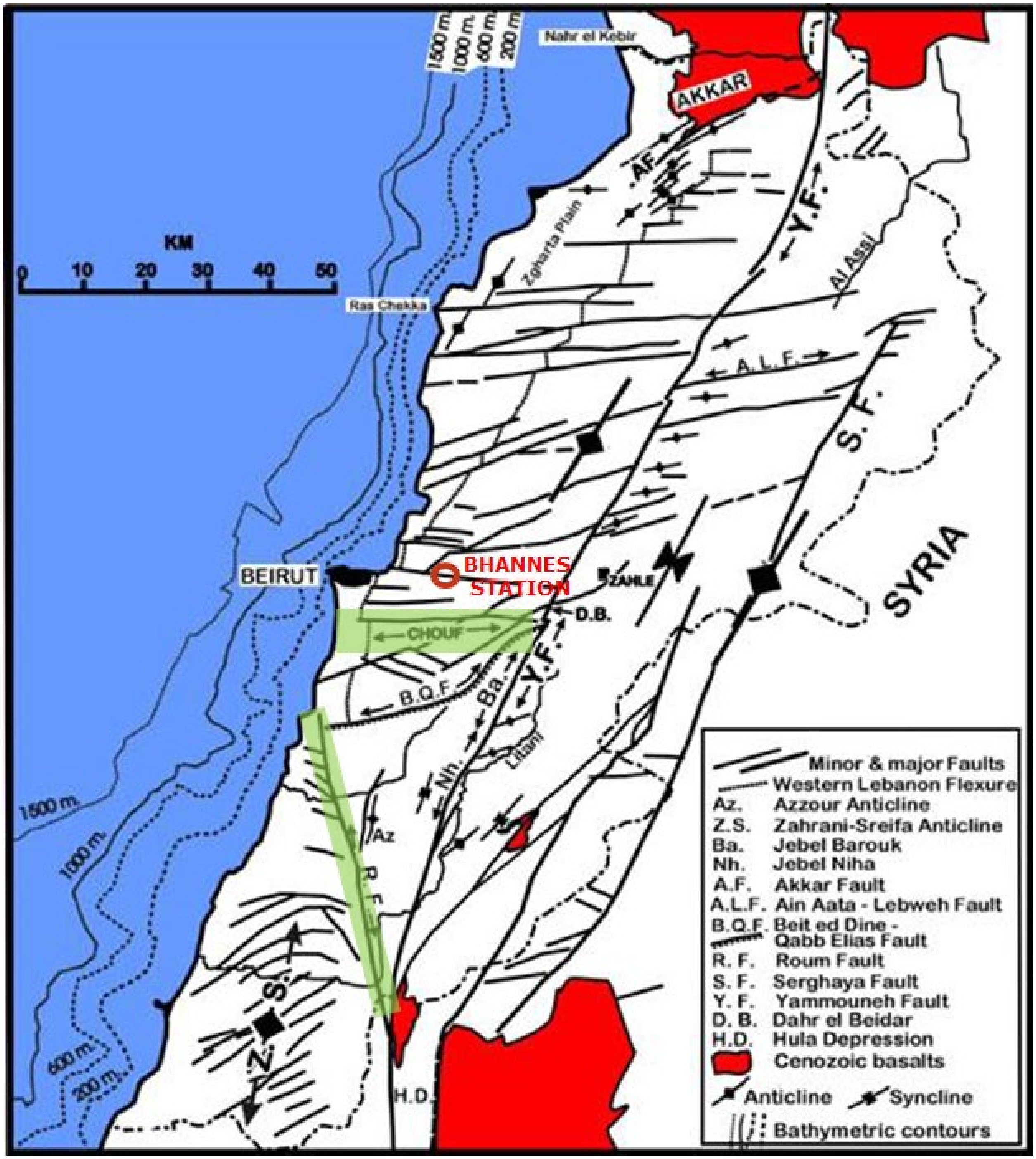


b - Vs30 Dispersion Map

10.2.1 Seismicity

The report of Tefirom Ground Report (2018) states that the epicenters of the strongest three seismic events in this century (1907, 1956, and 1997) are located in the Roum Fault Zone, including the Chouf Region and its offshore area (highlighted in green) as shown in **Figure 10-3**.

Figure 10-3 Fault Zones



This implies that the epicenter of this event could be relocated northward to become closer to the epicenters of its own aftershock and of the 1907 and 1956 events. Hence, the Chouf Area with its complicated structural setting, probably, constitutes a locked (northern) segment of the Roum Fault Zone, which probably terminates near Damour River. Moreover, information issued by the Lebanese Geophysical Center through its seismological station at Bhannes (the only recording station in Lebanon) indicated that the distance from the epicenter of the main 1997 event to the station is only 33km.

The earthquakes of 1907, 1956, and 1997 had a recurrence interval of 40 to 50 years. However, no major seismic events are known in Lebanon after the destructive 1837 earthquake, which has affected southern Lebanon. The epicenter of this earthquake has been located by many investigators near Salad in the Huleh Depression, where the Dead Sea Transform Fault (DSTF) bifurcates into its Lebanese fault branches.

Additional information on the effects of the Yammouneh Fault, east of the Project, are currently being assessed. The findings will inform mitigation, if applicable.

10.3 Impact Analysis

The Project will be located at the highest altitude points of the Akkar region and is not be expected to be exposed to flood or flooding due to its geological structure and elevation.

Further, since the Akkar region is not within a landslide area, it is considered that there will not be any slope stability issues. The Project site is situated within the rising block of the formation. The areas where active fault movements are observed are generally within the falling block. For this reason, earthquake impact and related problems are not predicted in the Akkar region.

A new seismicity catalogue for the area of Lebanon (32ø-35øN, 34ø-37øE) was compiled in 1997 (with 1,725 events including both historical earthquakes and instrumentally recorded tremors (Butler *et al.*, 1997). They concluded that changing (decreasing northward) seismicity characteristics along the Roum Fault Zone suggest a change in faulting mechanism, resulting in a slightly higher earthquake hazard for southwest Lebanon.

As such, the potential for earthquake at the Project site is minimal.

Mitigation

Ground stability problems are not expected due to high resistance values and safe carrying power values evidenced by the seismic measurements.

During detailed design, the OEM/EPC Contractor will incorporate the recommendations of the seismic study for excavation at the platform foundation locations to a depth where stable soils are encountered.

Following the implementation of these mitigation measures, the impact severity is considered Low, and the sensitivity of the receptor as High, resulting in a residual impact categorized as Moderate as shown in **Table 10-2**.

Table 10-2 Geophysical Ground and Seismicity Assessment

		Sensitivity of Receptor				
		Low	Low-Medium	Medium √	Medium-High	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	**Negligible √**	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

11. AIR QUALITY

11.1 Baseline Methodology

Air quality information was obtained through literature review. The Project is located in a rural area of Jabal Akroum. No industrial point sources of air pollution have been identified within the Project boundary. There are no sensitive receptors (i.e., residents, hospitals, schools) near the Project area. Background concentrations for criteria pollutants ozone (O_3), particulate matter less than 2.5 microns in diameter (PM2.5), particulate matter less than 10 microns in diameter (PM10), carbon monoxide (CO), nitrogen oxides (NOx), and sulfur dioxide (SO_2), at the locations shown in **Figure 11-1**. This data was collected in 2011 and published by the MOE in 2015.

It should be noted that in North Lebanon, the Tripoli Environment and Development Observatory (TEDO) operates several urban and background monitoring stations in Tripoli. Additionally, the MOE launched its first two phases of the Air Quality Monitoring Network (AQMN), with the support of the UNEP and UNDP, and the EU, which allowed to install 15 background air quality monitoring stations and 10 meteorological stations to provide real time air quality monitoring data in Lebanon. While the AQMN has been fully operational since 2017, data management and analysis are still underway and has not been published yet.

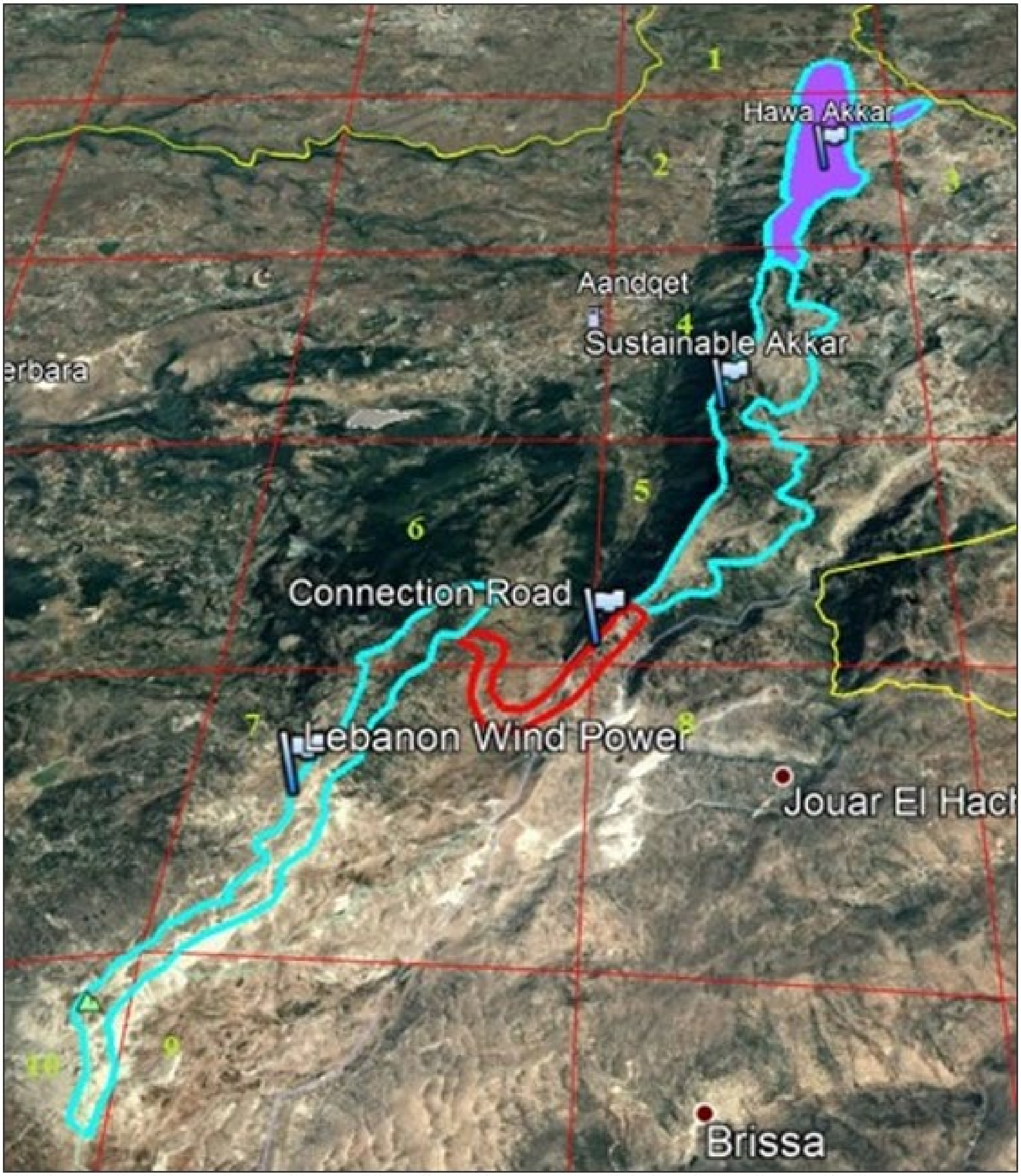
11.2 Baseline Findings

The 2011 background concentrations for priority pollutants are summarized in **Table 11-1**.

Table 11-1 Background Concentrations of Priority Pollutants in the Project Area (ug/m^3)

Cell ID	NO_2	O_3	PM10	PM2.5	SO_2	CO
1	9.169	83.319	17.740	15.420	10.070	201.113
2	11.879	81.668	17.613	15.469	10.554	206.054
3	10.483	81.116	17.116	15.061	9.950	199.545
4	11.097	82.540	16.436	14.555	9.555	201.673
5	9.995	82.868	15.382	13.658	8.592	195.067
6	12.006	81.465	16.219	14.296	9.761	203.033
7	6.460	85.945	14.304	12.484	6.356	185.880
8	7.000	85.618	14.078	12.452	6.512	184.593
9	4.694	87.115	13.383	11.665	4.988	175.124
10	7.071	85.847	14.283	12.369	6.463	183.716

Figure 11-1 MOE 2011 Air Monitoring Locations



The three wind farm sites are located in cell numbers 1 to 10, (each cell is 5km x 5 km):

		N		
W		1 to 10		**E**
		S		

Review of the baseline information indicates that concentrations of criteria pollutants are low in the Project area. Moreover, the latest national air quality assessment has been conducted as part of the environmental impacts of the Syrian crisis and it indicated that the impacts of the Syrian crisis in terms of air quality is negligible in the Project area. As such, it is expected that any negative deterioration on the air quality since 2011 would also be insignificant[1].

Background sources of air pollution include quarrying activities to the east of the Project which generate dust. Another source of air pollution is the transport sector emitting exhaust related pollutants such as PM, CO, NO_x, SO_x and hydrocarbons. However, the significance of the latter emissions on the Project area is low and the site can be considered located in a relatively pristine area with clean air and low air pollution levels.

11.3 Impact Analysis

11.3.1 Air Quality Standards

The World Health Organization (WHO) has developed a set of guidelines for air quality that serve as an international benchmark and offers guidance in reducing the health impacts of air pollution (WHO, 2006). They are set based on a review of the accumulated scientific evidence. **Table 11-2** presents the WHO Air Quality Guidelines for some pollutants (WHO, 2006). The IFC/World Bank Group (WB) adopts the WHO Air Quality Guidelines in the absence of national air quality regulations.

Table 11-2 WHO Air Quality Guidelines

Pollutant	Maximum Concentration	Averaging Period
Sulfur dioxide (SO_2)	500 µg.m^{-3}	10 minutes
	20 µg.m^{-3}	24 hours
Nitrogen dioxide (NO_2)	200 µg.m^{-3}	1 hour
	40 µg.m^{-3}	1 year
Ozone (O_3)	100 µg.m^{-3}	8 hours
Carbon monoxide (CO)	100,000 µg.m^{-3}	15 minutes
	60,000 µg.m^{-3}	30 minutes
	30000 µg.m^{-3}	1 hour
	10,000 µg.m^{-3}	8 hours
Total suspended particles (TSP)	*Not available*	
Particulate matter smaller than 10 µm (PM_{10})	50 µg.m^{-3}	24 hours
	20 µg.m^{-3}	1 year
Particulate matter smaller than 2.5 µm ($PM_{2.5}$)	25 µg.m^{-3}	24 hours
	10 µg.m^{-3}	1 year
Lead	0.5 µg.m^{-3}	1 year
Benzene	No safe level of exposure can be recommended	Excess lifetime risk of leukemia at a concentration of 1 µg.m^{-3} is 6×10^{-6}

[1] MOE/EU/UNDP, 2014. Environmental Impact of the Syrian Crisis. Available at http://www.moe.gov.lb/الوزارة/Agreements-Plans-and-Reports/تقارير/Lebanon-Environmental-Assessment-of-the-Syrian-Con.aspx.

In 1996, the MOE has issued in 1996 Decision 52/1 proposing national air quality guidelines. Annex 14 of Decision 52/1 provides ambient air standards (averaging periods and values) as shown in **Table 11-3**, presenting standards for SO_2, NO_2, O_3, CO, TSP, PM_{10}, Lead, and Benzene. Based on the IFC/WB EHS guidelines, since Lebanese regulations exist, they shall apply to this project.

Table 11-3 Air Quality Guidelines According to Lebanese Decision 52/1

Pollutant	Maximum Concentration	Averaging Period
SO_2	350 $\mu g.m^{-3}$	1 hour
	120 $\mu g.m^{-3}$	24 hours
	80 $\mu g.m^{-3}$	1 year
NO_2	200 $\mu g.m^{-3}$	1 hour
	150 $\mu g.m^{-3}$	24 hours
	100 $\mu g.m^{-3}$	1 year
O_3	150 $\mu g.m^{-3}$	1 hour
	100 $\mu g.m^{-3}$	8 hours
CO	30,000 $\mu g.m^{-3}$	1 hour
	10,000 $\mu g.m^{-3}$	8 hours
TSP	120 $\mu g.m^{-3}$	24 hours
PM_{10}	80 $\mu g.m^{-3}$	24 hours
Lead	1 $\mu g.m^{-3}$	1 year
Benzene	5 ppb	1 year

Moreover, the IFC/WB indicates that emissions resulting from a project shall not contribute to more than 25% of the applicable air quality standards to allow additional, future sustainable development in the same airshed. Consequently, based on the IFC guidelines which indicates the use of the national air quality standards, the Project shall not result in more than the values presented in **Table 11-4**.

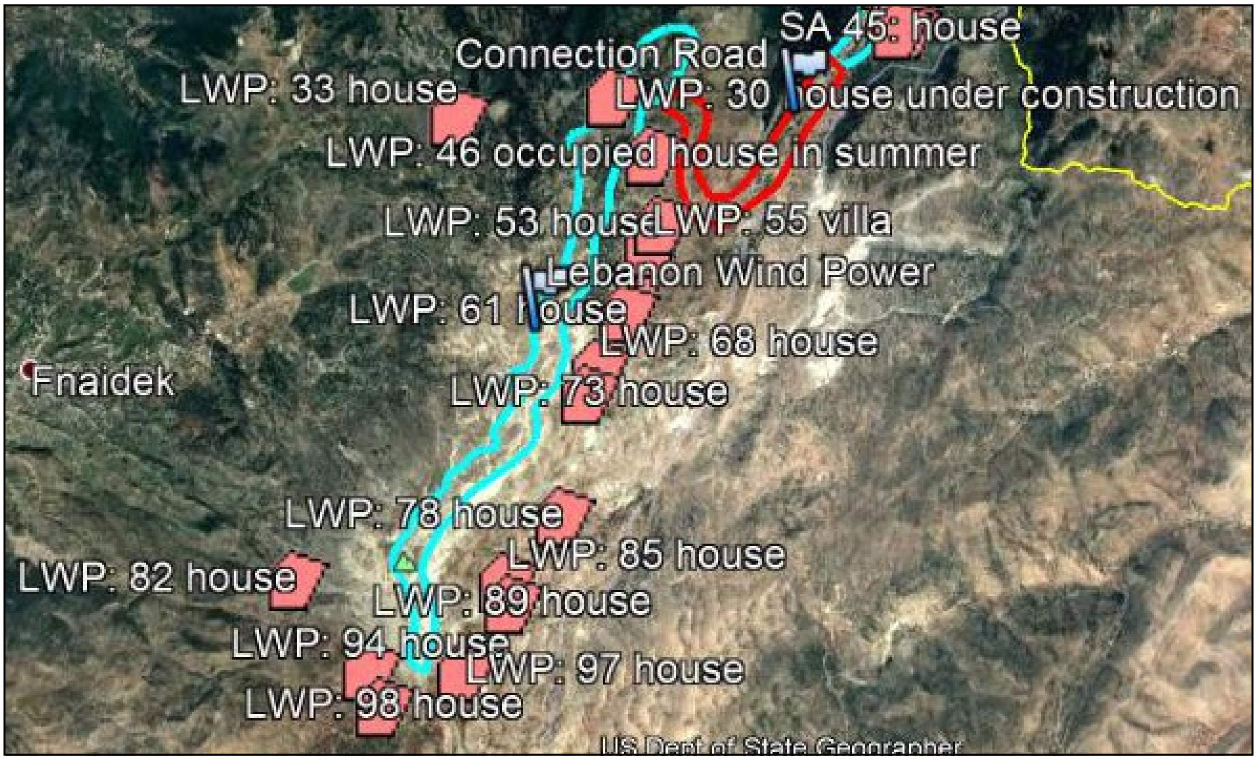
Table 11-4 Maximum Allowed Concentration Increments from the Project

Pollutant	Maximum Allowed Concentration	Averaging Period
SO_2	87.5 $\mu g.m^{-3}$	1 hour
	30 $\mu g.m^{-3}$	24 hours
	20 $\mu g.m^{-3}$	1 year
NO_2	50 $\mu g.m^{-3}$	1 hour
	37.5 $\mu g.m^{-3}$	24 hours
	25 $\mu g.m^{-3}$	1 year
CO	7500 $\mu g.m^{-3}$	1 hour
	2500 $\mu g.m^{-3}$	8 hours
TSP	30 $\mu g.m^{-3}$	24 hours
PM_{10}	20 $\mu g.m^{-3}$	24 hours

11.3.2 Sensitive Receptors

Many villages and houses exist near the Project site but are all more than 350m from the wind turbines locations at Lebanon Wind Power as shown in **Figure 11-2**.

Figure 11-2 Location of Sensitive Receptors near the Project



Generally, the receptors are also more than 50m from the road, except for one house currently under construction located approximately 40m from the road, as shown in **Figure 11-3**.

11.3.3 Emissions Estimation

Emissions were estimated for the construction phase, the operation phase (including maintenance), and the decommissioning phase of the Project.

The sources considered are combustion of fuel and fugitive emissions. The combustion sources encompass vehicle tailpipe and stacks, while the fugitive emissions consider mainly the dust entrainment generated by vehicles while running, and emissions from loading/unloading of material, bulldozing, etc.

Emission factors were acquired from the EMEP/EEA Guidebook (2016) for on-road and off-road vehicles, while the fuel consumption was provided by actual contractors (MAN and DAKO). The sulphur content used is the upper limit of the Lebanese regulations: 10 ppm maximum for automotive fuel while it is of 350 ppm for diesel used for boilers and reciprocating engines. The activity data assumed was acquired from the Sustainable Akkar, a larger wind farm, and therefore represents a conservative approach to the assessment.

As with the climate change assessment, the emission sources for activities by phase and emission factors and fuel consumption are as previously presented in **Appendix H**.

Figure 11-3 Location of a House Under Construction Approximately 40m From Road

11.3.4 During Construction

Air emissions during the construction phase can come from multiple sources including dust emissions/ particulate matter (PM) from site preparation (land clearing, excavation schemes, cut and fill operations), material sourcing, movement of trucks and heavy-duty equipment, and stockpiling activities.

Dust and PM emissions at the wind farm are particularly concerning given the high-wind velocity location of the Project site. Fugitive dust and other emissions from vehicular traffic and construction machinery can also contribute to degraded air quality. The use of construction equipment on-site is also expected to release vehicular induced pollutants such as carbon monoxide, nitrogen oxides, sulfur oxides, particulate matter (PM) and hydrocarbons (HC).

Emission sources are shown in **Table 11-5**.

Table 11-5 Emission Sources Considered

Emission Source	Emission Type	Fuel Type
Main crane	Exhaust	Diesel
Auxiliary crane	Exhaust	Diesel
LDV for personnel movement on site and out of site	Exhaust	Gasoline
Tractor FH440	Exhaust	Diesel
Bus	Exhaust	Gasoline
Trucks $20m^3$	Exhaust	Diesel
Jackhammer	Exhaust	Diesel
Caterpillar D9	Exhaust	Diesel
Excavator	Exhaust	Diesel
Concrete Mixer Truck	Exhaust	Diesel
Concrete Pump	Exhaust	Diesel
Skidoo	Exhaust	Gasoline
Bulldozing Moisture 1%, silt 5%	Fugitive	-
Loading/Unloading	Fugitive	-
Dust entrainment from paved roads - Truck 40t on average, silt $5g/m^2$	Fugitive	-
Dust entrainment from paved roads - LDV 1.8 t, silt $5g/m^2$	Fugitive	-
Dust entrainment from paved roads - Bus 5t, silt $5g/m^2$	Fugitive	-
Dust entrainment from unpaved roads - Trucks 40t on average	Fugitive	-
Dust entrainment from unpaved roads - LDV 1.8t	Fugitive	-
Dust entrainment from unpaved roads - Bus 5t	Fugitive	-

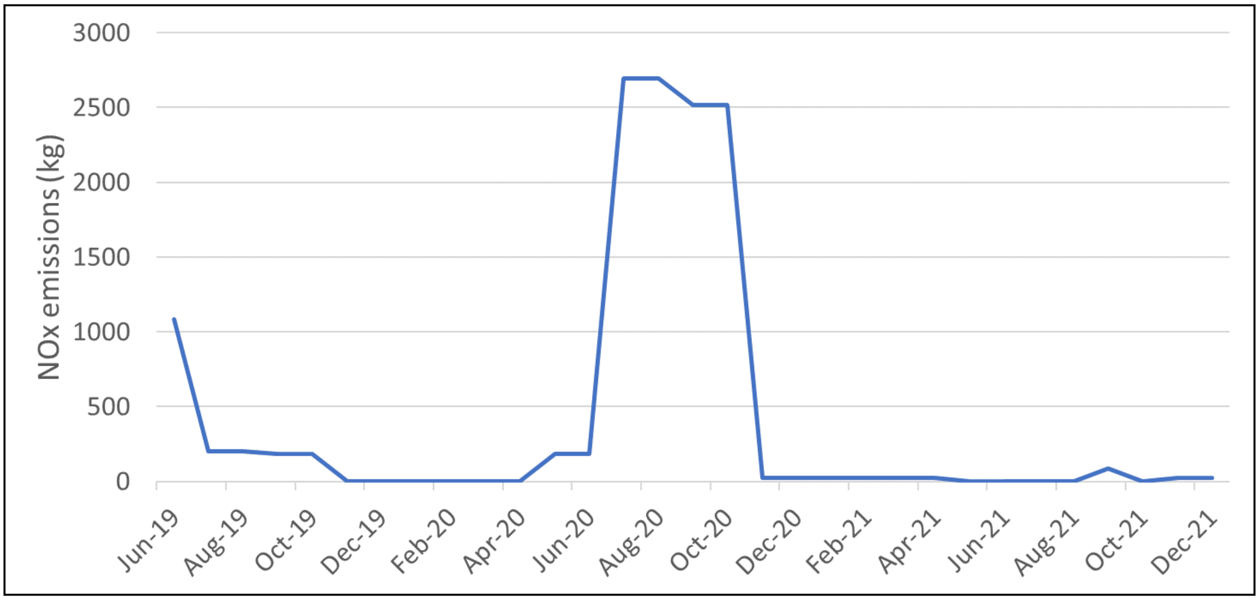
Results of the emissions estimation are presented in **Table 11-6**. The construction phase exhibits generally the highest emissions of the pollutants. The highest emissions are those of the PM and originate mainly from fugitive emissions (>99%).

Table 11-6 Emissions from the Construction Phase

Emissions in kg	NOx	PM10	PM2.5	SO_2	CO
Construction	12,651.2	583,330.8	117,504.3	86.3	3,288.6

Figure 11-4 shows the monthly variation of the NOx emissions from the construction phase. NOx comes from the combustion of fuel (transport but also reciprocating engines and boilers). The increase in mid-2020 relate to the turbine platform construction and erection.

Figure 11-4 NOx Emissions During Construction Phase



Impact of Particulate Matter

The fugitive emissions constitute one of the main concerns in construction and demolition activities (IAQM, 2016). The earthworks will pose greater impacts on human receptor since large quantities of material will be excavated and moved. Vehicle speeds for heavy-duty vehicles (HDV) are generally low, approximately 15-16 km/hr. In addition, less than 50 HDV will be passing along the Project roads per day.

According to IAQM "*Guidance on the assessment of dust from demolition and construction*" (2016), particles originating from a construction site have low impact if a "human receptor" is located beyond 350m. This is the case for most of the receptors of the Project, with the exception of a single sensitive receptor located 40m from the road that will be used by construction vehicles. Therefore, the above-mentioned impact applies before the implementation of any mitigation measures even though it is of short duration and reversible.

IAQM (2016), the Mojave Desert (2013) and Good International Industry Practice (GIIP) suggest the following mitigation measures:

- Use of wind screens or enclosures around dusty activities or the site boundary. Mojave Desert Air Quality Management District assumes that complete coverage by wind screens (on the windward side) will provide a control efficiency of 75 percent.
- Water spray is also used to reduce fugitive dust as it increases the moisture content of the material. Therefore, and according to Mojave Desert too, Water spray (Application point) will ensure a control efficiency of 75%. This is very useful for exaction for example.
- For unpaved roads, water flushing is the essential with 0.48 gallons per square yard twice per day to maintain a control efficiency above 50%.
- For paved roads, water flushing with 0.48 gallons per square yard followed by sweeping is very effective and can reach 96%. If conducted directly before the passage of the turbines convoy or the morning and evening passages of the project vehicles to and from the site, a consequent decrease will occur.
- A combination of the different above-mentioned measures will give a higher control efficiency that when applied individually.

The sensitivity of the area is Low; however, since construction workers are mainly impacted the sensitivity of the receptor is considered Medium, resulting in a Minor impact as shown in **Table 11-7**.

Table 11-7 Air Quality Assessment for the Construction Phase (Worst-Case Scenario)

		Sensitivity of Receptor				
		Low	Low-Medium	Medium √	Medium-High	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

11.3.5 During Operation

During the operations phase, vehicular traffic on unpaved access tracks can produce dust and PM emissions that can have negative impacts on air quality. Emissions from the operations phase are shown in **Table 11-8**. With proper management, air emission impacts during project operation are not expected to be significant.

Table 11-8 Emissions from the Operations Phase

Emissions in kg	NOx	PM10	PM2.5	SO_2	CO
Operation (1yr)	232.1	11,762.4	1,821.5	19.1	4,456.6

11.3.6 During Decommissioning

Decommissioning air quality impacts are expected to be similar to those stated for the construction phase. Dust and PM emissions are expected from equipment and turbine removal, from the movement of trucks and heavy-duty equipment, and from the transport and stockpiling of deconstruction materials. Carbon monoxide, nitrogen oxides, sulfur oxides, PM and HC are also expected to be released from vehicles and equipment onsite.

Given the temporary and short-term nature of the decommissioning activities, air emissions impacts are expected to be of low to moderate significance.

Air emissions during the construction phase are temporary in nature, thus the impact outside the Project site is only expected to be minor, especially given the implementation of an appropriate and endorsed ESMP. Mitigation measures are recommended to address PM emissions and specifically, fugitive PM. IAQM (2016), the Mojave Desert (2013) and Good International Industry Practice (GIIP).suggest the following mitigation measures:

- Use of wind screens or enclosures around dusty activities or the site boundary. Mojave Desert Air Quality Management District assumes that complete coverage by wind screens (on the windward side) will provide a control efficiency of 75 percent.
- Water spray is also used to reduce fugitive dust as it increases the moisture content of the material. Therefore, and according to Mojave Desert too, Water spray (Application point) will ensure a control efficiency of 75%. This is very useful for exaction for example.
- For unpaved roads, water flushing is the essential with 0.48 gallons per square yard twice per day to maintain a control efficiency above 50%.
- For paved roads, water flushing with 0.48 gallons per square yard followed by sweeping is very effective and can reach 96%. If conducted directly before the passage of the turbines convoy or the morning and evening passages of the project vehicles to and from the site, a consequent decrease will occur.
- A combination of the different above-mentioned measures will give a higher control efficiency that when applied individually.

The sensitivity of the area is Low; however, since construction workers are mainly impacted the sensitivity of the receptor is considered Medium, resulting in a Minor impact as shown in **Table 11-9**.

Table 11-9 Air Quality Assessment for the Decommissioning Phase

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

12. TRANSPORT AND TRAFFIC

12.1 Baseline Methodology

The traffic and transport baseline investigations were designed to assess existing road conditions to support the preferred route for WTG transport. Two route surveys and a Traffic Impact Study were undertaken as follows:

- In April 2018, Lebanon Wind Power and Sustainable Akkar commissioned a route survey undertaken by Madgelni to assess the conditions for the practical and safe transport of WTG components to the Lebanon Wind Power and Sustainable Akkar projects, as presented in **Appendix J**.
- In June 2018, the Ghorayeb International Freight Forwarding Co. (GIFCO) S.A.L. was engaged to assess potential routes for transporting the WTG components from the Tripoli seaport to the Sustainable Akkar wind farm site, also presented in **Appendix J.**
- In October 2018, a Traffic Impact Study was undertaken by Dr. Dima Jawad to review 8 key road segments, survey of existing peak hour traffic volumes at key junctions and conducting 3-day automatic traffic counts at key road links and manual counts at peak hours at critical junctions, also presented in **Appendix J**.

The methodologies for the separate studies are presented in the following sections.

12.1.1 Route Survey (Madgelni, April 2018)

Madgelni's route survey considered the two routes shown in **Figure 12-1**. The survey was undertaken to observe conditions, determine the necessity of civil works and precautions to be taken, starting from Tripoli Port to the Project Site entrance. An survey also considered the use of existing or newly constructed route segments as alternatives for reaching the site(s).

The route shown in red is referenced as the Aabde to Chadra Route, while the route shown in yellow and orange are referenced as the OBS33 Alternative Route. The OBS33 Alternative Route would use an existing road, as shown in **Figure 12-2**, until reaching OBS34, where a new segment of road would be constructed (shown in orange) to reach the existing asphalt road west of Machta Hammoud.

12.1.2 Route Survey (GIFCO, June 2018)

GIFCO's route survey considered the two routes shown in **Figure 12-3**. The survey can be viewed as a journey management exercise from the perspective of a freight shipment provider seeking to identify pinch points that may cause restrictions and/or obstacles between the Tripoli Port and the destination(s).

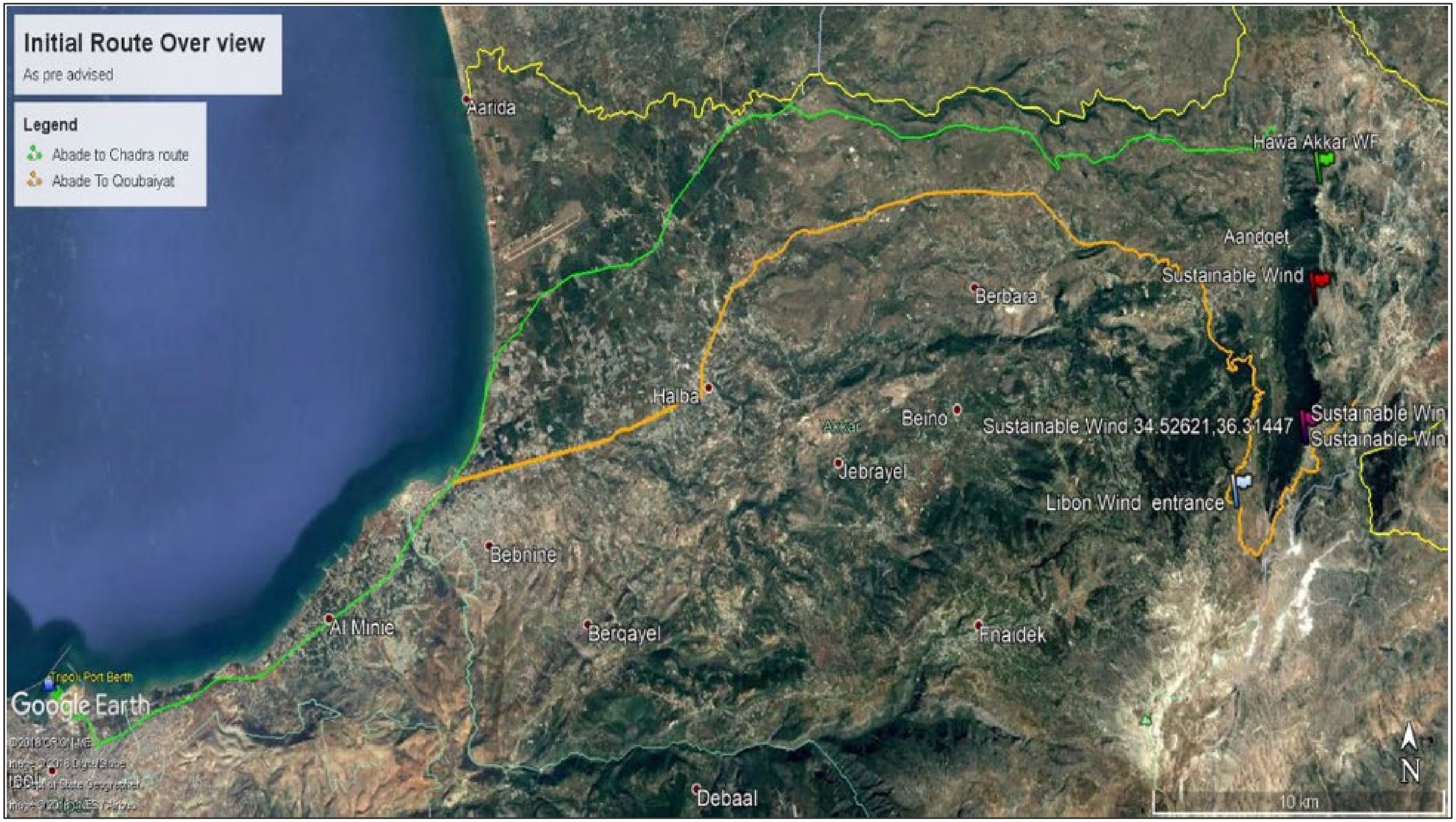
The route shown in green is referenced as the Aabde to Chadra Route. The study assessed the Aabde to Chadra route for the WTGs transport according to critical turning points, bridges, motorway bridges and pedestrian overpasses, the existing geometric clearances with swept path analysis of potential routes and identified the needed modifications and upgrades along the route so it can be suitable for transporting the WTGs. Note: the route shown in yellow is referenced as the Halba to Qobaiyat Route (and starts approximately 1km north of Aabde). The Halba to Qobaiyat Route was identified by GIFCO as a potential alternative route.

Figure 12-1 Routes Surveyed by Madgelni

Figure 12-2 Start of Alternative Route Surveyed by Madgelni

a – Aerial view of Obstacle 33 b – Pedestrian view of Obstacle 33 and start of Alternative Route north

Figure 12-3 Routes Surveyed by GIFCO



12.1.3 Transport Impact Study (October 2018)

The TIS was conducted as per Institute of Transportation Engineers (ITE) published guidelines, and its main objective was to determine the impact of the generated traffic by the proposed Project on the surrounding road network and identify the extent of required improvements, if any, to adequately and safely accommodate the additional generated traffic. Therefore, the assessment of traffic and transport comprised the following:

- Review of historical traffic growth patterns to inform estimation of the likely traffic volume growth across the road network, excluding traffic generated by the Project.
- Inspection of the road network from the Tripoli Port to Chadra, as well as rural distributors west-southwest of the Project site.
- Survey of existing peak hour traffic volumes at key junctions.
- Conducting 3-day automatic traffic counts at key road links and manual counts at peak hours at critical junctions.

12.1.3.1 Selected Roads and Junctions

Based on the potential WTG transport routes, 8 key existing road segments were identified for the baseline traffic study, as summarized in **Table 12-1** and shown in **Figure 12-4**.

12.1.3.2 Traffic Counts

24-hr automatic traffic counts were conducted at different locations along the selected road segments for a period of three days between 15 and 30 September 2018 inclusive. This period was chosen to ensure normal traffic operation in the absence of special events that may affect traffic. In addition, manual traffic counts were conducted at key junctions during the peak hours to determine turning movement counts. **Figure 12-5** shows pneumatic tubes installed for automatic traffic counts.

Table 12-1 Selected Road Characteristics

Road	Description	Lanes	Median Type	Width
A	*Tripoli Port – Abu Ali Roundabout* Urban major distributor, bidirectional and divided asphalt road that travels north along the coast of Lebanon. This road is in the vicinity of the construction site of the new Tripoli Freeway.	4	Concrete Jersey Blocks	15m
B	*Abu Ali Roundabout to Al Beddaoui* Urban arterial, bidirectional, divided 6-lane asphalt road with a parallel parking on each side. The majority of the junctions along this road are grade-separated, however uncontrolled junctions are also present.	6	Raised Median varied width	30m
C	*Al Beddaoui to Al Aabdeh* urban minor arterial, bidirectional and divided asphalt road with a raised median with concrete blocks. A few junctions along this road segment are grade-separated, while others are uncontrolled junctions or roundabouts (i.e. the junction at Halba Road).	4	Concrete Jersey blocks	18m
D	*Al Aabdeh to Mqaitea* Urban minor arterial, bidirectional, divided asphalt road with concrete blocks.	4	Concrete Jersey blocks	16m
E	*Mqaitea – Aabboudiye* Rural arterial connecting Lebanon to the Syrian border. It is a bidirectional and undivided 2-lane asphalt road.	2	Painted	10m
F	*Menjez – Chadra* Rural distributor, bidirectional and undivided asphalt road that travels east to Chadra. This road is rolling/mountainous road with a grade that varies up to 9%.	2	Painted	10m
G	*Andqet – Qobaiyat* Rural distributor, bidirectional, undivided asphalt road connecting Aandeqt to Qobaiyat.	2	Painted	9-10m
H	*Qobaiyat - Qatlabe* Rural distributor, bidirectional, undivided asphalt road.	2	Painted	8m

Figure 12-4 Selected Roads Surveyed

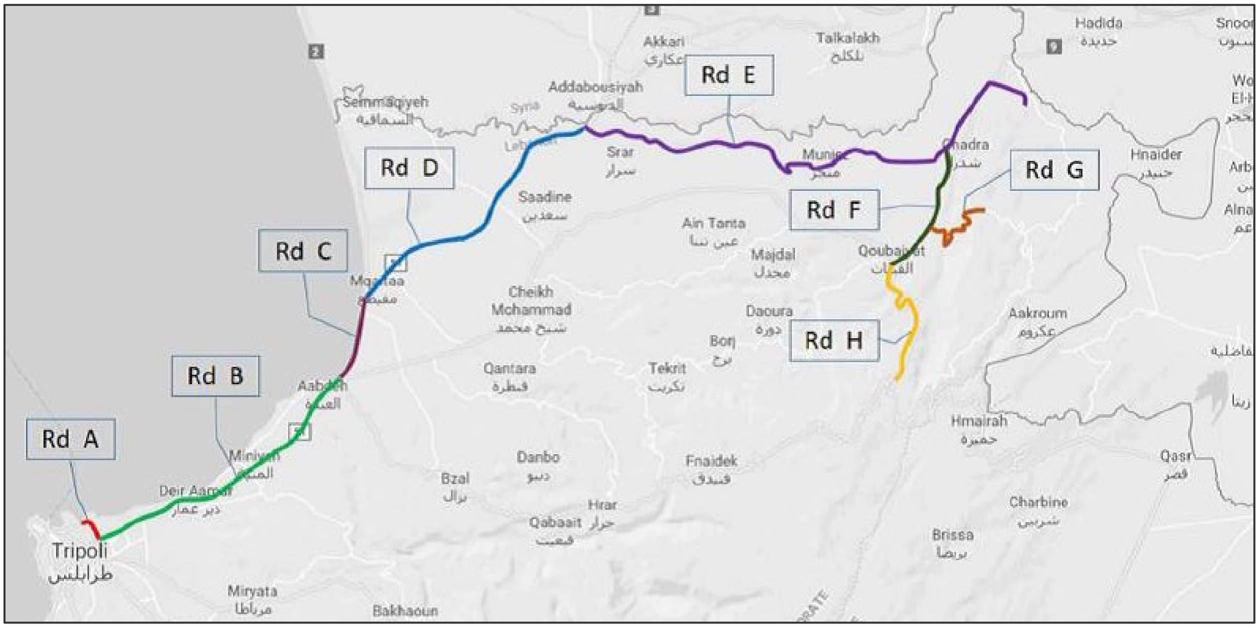


Figure 12-5 Images of Automatic Traffic Counts

12.2 Baseline Findings

12.2.1 Route Survey (Madgelni, April 2018)

The Madgelni Route Survey identified 32 obstacles along the Aabde to Chadra route and 11 obstacles along the OBS33 Alternative Route, as summarized in **Table 12-2**.

The most significant concern noted by the route survey was the need for the construction of a new connection road between OBS35 and OBS36. This segment is to be studied and designed separately. In addition:

- All electric and phone cables over the road must have a clearance of 6m above ground.
- The access and site road longitudinal gradient must be a maximum of 8° (14%).
- Additional pulling units are required during transportation for gradient above 14%.
- Minimum transverse inclination of road is to be 2% to one or both sides in within the Project site.
- The load bearing capacity of all site roads must have a compaction of min. 95%.

The location of the obstacles identified are shown in **Figures 12-6** through **12-8**.

12.2.2 Route Survey (GIFCO, June 2018)

The GIFCO Route Survey identified 33 obstacles along the Aabde to Chadra route, as summarized in **Table 12-3**.

It is noted that GIFCO's survey ended once it was observed that Chadra through Machta Hammoud was impassable.

In response, GIFCO identified the following alternative routes:

- Halba to Qobaiyat route (refer to the yellow route in **Figure 12-9**).
- A potential road upgrade linking the Halba to Qobaiyat route to the Aabde to Chadra route, starting at Begdadhi, linking Begdadhi to Noura El Tahta, as shown in **Figure 12-10**. This route is currently serving villages, farms and residential properties.
- A potential new road link connecting the Aabboudiye/Chadra route with the Aabde to Chadra route. This option would involve improving a steep gradient with a sharp turn, as shown in **Figure 12-8**.

Table 12-2 Potential Obstacles Identified by Madgelni

Obstacle	Type	Coordinates	Description/Suggestion
OBS01	Storage Yard	N 34°27’29” E 35°49’45”	It was confirmed that the required storage area 10,000m² can be provided.
OBS02	Concrete debris	N 34°27’08” E 35°50’09” Km: 0+000	Debris should be removed.
OBS03	Parallel parking on road	N 34°27’11” E 35°50’26” Km: 1+200	Second-row car park should not be allowed during the transportation.
OBS04	Bridge	N 34°27’06” E 35°50’33” Km: 1+450	Bridge height is over 6m. It is suitable for passing.
OBS05	Roundabout	N 34°26’44” E 35°50’47” Km: 2+400	Car parking should not be allowed during transportation.
OBS06	30m on-site cast bridge in Tripoli	N 34°26’44” E 35°50’51” Km: 2+500	Suitable for passing.
OBS07	Pedestrian overpass in Tripoli	N 34°26’48” E 35°51’04” Km: 2+900	Height is over 5.77m. It is suitable for passing.
OBS08a	Highway overpass in Tripoli	N 34°26’54” E 35°51’24” Km: 3+200	Vertical curve should be checked during test drive.
OBS08b		N 34°26’54” E 35°51’24” Km: 3+200	Distance of Span: 24m. It is suitable for passing.
OBS09	Pedestrian overpass in Tripoli	N 34°27’07” E 35°51’46” Km: 4+100	Height is over 5.70m. It is suitable for passing.
OBS10	Pedestrian overpass in Tripoli	N 34°27’13” E 35°51’60” Km: 4+500	Height is over 5.00m. It should be checked after WTG selection.
OBS11	Overhead placard in Tripoli	N 34°27’30” E 35°52’58” Km: 6+300	Height is over 5.50m. It is suitable for passing.
OBS12	Deir Amar Army Control Point	N 34°27’47” E 35°53’31” Km: 7+200	Concrete and steel barriers should be removed during the transportation
OBS13	Pedestrian overpass	N 34°27’48” E 35°54’12” Km: 8+100	Height is over 5.60m. It is suitable for passing.
OBS14	Pedestrian overpass	N 34°28’24” E 35°55’24” Km: 10+300	Height is over 5.15m. It should be checked after WTG selection.
OBS15	Pedestrian overpass	N 34°28’50” E 35°56’11” Km: 11+800	Height is over 5.25m. It should be checked after WTG selection.
OBS16	Pedestrian	N 34°29’42”	Height is over 5.19m. It should be checked

Obstacle	Type	Coordinates	Description/Suggestion
	overpass	E 35°57′28″ Km: 14+300	after WTG selection.
OBS17	Overhead placard	N 34°30′13″ E 35°57′49″ Km: 15+300	Height is over 5.60m. It is suitable for passing.
OBS18	Pedestrian overpass	N 34°30′31″ E 35°58′01″ Km: 16+100	Height is over 5.40 m. It is suitable for passing.
OBS19	Roundabout fencing	N 34°31′03″ E 35°58′40″ Km: 17+500	Fencing should be removed during the transportation period.
OBS20	Roundabout curbs	N 34°31′03″ E 35°58′40″ Km: 17+500	Concrete curbs should be removed during the transportation period.
OBS21	Roundabout poles	N 34°31′03″ E 35°58′40″ Km: 17+500	Poles and signboard should be removed during the transportation period.
OBS22	3 span on-site cast bridge	N 34°32′58″ E 35°59′31″ Km: 21+400	It is suitable for passing.
OBS23	7 span on-site cast bridge	N 34°35′46″ E 36°03′46″ Km: 30+400	It is suitable for passing.
OBS24	Trees	N 34°36′09″ E 36°04′02″ Km: 31+000	Trees should be pruned prior to transportation.
OBS25	Car/truck park	N 34°37′43″ E 36°06′11″ Km: 35+800	Car/truck parking should not be allowed during the transportation.
OBS26a	Old Customs Building	N 34°37′44″ E 36°06′16″ Km: 35+900	Section of the building should be removed.
OBS26b	Old Customs Building	N 34°37′44″ E 36°06′16″ Km: 35+900	Building wall should be removed and pole moved.
OBS27	Sharp right turn	N 34°37′53″ E 36°06′47″ Km: 36+800	Ground should be compacted, and pole removed.
OBS28	2 span on-site cast bridge	N 34°36′39″ E 36°13′32″ Km: 48+400	It is suitable for passing. Side slopes to be checked during test drive.
OBS29	1 span on-site cast bridge	N 34°36′46″ E 36°14′27″ Km: 50+300	It is suitable for passing.
OBS30	Army Control Point	N 34°36′50″ E 36°14′41″ Km: 50+800	Barrels and hut should be removed during the transportation.
OBS31	Chadra Control Point	N 34°37′17″ E 36°18′45″ Km: 57+800	All concrete blocks and huts should be removed during the transportation.
OBS32	End point	N 34°37′22″ E 36°19′00″ Km: 58+200	The defined route is not convenient for transport after this point.
OBS33	Obstacle 33 Alternative	N 34°36′58″	30m X 10m area should be filled and compacted. Pole and trees should be

Obstacle	Type	Coordinates	Description/Suggestion
	Route	E 36°17′16″ Km: 55+500	removed.
OBS34	Unpaved road	N 34°37′08″ E 36°17′22″ Km: 56+000	Road surface should be improved. The minimum road width should be 5m.
OBS35	New road between OB35 and OB36	N 34°37′27″ E 36°17′17″ Km: 56+500	New road should be constructed from OBS35 and OBS36. The minimum road width should be 5m and dimensioned according to turbine transport guidelines.
OBS36		N 34°38′30″ E 36°19′02″ Km: 61+500	
OBS37	Unpaved road	N 34°39′02″ E 36°18′44″ Km: 62+750	The road surface should be improved. The minimum road width should be 5m. Temporary or permanent relocation of electric poles and other obstacles must be studied separately.
OBS38	Right turn	N 34°39′19″ E 36°18′33″ Km: 63+500	Vegetated area on inside of turn should be removed.
OBS39	Sharp right turn	N 34°39′24″ E 36°18′35″ Km: 63+700	One of two alternative bypass roads should be constructed.
OBS40	Unpaved road	N 34°39′25″ E 36°18′39″ Km: 63+750	The road should be improved from this point to OBS41, about 3 km. There are unused railway tracks under the surface. This needs to be checked with railway authority for any revision.
OBS41	2 alternative roads	N 34°39′24″ E 36°20′39″ Km: 67+000	Alternative 1 : OBS41 – OBS 42 –OBS44 Alternative 2 : OBS41 – OBS 43 –OBS44
OBS42	Alternative 1: OBS41 – OBS 42 –OBS44	N 34°39′16″ E 36°20′47″ Km: 67+300	New by-pass road of about 300 m., passing through the fields at each turn, should be constructed from OBS41 to OBS42.
OBS43	Alternative 2: OBS41 – OBS 43 –OBS44	N 34°39′22″ E 36°21′02″ Km: 67+600	Right turn through field (20m X 40m area) should be filled / compacted until road level.
OBS44	Same endpoint of 2 alternative roads	N 34°39′14″ E 36°21′04″ Km: 68+000	Alternative 1 has three sharp turns to reach PSEP (OBS45) Alternative 2 seems to be a better option, as it has a single right turn and reaches straight towards the Project site entrance point.
OBS45	Project site entrance	N 34°39′10″ E 36°21′08″ Km: 68+200	Connection to Project site entrance.

Figure 12-6 Obstacles OBS01 through OBS21

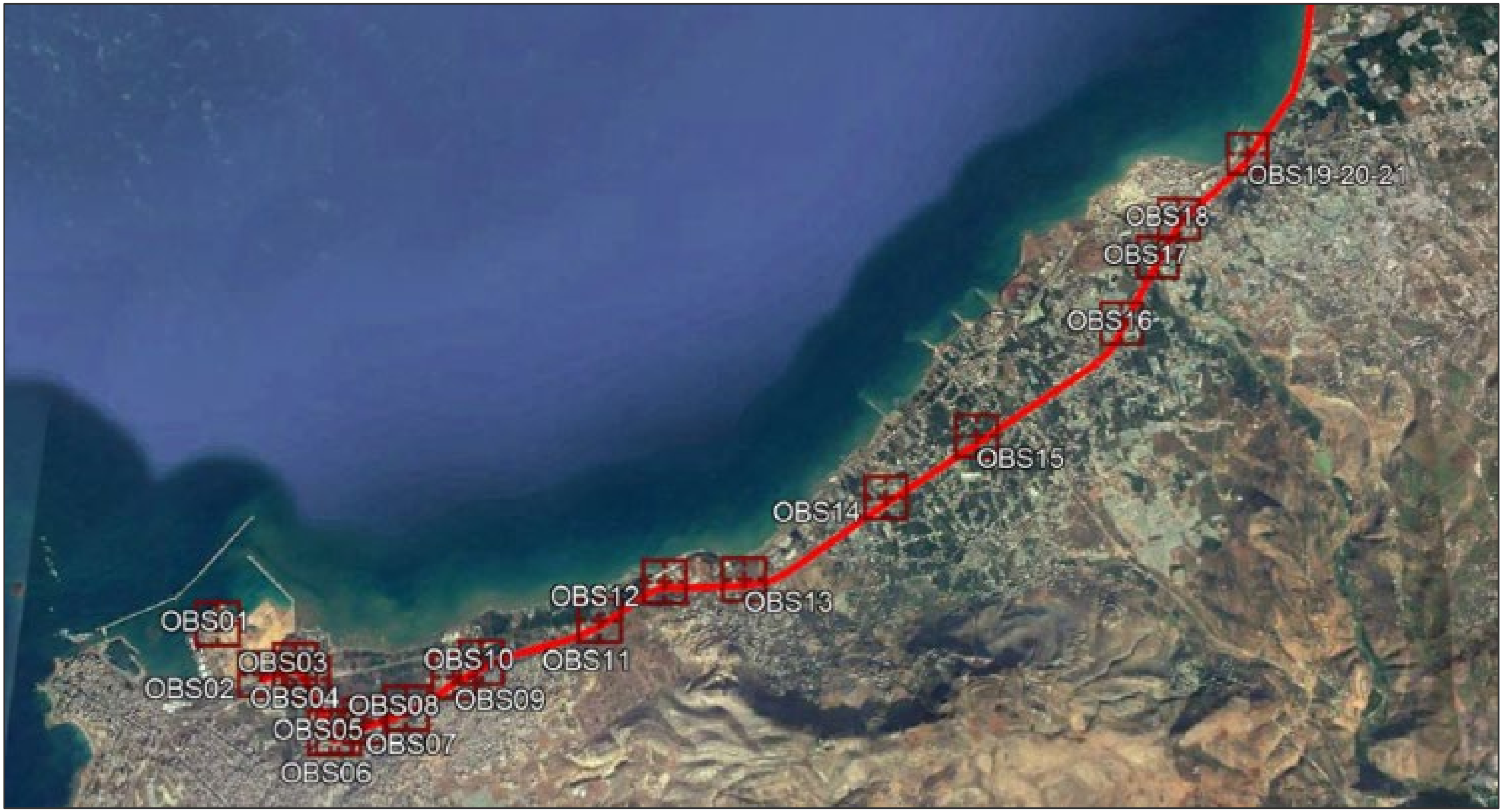


Figure 12-7 Obstacles OBS22 through OBS29

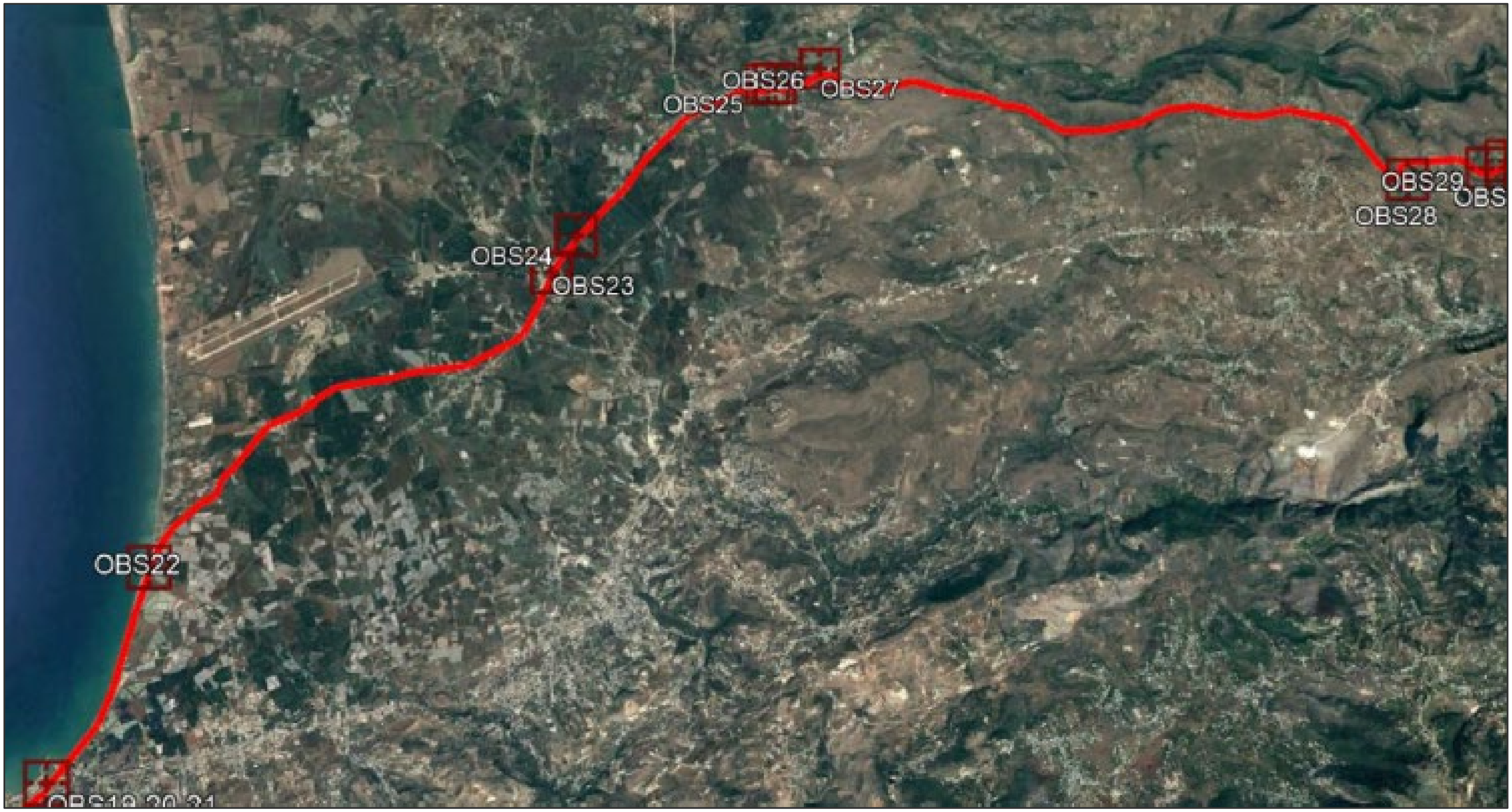


Figure 12-8 Obstacles OBS30 through OBS45

Table 12-3 Potential Obstacles Identified by GIFCO

Pinch Point	Type	Coordinates (where provided)/Description/Suggestion	
PP01	Tripoli Port Customs Hall	Within the port and on the exist route, there is a Customs Hall that all vehicles transit. Measurement of the facility was not possible at the time of the survey. Currently, there is no bypass road around this facility. However, there is suitable vacant land to the immediate side of the hall.	
PP02	Port internal access road	The port internal access road by the exit gate is approximately 19m wide, reducing to approximately 15m nearer the exit gate. Each side is bordered by concrete bund walls surmounted by steel poles and wire mesh infills. They appear to be movable, should it be necessary to increase the clear over-sail and overhang sweep area to allow the WTG blades to exit the port unhindered.	
PP03	Port exit gate	The exit from the Port is by a commercial gate which is approximately 13m wide. There are concrete bund walls approximately 3m X 6m. In addition, a small security/personnel/car access gated building is located to the left.	
PP04	Port exit	Various concrete block items require removal, and the ground/roadway improved such that the vehicles can utilize all of the available area.	
PP05	Overhead cables	Subject to a topographic survey; overhead cables and supporting pylons may need to be temporarily repositioned, removed or permanently relocated.	
PP06	New road construction	N 34.451849° E 35.842352°	A new road is being constructed with a concrete beamed bridge passing over the main port road. The measured minimum heights are 6.7m X 6.7m.
PP07	Over bridge	N 34.453341° E 35.840381°	Between the port gate and the over bridge, there is a sweeping curve to the right. This area is lined on the left with commercial properties and young trees on the central reserve. The surveyor recommends that this area be cleared of all parked vehicles and traffic flow before and while transport passes.
PP08	About Ali Roundabout	2.2km	The Abou Ali Roundabout is approximately 140m X 84m and fluctuates between 13 and 18m wide. Entry into the roundabout is from a 15m wide

Pinch Point	Type	Coordinates (where provided)/Description/Suggestion	
			road. This is split by a divider reducing the road to 10m.
PP09	Lamp post	N 34.446588° 3 35.846541°	On the left side of the road, set back approximately 22m from the diameter apex, there is a lamp post which may need to be removed to allow entry into the roundabout.
PP10	Blank in report		
PP11	Roundabout	2.4km	This roundabout is intersected by a river, through its short axis, and passed over by a single span concrete bridge of 30m which if full width of the surrounding road. It was not possible to ascertain the condition and type of construction. Further investigation into load support and permissible axle loads should be provided. It is estimated that the bridge is structurally sound and a minimum of a 50B rating. All parked vehicles and traffic should be removed during transit.
PP12	Footbridge	2.78km	Minimum clearance of 5.7m is required.
PP13	Ramp	3.1km	A fly over ramp with an angle of 3.5o over a longitudinal length of 95., with an apex of approximately 5.45, gradually descending back to ground level after 600m. More information from the Ministry of Roads is required to clarify structural integrity and suitability for proposed load configurations.
PP14	Concrete footbridge	N 34.451930° E 35.863013°	The bridge measures from 5.1m in height to the left and lowering to 4.49m to the right. The calculated maximum height of the cylindrical load center is 4.88m. The is the lowest structural height restriction encountered along the route, and the limiting factor on traveling height of all loads out of Tripoli.
PP15	Footbridge with sign	N 34.27123o E 35.151583^{0}	The sign over the road measured 5.7m on the left 12m wide roadway.
PP16	Military checkpoint	N 34.463103° E 35.892431^{0}	Military checkpoint with concrete blocks.

Pinch Point	Type	Coordinates (where provided)/Description/Suggestion	
PP17	Sign	N 34.464440º E 35.903116º	Height of sign is 5.7m on the left and 5.75m on the right.
PP18	Underpass tunnel	N 34.463815º E 35.906872º	To the right there is a slip road off and back onto the main highway. The bypass road has no overhead restrictions and is suitable for transport.
PP19	Footbridge	N 34.473213º E 35.923225º	Footbridge measures 5.52 on the left and 5.63 on the right. The road width is 11m.
PP20	Footbridge	N 34.480712º E 35.936339º	Footbridge measures 5.1m on the left and 5.13m on the right.
PP21	Footbridge	N 34.494877º E 35.957846º	Footbridge measured 5.1m on the left and 5.33m on the right.
PP22	Underpass tunnel	N 34.49882º E 35.960169º	To the right there is a slip road off and back onto the highway. This bypass road has no overhead restrictions and is suitable for transport.
PP23	Overhead sign	14.7km	Measured 5.6m on the right side. Traffic too heavy for left side measurement.
PP24	7 span concrete bridge	N 34.503154º E 35.963379º	Measured overall span of 36m bearing to bearing. Each span is 5m resting on supports of 30cm for the full width of the roadway. Details of the bridge capacity and structural status should be obtained from MoR. However, the bridge is expected to be suitable for transport.
PP25	Footbridge	N 34.508707º E 35.966972º	This bridge measured 5.5m on the right side. Traffic was too substantial to measure the left side.
PP26	Roundabout	17.4km	Major intersection of the highway to Halba. One exit to the right to Halba, second exit to Aarida toward Syria. Due to the numerous street furniture, lamps, fencing etc., as well as substantial traffic volume, a topographic

Pinch Point	Type	Coordinates (where provided)/Description/Suggestion	
			survey is recommended to assess transport at this location.
PP27	3 span concrete bridge	N 34.54968° E 35.99218°	Overall span of the bridge is 17m bearing to bearing. Support columns are approximately 40cm thick. Details of the bridge capacity should be obtained from MoR.
PP28	Roundabout	N 34.553346° E 35.993084°	At this roundabout, the highway splits. The left fork continues along the coast toward Aarida and the Syrian border crossing. The right fork leads toward Aabboudiye.
PP29	Customs Hall		This facility is made up of three halls, two narrow halls joined in the center with office and inspection kiosks/tables. With a separate wider and higher hall to the right that is clear of obstacles. Removal of a portion of the Customs Hall is recommended.
PP30	Right turn	N 34.631685° E 36.113019°	The right turn leads toward Kouchara and is a 14m wide road flanked on each side by commercial properties and an area with small trees onto a 25m dual carriageway with a low concrete divider. The trees and the power pylon should be removed.
PP31	U bend in the valley	N 34.610594° E 36.225503°	Between Dibbabiye and Fraidis there is a U bend in a valley with two separated single span cast in place concrete bridges. The single span bridges are 13m each. The road's inner radius is 50m with an outer radius of 60m. Due to gradient changes between the approach road and the egress road, the angles and gradient will require plotting to ensure they are within the wing trailer's maneuvering capability. In addition, the rock face near the apex of the bend requires review for wing trailer's maneuverability.
PP32	Curve between Fraidis and Menjez	N 34.612789° E 36.240019°	The radii of curbs to be surveyed to ensure blade over-sail and overhang are not encroached.
PP33	Security checkpoint	N 34.610594° E 36.225503°	Remove any checkpoint obstacles.

Figure 12-9 GIFCO Alternative between at Begdadhi and Nour El Tahta

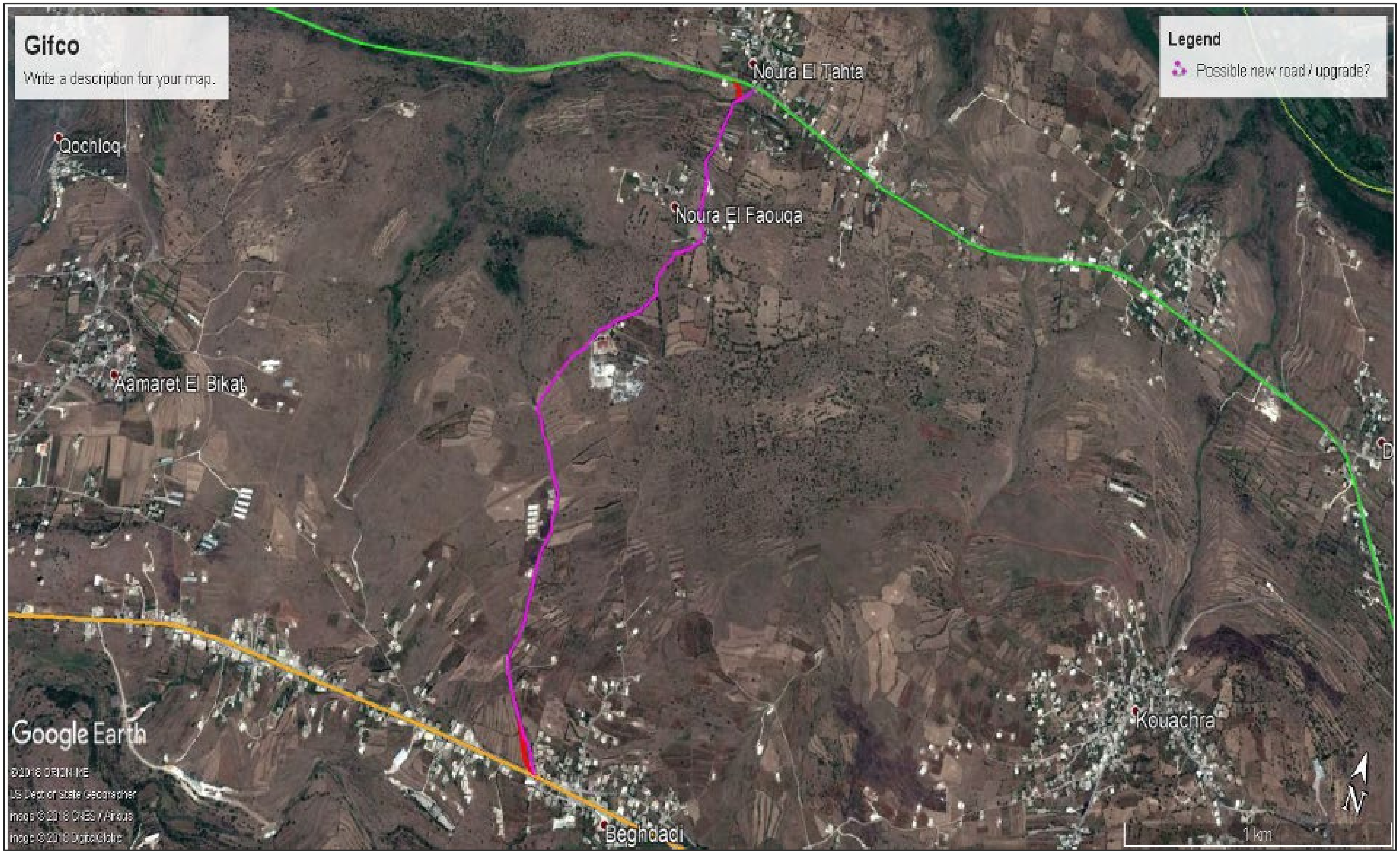


Figure 12-10 GIFCO Alternative between the Aabboudiye/Chadra Route with the Aabde to Chadra Route

12.2.3 Transport Impact Study (October 2018)

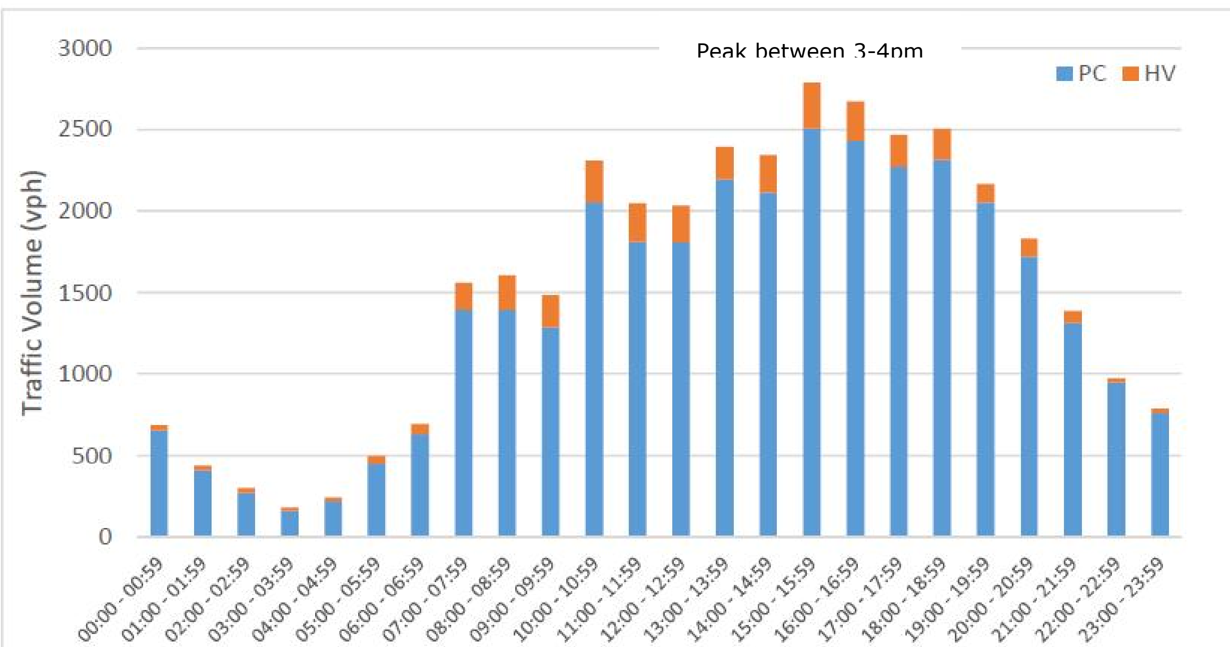
Table 12-4 summarizes the average daily traffic volumes recorded along the selected road segments.

Table 12-4 Existing Average Daily Traffic Along Selected Roads

ID	Road Designation	ADT (PC)	ADT (HV)	ADT (Total)
A	Tripoli Port - Abu Ali Roundabout	12,740	1,771	14,511
B	Abu Ali Roundabout – Al Beddaoui	33,173	3,219	36,392
C	Al Beddaoui – Al Aabdeh	19,230	1350	20,580
D	Aabdeh - Mqaitea	14,927	1080	16,007
E	Mqaitea - Aabboudiye	11,350	720	12,070
F	Menjez - Chadra	2,265	28	2,293
G	Andqet - Qobaiyat	2,279	1,291	4,470
H	Qobaiyat – Qatlbe (beyond Qobaiyat)	670	110	780

Figure 12-11 is provided to represent the collected hourly traffic volumes at Abu Ali Roundabout – Beddaoui to illustrate the peak traffic hours occurring on the main coastal road.

Figure 12-11 Classified Average Hourly Volume from Abu Ali Roundabout – Beddaoui



The North American Highway Level of Service (LOS) standards use letters A through F, with A being the best and F being the worst as described in **Table 12-5**.

Table 12-5 Level of Service Definitions

Level of Service	Description
A	Free flow. Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. The average spacing between vehicles is about 167m or 27 car lengths. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed. LOS A generally occurs late at night in urban areas and frequently in rural areas.
B	Reasonably free flow. LOS A speeds are maintained, maneuverability within the traffic stream is slightly restricted. The lowest average vehicle spacing is about 100m or 16 car lengths. Motorists still have a high level of physical and psychological comfort.
C	Stable flow, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Minimum vehicle spacing is about 67m or 11 car lengths. Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect, but localized service will have noticeable effects and traffic delays will form behind the incident. This is the target LOS for some urban and most rural highways.
D	Approaching unstable flow. Speeds slightly decrease as traffic volume slightly increase. Freedom to maneuver within the traffic stream is much more limited and driver comfort levels decrease. Vehicles are spaced about 160 ft(50m) or 8 car lengths. Minor incidents are expected to create delays. Examples are a busy shopping corridor in the middle of a weekday, or a functional urban highway during commuting hours. It is a common goal for urban streets during peak hours, as attaining LOS C would require prohibitive cost and societal impact in bypass roads and lane additions.
E	Unstable flow, operating at capacity. Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the posted limit. Vehicle spacing is about 6 car lengths, but speeds are still at or above 80km/hr. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Drivers' level of comfort become poor. This is a common standard in larger urban areas, where some roadway congestion is inevitable.
F	Forced or breakdown flow. Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS because LOS is an average or typical service rather than a constant state. For example, a highway might be at LOS D for the AM peak hour, but have traffic consistent with LOS C some days, LOS E or F others, and come to a halt once every few weeks.

The LOS calculated for the selected road segments are presented in **Table 12-6**.

Table 12-6 Existing Level of Service

Segment	Description	Volume Vehicles/Hr	Flow Rate Vehicles/hr/lane	Speed Km/Hr	LOS
A	Tripoli Port - Abu Ali Roundabout	245	138	94.8	A
B	Abu Ali Roundabout – Al Aabdeh	563	215	92.4	A
C	Aabdeh – Mqaitea	313	169	91.4	A
D	Mqaitea – Aabboudiye	250	144	91.2	A
E	Aabboudiye – Chadra	434	284	59.4	A
F	Chadra to Aandqet	110	109	63.4	A
G	Andqet – Qobaiyat	431	327	60.3	B
H	Qobaiyat – Qatlbe	78	106	63.6	A

Across the 8 road segments, 3 key junctions were identified where the transport of WTG components could potentially create bottlenecks, as summarized in **Table 12-7**.

Table 12-7 Key Selected Junctions

No	Segment	Junction	Description	Number of Directions
1	E	Chadra Entrance	Mini roundabout	3
2	F	Andqet	T junctions	3
3	F/H	Qobaiyat Roundabout	Mini roundabout	4

Figure 12-12 shows the location of these junctions within the study area. The three junctions were not included for traffic count analysis as WTG transport along this corridor would result in a travel delay in a range between 100–300 seconds, reducing the junction LOS to F. Note: Junctions 1, 2 and 3 are not included in the preferred WTG transport corridor (refer to **Section 3 Analysis of Alternatives**).

During the Traffic Impact Study, the following obstacles and associated civil works were identified between Tripoli and Chadra, as presented in **Table 12-8**. These recommendations will be combined with those provided by Madgelni and GIFCO, as applicable, to the preferred route selected. Obstacle removal activities which will be undertaken by the Developer in close coordination with the concerned local authorities. Obstacles will be removed either temporarily (concrete blocks, selected poles) or permanently before being moved to another location (selected poles) or reinstated with an improved design (roundabout islands).

Figure 12-12 Location of Key Junctions

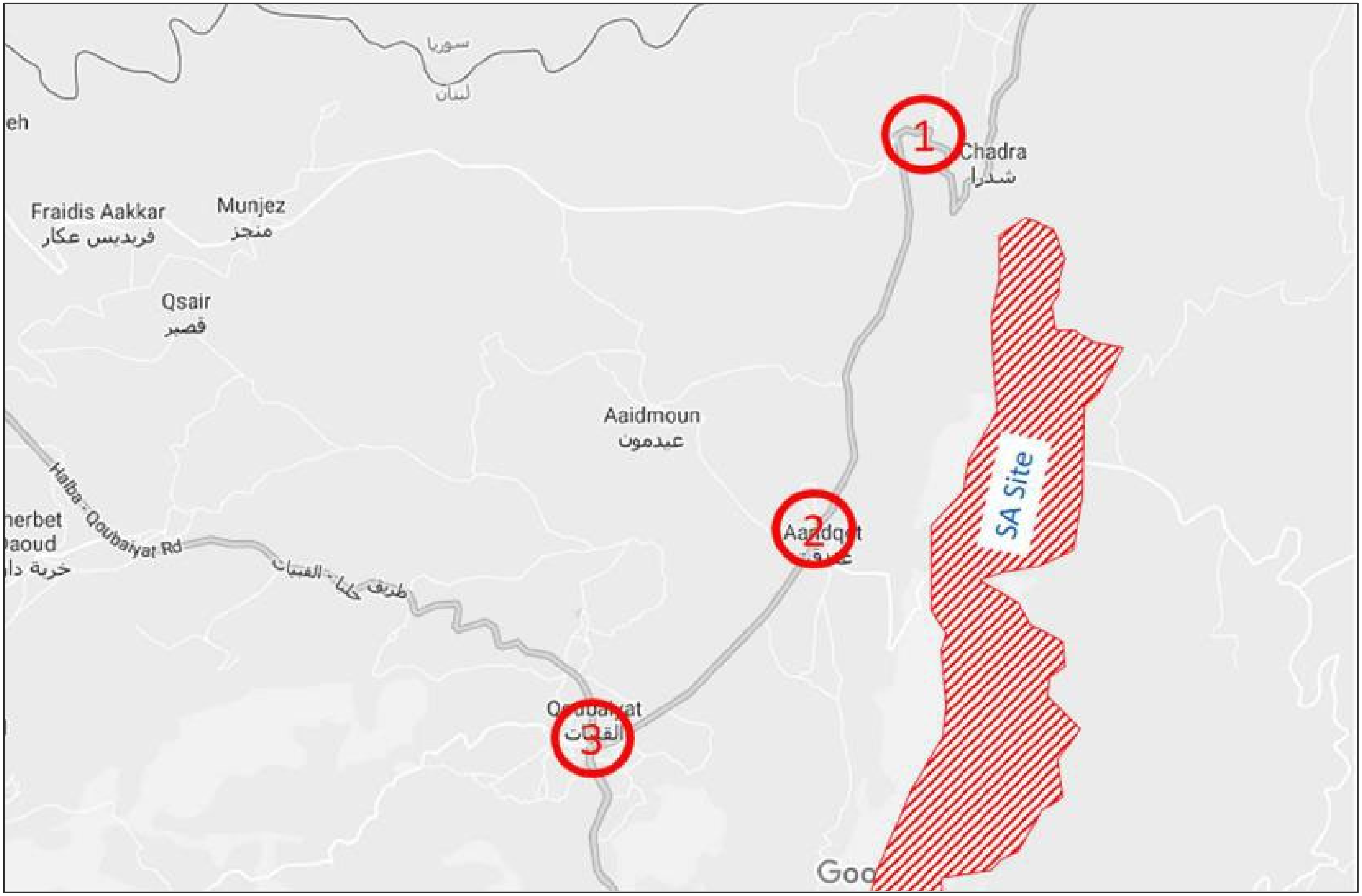


Table 12-8 Obstacles and Associated Civil Works

KM	Civil Works / Measures to be Taken
0.0	• Outer wall of port premises needs to be demolished at a length of 45m. • The curbs between the light poles need to be removed/levelled. • Light poles and electricity poles need to be removed. • The concrete blocks opposite the port exit gate need to be removed. • The curbs between the 2 traffic lanes opposite the port exit gate need to be removed/levelled.
0.3	• Roads must be free of any advertising board and sales booth. • All trees along the midway need to be removed.
3.4	• Pedestrian bridge (concrete) needs to be lifted up to a clearance of +560cm.
8.9	• Pedestrian bridge (concrete) needs to be lifted up to a clearance of +560cm.
10.4	• Pedestrian bridge (concrete) needs to be lifted up to a clearance of +560cm.
12.8	• Pedestrian bridge (concrete) needs to be lifted up to a clearance of +560cm.
13.0	• 2 light poles at the right need to be removed or shifted to the right for 2m.
14.4	• Pedestrian bridge (concrete) needs to be lifted up to a clearance of +560cm.
15.8	• Steel fence needs to be removed. • The curbs, steel fence and small trees in the roundabout-center need to be removed. • Curbs. steel fence at roundabout-exit need to be removed at a length of 20m.
26.2	• Electricity pole and traffic sign at the left need to be shifted leftwards 1.5m. • Electricity pole at the right needs to be shifted rightwards 1.5m.
30.3	• Electricity pole at the right needs to be shifted rightwards 3.5m.
34.0	• Boundary wall on the right (before the check point) needs to be removed. • Electricity pole on the right (before the check point) needs to be removed. • 50m after passing the check point an area of 15m on the right needs to be levelled.
34.2	• 4 electricity poles on the right (after passing the check point) need to be shifted rightwards. • Trees. bushes. electricity pole on the left need to be removed at a width of 4m.
34.8	• Before the right-turn the road needs to be extended to the left side on 75m length and 10m width (levelling/paving). • An electricity pole needs to be removed.
46.1	• 4-9m of the terrain and rock face right along the curve need to be cleared, levelled and drainage needs to be filled up. • At the curve vertex approx. 8m of the rock face need to be removed in order to widen the road clearance to the right.
48.2	• On the outer curve the rock face needs to be removed at a length of 85m/width 5.5m. • 3 light poles on the left (inner) side of the curve to be removed. • Light poles & crash barrier on the left (inner) side of the curve need to be removed. • Incline left beside the inner curve needs to be filled up and levelled at a length of 50m.
49.1	• All wooden poles on the right need to be removed. • Road need to be cleared of bushes and branches on both sides for a minimum of 45m. • Earth mounds on both sides need to be levelled at a width of 4m.

KM	Civil Works / Measures to be Taken
	• Bushes. poles and trees need to be removed.
54.9	• 5 poles on the inner (left) side of the curve need to be removed or shifted to the left for a minimum of 2.5m. • 2 poles on the outer (right) side of the curve need to be shifted to the right for 4m.
55.1	• Curve entry: 2 poles on the left need to be shifted leftwards for approximately 3.5m. • 4 further poles on the left need to be shifted leftwards for approximately 3.5m. • A tree on the left needs to be removed. • A pole on the right needs to be shifted rightwards for 3.5m.
55.4	• 3 marked poles on the left need to be shifted to the left for approximately 3.5m.
55.8	• Inner (right) curve needs to be widened to the right.
55.9	• All poles on the left need to be removed throughout the whole curve. • On the right all poles. trees and bushes need to be removed at a length of 90m.
56.0	• Center of roundabout needs to be levelled/curbs to be removed.
56.1 – 56.8	• A bypass road of 700m needs to be constructed.
57.0	• A bypass road of 150m length needs to be constructed.
57.9	• At the end of the bypass road an electricity pole needs to be removed or shifted.
57.9	• S-curve: a fence mounted on a low wall. smaller trees and bushes on the left side need to be removed. • The boundary wall needs to be removed at a length of 20m. • A foundation on the right needs to be removed for a minimum 3-4m; the electricity pole needs to be shifted to the right for 3-4m.
58.0	• Left of the road all poles. trees and other obstacles need to be removed at a length of 68m and a width of 1-9m. • Right before the junction all obstacles (poles, trees, walls, fences) need to be removed at a length of 25m and a width of 4m.
58.3	• 90° left-turn: an area of approx. 1.200m^2 on the left needs to be cleared. reinforced and levelled down to road-level, • The wall on the left needs to be removed.
58.9	• Poles on the left need to be shifted leftwards for 4m – bushes/trees need to be removed. • All trees and bushes on the right need to be cut off at a width of 3m. • Sunshades/canopies on the right need to be closed or removed.
59.6	• Bushes and trees on the right need to be removed at a width of 3m. • 4 solar light poles on the right need to be removed. • Further electricity pole needs to be shifted rightwards for 3.0m.
60.0	• Wall on the right side (outer curve) needs to be removed; the electricity pole needs to be shifted to the right for 3m. • 2 electricity poles and total 6 solar light poles on the left of the road need to be removed or shifted to the left for approximately 4m. • The curbs on the left need to be removed at a length of approximately 75m and the area left behind needs to be filled up/levelled.
60.1	• On the outer curve all poles, trees and bushes need to be removed at a length of 74m and a width of 3m.

12.3 Impact Analysis

The transport route for the WTG components will begin at the Tripoli Port and proceed to the Project site using existing roads and new road or links, as described in **Section 2**. During the baseline survey, the average daily traffic (ADT) and associated Level of Service (LOS) for 8 road segments between the Tripoli Port and Chadra were determined, with peak traffic volumes occurring between 3pm and 4pm.

The assessment of traffic and transport impacts was based on the following:

- The nature, duration and receptor sensitivity of the obstacle removal and road development activities during construction and decommissioning.
- The addition of traffic and related changes to the LOS during construction, operation and decommissioning.
- The addition of traffic related to transport of construction materials from existing quarries to the Project site during construction.
- The outcomes of consultation with communities along the planned transport corridor, on existing and new road segments.

It is noted that community health, safety and security impacts from transport and traffic are presented in **Section 17 Community Health, Safety and Security**.

12.3.1 During Construction

12.3.1.1 Road Obstacle Removal

During the traffic and transport studies undertaken by Madgelni (April 2018), GIFCO (June 2018) and Dr. Dima (October 2018), potential obstacles were identified as summarized in **Tables 12-2, 12-3** and **12-8**. It is noted that some of the potential obstacles overlap, and as such have been summarized in **Table 12-9**. The following minor civil works will be necessary for trucks carrying the WTG components to navigate from the Tripoli Port to the Project site:

- The Port: Temporary concrete bund, curb, electric pole and overhead removal, will be necessary for trucks to navigate the Port. At the Port exit, 45m of concrete wall will need to be demolished to facilitate exit by trucks carrying the WTG components.
- Ramps, roundabouts and curves: Car parking will be prohibited during transport and removal of curbs, electric poles, trees, lamp posts, and fencing will be necessary.
- Pedestrian bridges: Raising of the bridges to provide a vertical clearance of 570cm will be required.
- At significant curves: Ground leveling and compaction to facilitate maneuverability.

Identification of potential obstacles between Chadra and Sahle Checkpoint was undertaken as part of developing the preferred WTG component transport route.

Mitigation

- An additional route survey will be undertaken once the OEM/EPC Contractor is selected.
- The temporary removal of concrete bund, curb, electric pole and overhead cable, and demolition of the 45m of concrete wall be coordinated with the Port Authority.
- Raising of pedestrian bridges, prohibition of car parking, removal of curbs, electric poles, trees, lamp posts, and fencing at ramps and roundabouts and ground leveling and compaction of significant curves will be coordinated with the Ministry of Transport.

Table 12-9 Potential Obstacles Between the Tripoli Port and Chadra

Location	KM/ Coordinates	Civil Works / Measures to be Taken
Tripoli Seaport	0.0	• Internal Roads: Temporarily move concrete bund walls with steel poles and wire mesh. • Outer wall of Port premises: Demolish a length of 45m, remove curbs and light poles; improve road such that the vehicles can utilize all of the available area. • Overhead: Overhead cables and supporting pylons may need to be temporarily moved.
Outside Port Exit	0.3	• The concrete blocks opposite the port exit gate need to be removed. • The curbs between the 2 traffic lanes opposite the port exit gate need to be removed/levelled. • Roads must be free of any advertising board and sales booth. • All trees along the midway need to be removed. • Between the Port exit and the bridge, car parking prohibited during transport. • Lamp post removal on the left side of the road at N 34.446588º and 3 35.846541º, to allow entry into the roundabout.
Roundabout	2.4	• Parking around roundabout prohibited during transport.
Concrete Pedestrian Bridge	2.7	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Ramp	3.1	• A fly over ramp with an angle of 3.5º over a longitudinal length of 95m, with an apex of approximately 5.45m, gradually descending back to ground level after 600m. More information from the Ministry of Roads is required to clarify structural integrity and suitability for proposed load configurations.
Concrete Pedestrian Bridge	3.4	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Concrete Pedestrian Bridge	4.5	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Deir Amar Army Checkpoint	7.2	• Concrete blocks should be temporarily removed during transport.
Concrete Pedestrian Bridge	8.1	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Concrete Pedestrian Bridge	8.9	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Concrete Pedestrian Bridge	10.4	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Concrete Pedestrian Bridge	11.8	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.

Location	KM/ Coordinates	Civil Works / Measures to be Taken
Concrete Pedestrian Bridge	12.8	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Light Poles	13.0	• 2 light poles at the right need to be removed or shifted to the right for 2m.
Concrete Pedestrian Bridge	14.1	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Overhead Sign	14.7	• Sign needs to be lifted up to a clearance of +570cm.
Roundabout	15.8	• Steel fence needs to be removed. • The curbs, steel fence and small trees in the roundabout-center need to be removed. • Curbs and steel fence at roundaboutexit need to be removed at a length of 20m.
Concrete Pedestrian Bridge	16	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Roundabout	17.5	• Fencing, curbs, poles and signboard should be temporarily removed during transport.
Concrete Pedestrian Bridge	N 34.508707° E 35.966972°	• Pedestrian bridge needs to be lifted up to a clearance of +570cm.
Electric Poles/Traffic Sign	26.2	• Electric pole and traffic sign at the left need to be shifted leftwards 1.5m. • Electric pole at the right needs to be shifted rightwards 1.5m.
Electric Pole	30.3	• Electricity pole at the right needs to be shifted rightwards 3.5m.
Trees	31.0	• Trees to be pruned prior to transportation.
Customs House	34.0	• Boundary wall on the right (before the check point) needs to be removed. • Electricity pole on the right (before the check point) needs to be removed. • 50m after passing the check point an area of 15m on the right needs to be levelled.
Electric Poles/Trees	34.2	• 4 electricity poles on the right (after passing the check point) need to be shifted to the right. • Trees, bushes, electricity pole on the left need to be removed at a width of 4m.
Right Turn	34.8	• Before the right-turn the road needs to be extended to the left side on 75m length and 10m width (levelling/paving). • An electric pole needs to be removed. • Due to gradient changes between the approach road and the egress road, the angles and gradient will require plotting to ensure they are within the wing trailer’s maneuvering capability. In addition, the rock face near the apex of the bend requires review for wing trailer’s maneuverability.

Location	KM/ Coordinates	Civil Works / Measures to be Taken
Car Park	35.8	• Car parking probibited during transport.
Ground Surface	36.8	• Ground should be compacted.
Curve between Fraidis and Menjez	N 34.612789º E 36.240019º	• The radii of curbs to be surveyed to ensure blade oversail and overhang are not encroached.
Curve	46.1	• 4-9m of the terrain and rock face right along the curve need to be cleared, levelled and drainage needs to be filled up. • At the curve vertex approx. 8m of the rock face need to be removed in order to widen the road clearance to the right.
Curve	48.2	• On the outer curve the rock face needs to be removed at a length of 85m/width 5.5m. • 3 light poles on the left (inner) side of the curve to be removed. • Light poles & crash barrier on the left (inner) side of the curve need to be removed. • Incline left beside the inner curve needs to be filled up and levelled at a length of 50m.
Road Clearance	49.1	• All wooden poles on the right need to be removed. • Road need to be cleared of bushes and branches on both sides for a minimum of 45m. • Earth mounds on both sides need to be levelled at a width of 4m. • Bushes. poles and trees need to be removed.
Chadra Army Checkpoint	50.8	• Temporarily remove checkpoint obstacles.
Electric Poles	54.9	• 5 poles on the inner (left) side of the curve need to be removed or shifted to the left for a minimum of 2.5m. • 2 poles on the outer (right) side of the curve need to be shifted to the right for 4m.
Curve	55.1	• Curve entry: 2 poles on the left need to be shifted leftwards for approximately 3.5m. • 4 further poles on the left need to be shifted leftwards for approximately 3.5m. • A tree on the left needs to be removed. • A pole on the right needs to be shifted rightwards for 3.5m. • 3 marked poles on the left need to be shifted to the left for approximately 3.5m. • Inner (right) curve needs to be widened to the right. • All poles on the left need to be removed throughout the whole curve. • On the right all poles, trees and bushes need to be removed at a length of 90m.

- Asphalt speed bumps will be replaced with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass.
- Any modification required for the Al Aabdeh roundabout will be discussed with the municipality as it is under their authority.
- Such works will be coordinated and permitted by the Project Proponent and the Ministry of Transport and scheduled for time periods when traffic levels and/or pedestrian use are lowest.

As such, the impact severity is considered Slight and the receptor sensitivity considered Medium, resulting in a Minor Impact as shown in **Table 12-10**.

Table 12-10 Assessment of Minor Civil Works Required for Obstacle Removal

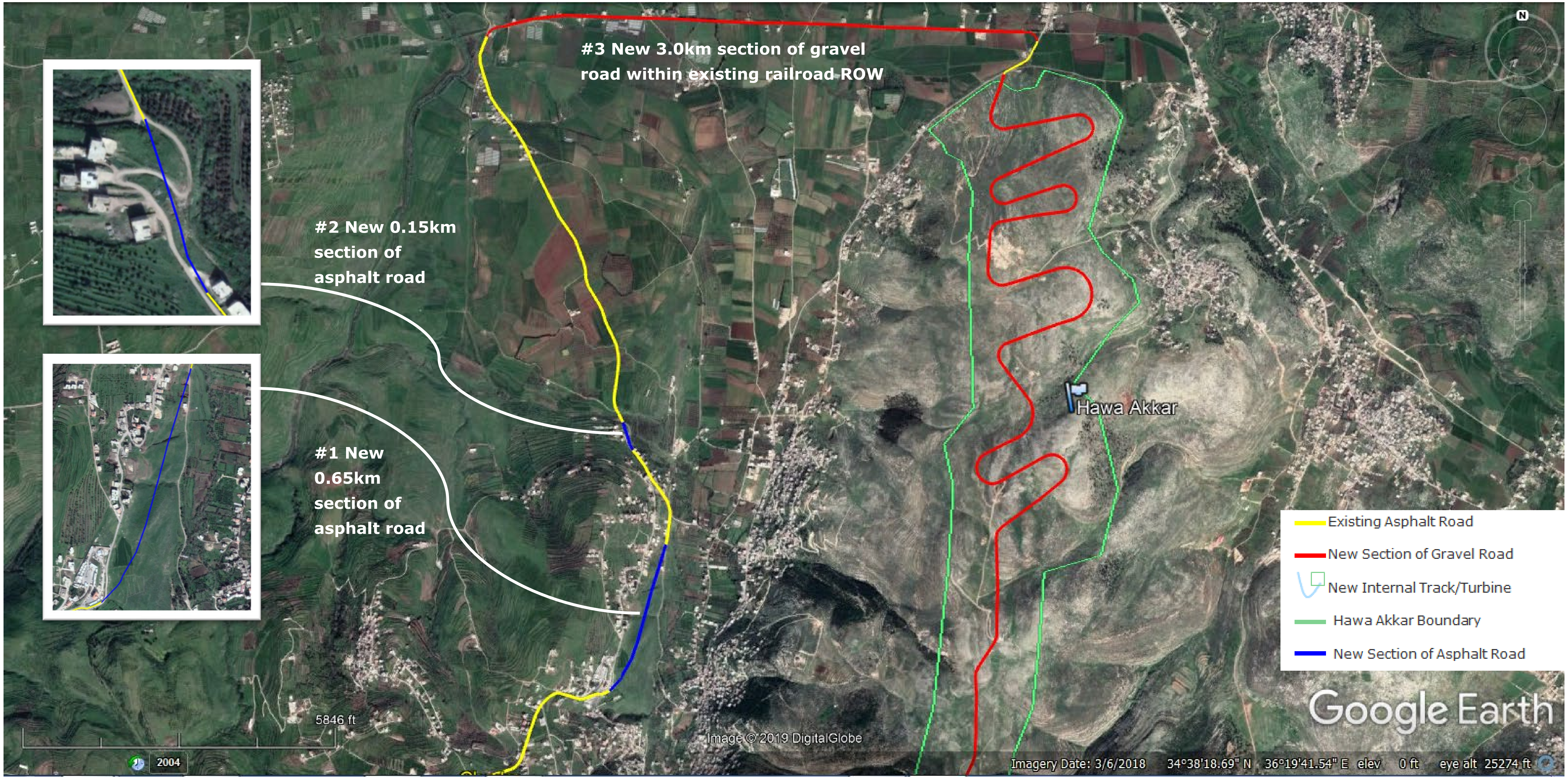
		Sensitivity of Receptor				
		Low	Low-Medium	Medium √	Medium-High	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	**Negligible √**	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

12.3.1.2 New Road Development

New road segments will be developed as follows:

- In order to avoid impacts to Chadra, Machta Hassan and Machta Hammoud, a new 0.65km section of asphalt road will be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 12-13**). The new road section will connect with the existing asphalt road outside of Machta Hammoud.
- A new 0.15km section of asphalt road will be constructed (shown as #2 in **Figure 12-13**) between two existing sections of asphalt road in order to avoid hairpin turns near homes.
- A new 3.0km section of gravel road will be constructed within the existing railroad right of way (ROW) managed by Machta Hammoud Village (shown as #3 in **Figure 12-13**), traveling east before connecting to an existing asphalt road to enter the Hawa Akkar Wind Farm.

Figure 12-13 New Road Segments



Identification of potential obstacles between Chadra and the Sahle Checkpoint was undertaken at a high level as part of developing the preferred WTG component transport route as follows:

- No obstacles were identified along the 0.9km segment of asphalt road to be constructed through the ~12.5ha parcel of land.
- No obstacles were identified along the 1.7km segment of track to be constructed between the existing Hawa Akkar internal track and the Sahle Checkpoint. The track alignment was selected to match the existing contours of the land and provide adequate buffer between the track and the Lebanese Army Military Base.

Mitigation

The construction of asphalt roads will occur for a period of 6 months and will be coordinated and permitted by Ministry of Transport and scheduled for time periods when traffic levels are lowest. Construction of internal track will occur for a period of 3 months and will be coordinated with the Ministry of Transport and the Lebanese Army.

It is considered that construction of the internal tracks will have no impact on access to and operations at the Lebanese Army Military base and/or residents of Mqaible. Therefore, the impact severity is considered Low and the receptor sensitivity considered Medium, resulting in a Minor Impact as shown in **Table 12-11**.

Table 12-11 Assessment of New Road Development

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

12.3.1.3 Transport of WTG Components, Construction Materials and Workers

The construction phase will include the transport of WTG components, transport of construction materials and transport of construction workers to the Project site.

Transport of WTG Components

Several assumptions were considered in the assessment to calculate vehicle trips, as shown in **Table 12-12**.

Table 12-12 Vehicle Trips Required for Transport of WTG Components[1]

Component	Quantity	Maximum Turbines	Units	Vehicle Type	Estimated Roundtrips From Tripoli Port to Project Site		
					Max. Trips per Week	Max. Truck Trips per Week	Duration = 16 turbines, Twice per Week
Tower	5 sections per tower per turbine	16	80	5 oversize trucks per tower per turbine	2	10	**8 weeks**
Nacelles	2 sections per nacelle per turbine	16	32	2 oversize trucks per nacelle per turbine		4	
Hub	1 hub per turbine	16	16	1 oversize truck per hub per turbine		2	
Blades	3 blades per turbine	16	48	3 oversize trucks per turbine		6	
		Totals	**176**	**11 oversize trucks per turbine**	**2**	**22**	
Substation	1 substation	NA	1	1 oversize truck per substation	1	NA	
Switchgear	1 switchgear	NA	1	1 semi-trailer (20-ton) per switchgear	1	NA	

[1] Each turbine transport consists of 11 overweight / oversized components, each to be transported on a separate truck. A full set of WTG components are to be transported in one night. Two sets of WTG components are to be transported per week.

To assess impacts from the transport of WTG components, the vehicle trips were added to the existing ADT and LOS (as summarized in **Table 12-4** and **Table 12-6**) along the 5 road segments. The truck traffic for transport of the WTG components was then added to the 5 road segments to assess the increase in traffic volume, an increase of 0.015% as shown in **Table 12-13**. Note: the ADTs for personal cars (PC) and heavy vehicles (HV) presented in **Tables 12-4** were multiplied by 7 to estimate the weekly ADTs.

Table 12-13 Weekly Traffic Along WTG Transport Route

ID	Road Designation	ADT (PC)/ Week	ADT (HV)/ Week	Total Weekly ADT	Total Weekly ADT with WTG Trucks
A	Tripoli Port - Abu Ali Roundabout	89,180	12,397	101,577	101,599
B	Abu Ali Roundabout – Al Aabdeh	232,211	22,533	254,744	254,766
C	Al Aabdeh- Mqaitea	134,610	9,450	144,060	144,082
D	Mqaitea - Aabboudiye	104,489	7,560	112,049	112,071
E	Aabboudiye - Chadra	79,450	5,040	84,490	84,512
	Totals	**639,940**	**56,980**	**696,920**	**697,030**
				Δ = 0.015%	

The increase in weekly ADT was used to undertake capacity analysis of the 5 road segments to be used, Road Segments A, B, C, D, and E, under three scenarios:

1. The existing traffic conditions (year 2018); This scenario uses the existing traffic volumes collected through automatic and manual counts.
2. Future background traffic conditions (year 2020) without the Project; this projection applied a conservative traffic growth rate of 3%.
3. Future traffic conditions (year 2020) with the Project; the projection was derived after assigning the generated trips for the transport of the WTG components in combination with the projection generated under Item 2.

The resulting LOS was then calculated for the selected road segments under the three scenarios to illustrate the impact of the additional traffic, as shown in **Table 12-14**. As an extra measure of conservatism, the LOS was calculated between 10pm and 11pm (a period of higher traffic volume), whilst the WTG component transport will be undertaken between 12am and 4am.

As a result of WTGs transport, the LOS of Road Segment A will be reduced from A to B, Road Segment B will be reduced from A to C, Road Segment C will be reduced from A to B, and Road Segment D will be reduced from A to B. For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road. For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.

Table 12-14 Projected Level of Service Change for Transport of WTG Components

Road		Year 2018 Existing Traffic	Year 2020 Traffic without Project	Year 2020 Traffic WITH Project
No.	Description	LOS	LOS	LOS
A	Tripoli Port - Abu Ali Roundabout	A	A	B
B	Abu Ali Roundabout – Al Aabdeh	A	A	C
C	Al Aabdeh- Mqaitea	A	A	B
D	Mqaitea - Aabboudiye	A	A	A
E	Aabboudiye - Chadra	A	A	C

Different performance indicators were used as types of these roads vary, volume to capacity ratio, density and percent time spent on the road. All roads have a configuration that is more than adequate to carry current and future background traffic during the time of WTG component transport. It is noted that the calculated decrease in LOS will only occur temporarily, two times per week over a total period of 8 weeks. Further, the LOS will not decrease below LOS C, which:

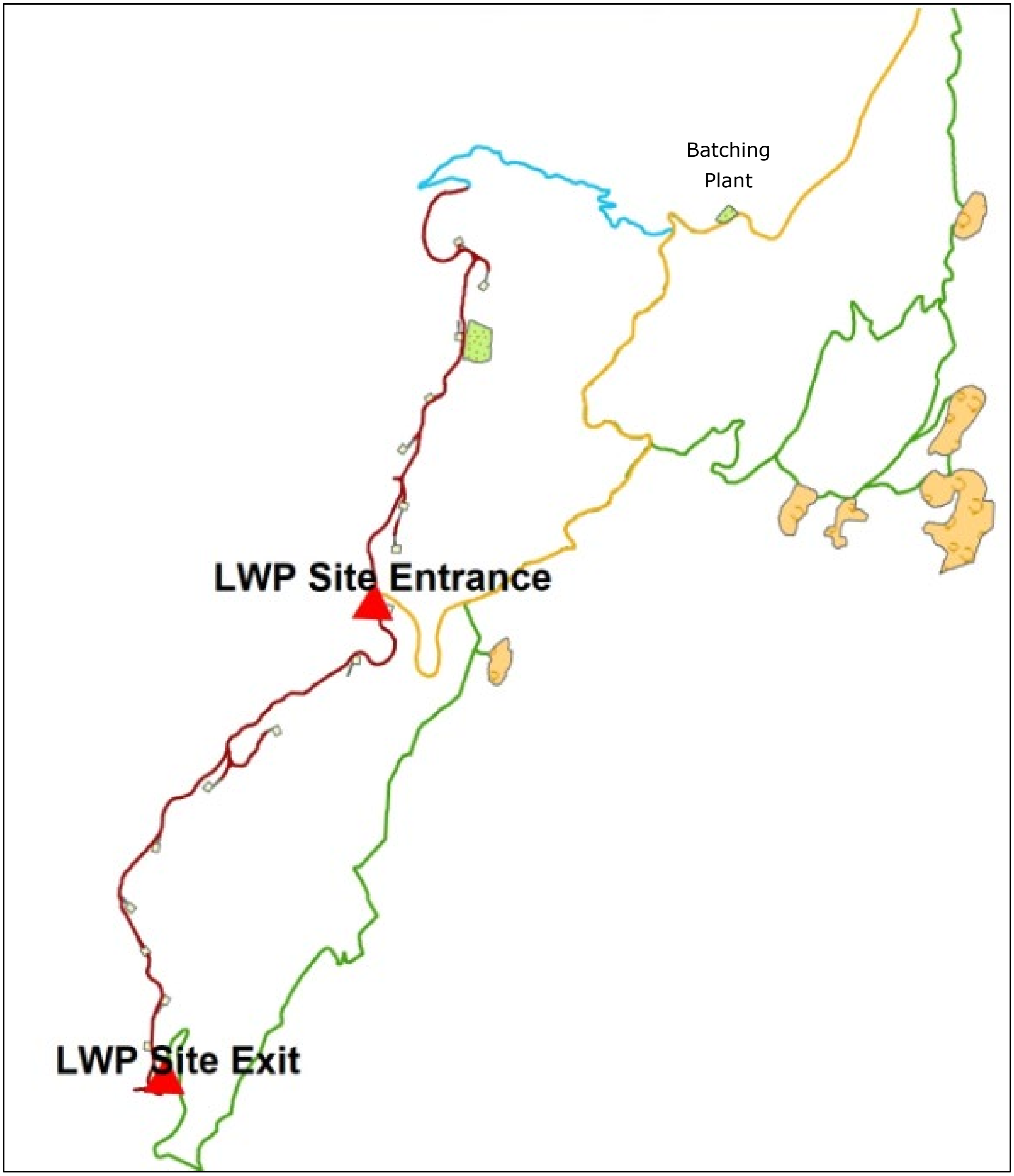
- Is the target LOS for some urban and most rural highways.
- Represents stable flow, at or near free flow.
- Noticeably restricts lane maneuverability and land changes require more driver awareness.
- Provides comfort to most experienced drivers, with roads remaining safely below but efficiently close to capacity and posted speed is maintained.
- May result in no effect from minor incidents, but localized service will have noticeable effects and traffic delays will form behind the incident.

Transport of Construction Materials

Based on efforts to avoid traffic impacts, the transport of construction materials will be undertaken as follows as shown in **Figure 12-14**:

- All rock excavation will be generated within the Project site, will remain within the Project site, and will not result in the addition of traffic to external roads.
- All backfilling from excavation will remain on the Project site and will not result in the addition of traffic to external roads.
- The destination of all surplus excavated earth material will be the 6 quarries, using tracks internal to the Project site, the existing asphalt road (in red) and the existing quarry tracks (in green), approximately 86 trucks per day for a period of 90 days.
- The highest traffic volumes are anticipated between the quarry and the Project site (yellow route near the Project entrance). The daily vehicle trip generation is estimated to be approximately 86 trips. This equates to approximately 7 two-way HGV trips per hour assuming a 12-hour working day, representing a minor number of trips over a temporary period.

Figure 12-14 Quarries and Existing Tracks (Green) Joining Existing Road (Yellow)



- All ready-mix concrete will be sourced from the Batch Plant to be constructed in Rweimeh Village (as shown on **Figure 12-12**) and will be transported to the Project site using the existing asphalt road (in yellow), approximately 13 trucks per day for a period of 90 days.
  - Sand and gravel will be sourced from the 6 quarries using the existing quarry tracks (in yellow), the existing asphalt road (in red), and tracks internal to the Project site, approximately 9 trucks per day for a period of 90 days.
- All cement will be sourced from Chekkah, south of Tripoli and the location of two large cement plants, using approximately 1 truck per day for a period of 90 days. The location of Chekkah is shown in **Figure 12-15.**

Figure 12-15 Location of Chekkah and Cement Plants

- Reinforced steel will be sourced from Tripoli, approximately 1 truck per day for a period of 80 days. The addition of 2 additional trucks per day along the WTG transport route for the transport of cement and reinforced steel will not affect the LOS C determined by the Traffic Impact Study.

The vehicle trips for transport of construction materials are calculated as shown in **Table 12-15**.

Table 12-15 Vehicle Trips Required for Transport of Construction Materials

Lebanon Wind Power	Quantities		Transport		Total Number of Trips		No. of Working Days	Total Number of Trips/Day		
	Low Range	High Range	Description	Capacity	Low Range	High Range		Low Range	High Range	Average
Rock excavation in m^3	343,568	429,461	Semi-Trailer (m^3)	20	NA	NA	NA	NA	NA	NA
Backfilling from excavation in m^3	206,141	257,676	Semi-Trailer (m^3)	20	NA	NA	NA	NA	NA	NA
Surplus from excavation managed in m^3	137,427	171,784	Semi-Trailer (m^3)	20	6,871	8,589	90	76.35	95.44	85.89
Ready-mixed concrete in m^3 sourced from Batching Plant in Rweimeh Village	10,737	12,884	Concrete Mixer Truck (m^3)	10	1,074	1,288	90	11.93	14.32	13.12
Cement in tonnes sourced from Chekkah	4,295	5,154	Powder Cement Tank Trailer (tonnes)	45	95	115	80	1.19	1.43	1.31
Sand in m^3 from 6 Quarries	4,295	5,154	Semi-Trailer (m^3)	20	215	258	80	2.68	3.22	2.95
Gravel in m^3 from 6 Quarries	8,589	10,307	Semi-Trailer (m^3)	20	429	515	80	5.37	6.44	5.91
Construction steel in tonnes from outside northern Akkar, likely Tripoli	1,074	1,503	Semi-Trailer (m^3)	20	54	75	80	0.67	0.94	0.81

Transport of Construction Workers

The construction phase may require a worst-case scenario of up to 200 staff working in a single day, across a total construction period of 344 days.

Approximately 25% of the workers (up to 50) will be hired from the local communities in the northeastern part of Akkar, including Wadi Khaled. The EPC Contractor will be required to transport local workers from local villages through carpooling and/or van transport to minimize traffic impacts to rural roads.

The balance of the workforce (up to 150) will be accommodated in nearby villages in hotels and/or apartments. Again, the EPC Contractor will be required to provide carpooling and/or van transport of workers to reduce traffic impacts to rural roads. The exact details are to be determined following selection of the EPC Contractor and the location of hired construction workers.

Mitigation

As presented in **Section 6**, engagement was undertaken with village leadership along the WTG component transport corridor in February 2019.

The main concerns of the mayors was the timing of the transport and agreed with the plant to undertake transport of the WTG components after 12am when the traffic is at its lowest. Most of the municipalities offered to provide a police escort of the WTG components and emphasized a willingness to provide further coordination across the municipalities and Project companies in accomplishing the Project as quickly as possible. In particular, the North Lebanon Governor was supportive and promised to facilitate any issue Lebanon Wind Power will be facing before and during the transport.

In addition, the members of El Rweimeh Village are supportive of the location of both the Substation and the Batching Plant within the village, as: 1) they will be fairly compensated for the acquisition of land for the Substation; 2) they will be fairly compensated for the lease of land for the temporary location of the Batching Plant; 3) they are accustomed to transport of quarry materials along the existing asphalt roads to supply the north Akkar region with sand and gravel; and 4) over 90% of El Rweimeh Village members are only present 3 months of the year.

- A communications protocol being developed for the transport of WTG components will be distributed to all Mayors two to three months prior to the start of transport. A final transport route map will be provided to all municipalities.
- All three wind farms will use the same traffic access plan.
- Announcements will be made to all villages along the WTG transport route from the Tripoli Port to the entrance of the Project site).
- WTG components will be transported 2 days per week, a total of 22 trucks roundtrip per week.
- Municipal police will provide an escort for the WTG transport convoy.
- Transport will be timed before and after farmers take their crops to the Akkar Vegetable Market.
- The road that passes through El Rweimeh Village is the main access of the trucks transporting rocks and gravel, and maintenance activities will be undertaken by the Project Proponent.
- For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road.

- For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.
- Once the EPC Contractor has been selected, and the number and location of construction numbers are known, measures will be put in place to maximize mitigation of traffic impacts through carpooling and group transport by van.

Given the above, the impact severity of traffic and transport from transport of WTG components, construction materials and workers during the construction phase is considered Low and the receptor sensitivity considered Medium, resulting in a Minor Impact as shown in **Table 12-16**.

Table 12-16 Assessment of WTG Component, Construction Materials and Worker Transport during Construction

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

12.3.2 During Operation

Traffic impacts during the operational phase are expected to be low to negligible and relate only to travel to the Project site by the EPC Contractor for periodic maintenance activities at the Project site.

12.3.3 During Decommissioning

During the decommissioning phase, the wind turbines will need to be dismantled and removed from the Project site. Traffic impacts are expected to be similar to that of the construction phase but will require assessment at the time to capture the most up-to-date traffic conditions along the expected disposal route.

13. BIODIVERSITY

This section sets out the details the biodiversity assessment of the Project site and surrounding area. It does not include assessments related to birds or bats as these are covered by separate chapters. The chapter is further subdivided as follows:

- Assessment of Baseline Conditions.
- Assessment of Potential Impact.

Details of all survey methodologies are provided along with all survey results. Where survey results are awaited, desk study data have been used to develop the likely baseline conditions.

The biodiversity assessment follows the approach previously described in this ESIA, considering both the DAOI and IAOI. In keeping with the surveys previously completed, it considers an immediate zone (or Project site), a middle zone up to 3km from the Project site boundary and a furthest zone extending to 15km out. The three zones make up the study area. Where the assessment has considered features outwith those study areas, this is made clear in the text.

The study area boundaries are being refined as part of the process to update the ESIA. However, the use of the existing study area is not considered to be a material gap in this assessment.

13.1 Assessment of Baseline Conditions

13.1.1 Habitats and Flora

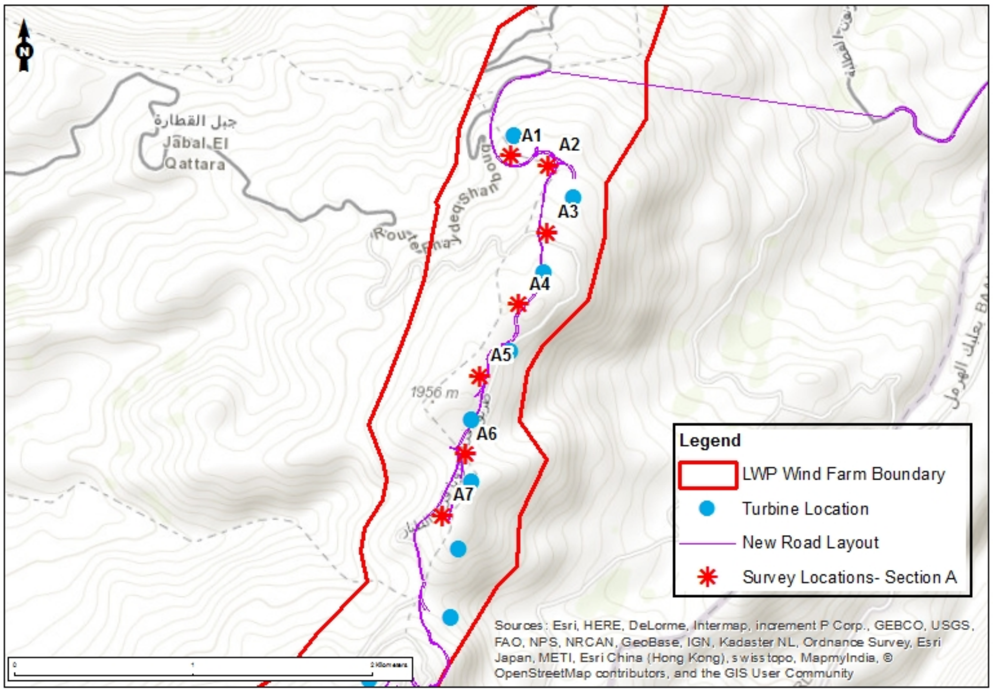
13.1.1.13 Methodology

Information regarding habitats and flora was obtained through a combination of literature review, field surveys and data analysis. A detailed qualitative and quantitative assessment of the floral species encountered at the plots that will be used by the proposed Project for turbine installation and road development was implemented 5-13 September 2018.

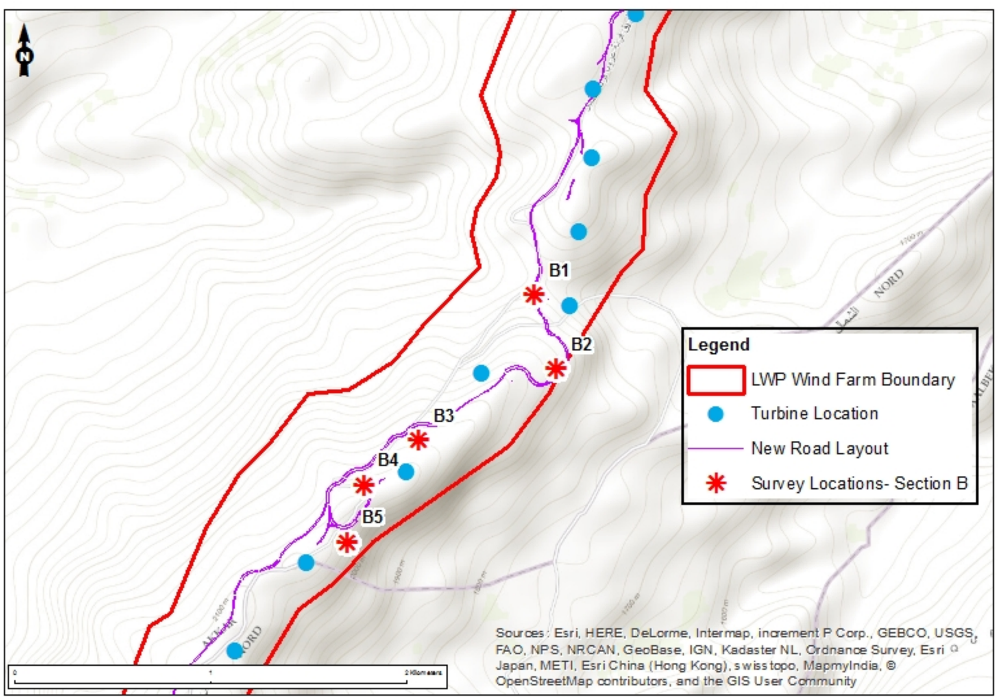
The habitat mapping will be updated in Summer 2019 through a combination of further field survey to map the boundaries between habitat types and the location of existing features such as tracks and borrow pits and therefore refine the habitat loss calculations which are currently based solely on the high-level land cover mapping. In addition, the surveys will aim to verify the potential presence of threatened and/or endemic floral species. The results of these surveys will be used to develop verify existing land cover mapping for the site.

For the purpose of the assessment, the Project site was split into three different survey sections (A, B and C from north to south), with each survey section further split into several subsections (1, 2, 3, etc.), as shown on **Figure 13-1**. While there was no floral cover along the new road alignment running parallel to Machta Hassan (refer to **Figure 2-8**), the rest of the new proposed roads were covered by the floral survey and were subdivided into sub-roads as shown on **Figure 13-2**. The plots for sub-road c (the road running parallel to the military base) were undertaken at the same locations as Section C, as shown on **Figure 13-1**.

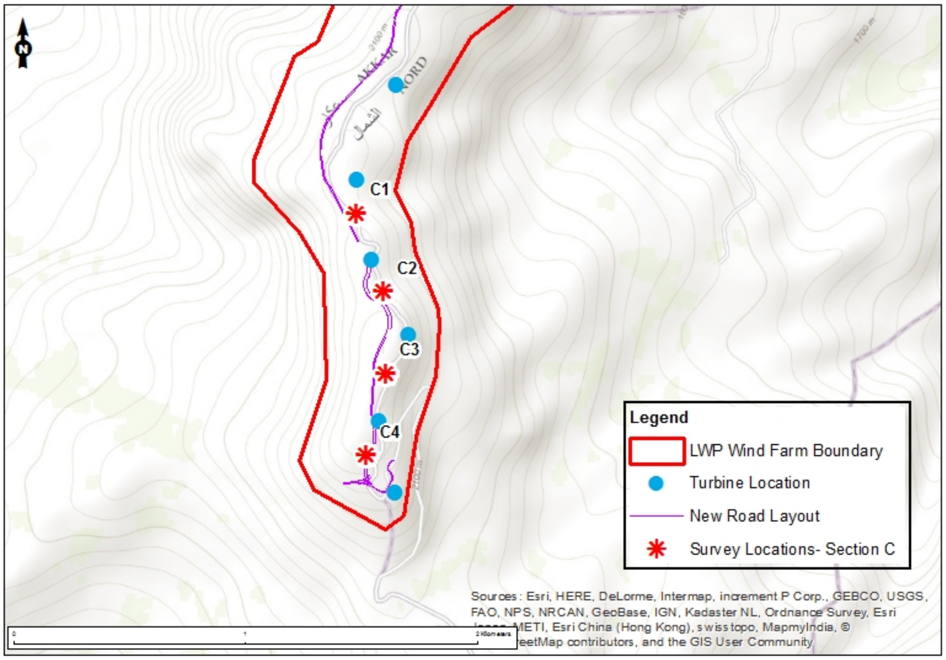
Figure 13-1 Survey Sections of the Vegetation Survey



a - Section A

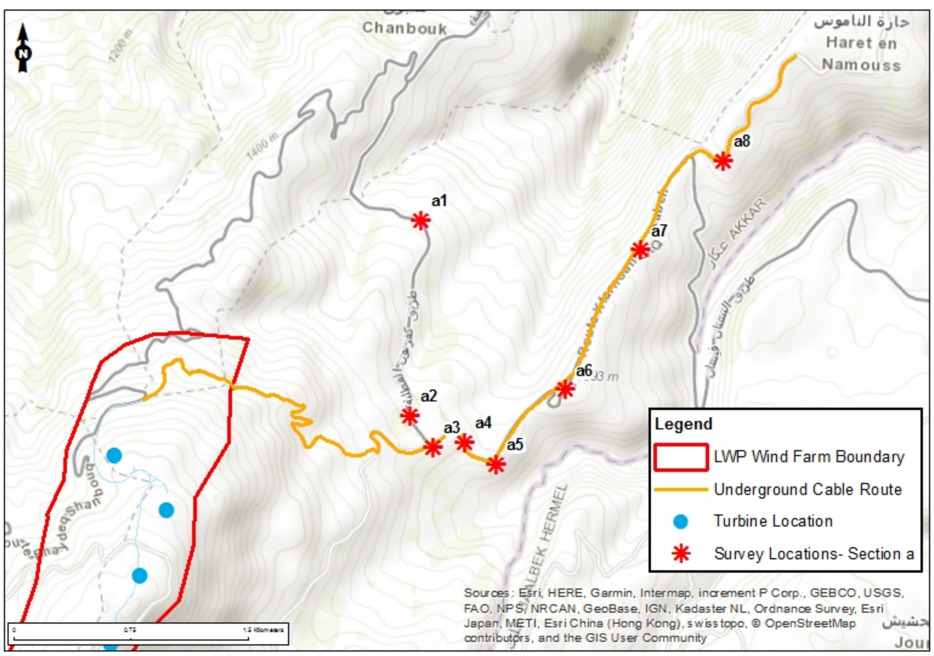


b - Section B

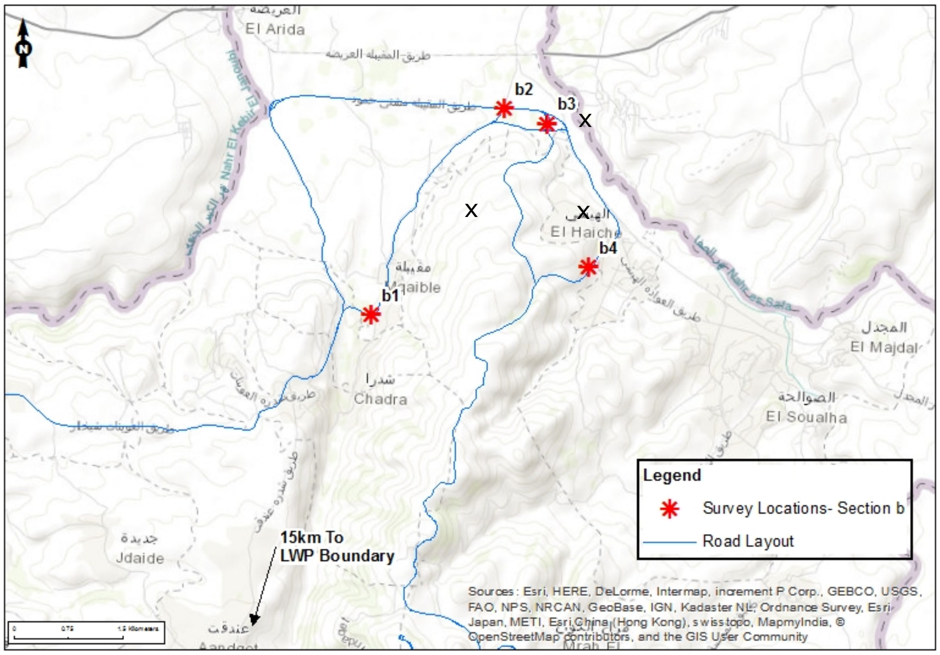


c - Section C

Figure 13-2 New Proposed Access Roads Covered by Flora Campaign



a – Buried Transmission Line Location



b - Road starting from Machta Hammoud through Mqaible and ending at Hawa Akkar Wind Farm (note: the roads marked with **X** have been removed from consideration).

13.1.1.13 Findings

Lebanon, which is considered as a hotspot for biodiversity in the Mediterranean Basin[1], is characterized by the coexistence of plants with diverse biogeographical origins and a large number of narrow endemic taxa. The combination of geological variation and altitude, along with strong climatic variation among different slopes, created a marked heterogeneity in the ecological forces acting on the evolution of plant differentiation. Its floristic richness is estimated at 2,612 vascular plant taxa, of which 108 are endemic to Lebanon[2].

The main components of the proposed development, the turbines and the substation, are situated between 1,800m and 2,190m above sea level in a mountainous region of northeastern Lebanon. The landscape is dominated by scattered coniferous forests, shrublands, ephemeral vegetation and areas of bare rocky land. The project site itself is distinctly alpine, dominated by bush and shrub species including *Berberis libanotica, Juniperus drupacea, Quercus calliprinos* and *Astragalus angulosus.* Mature trees are not present on the exposed ridges due to high winds.

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[1] Médail & Quézel, 1997; Myers, Mittermeier, Mittermeier, Fonseca, & Kent, 2000.

[2] Tohmé and Tohmé, 2004, Tohmé and Tohmé, 2011, Tohmé and Tohmé, 2014.

Target 5 of the Convention on Biological Diversity (CBD) Global Strategy for Plant Conservation[3] (GSPC) endorses the conservation of Important Plant Areas (IPAs). IPAs are areas identified at national level using internationally standardized criteria such as the presence of endemic threatened species, botanical richness, and the presence of threatened habitats[4]. The Project site is situated entirely within the Qammouaa-Dinnyeh-Jurd Hermel IPA[5] as shown in **Figure 13-3**.

Based on a 2018 study[6], species richness values for the Qammouaa-Dinnyeh Jurd Hemel IPA range between 200-337 species per 3m². The Qammouaa-Dinnyeh Jurd Hermel IPA contains the largest continuous stands of natural forests in Lebanon. A huge diversity of forest types occur in the IPA, including Calabrian pines, mixed cedar, fir and juniper, mixed fir and cedar, pure fir, evergreen oak and relic turkey oak stands. The area covers four vegetation series: the Eu-, Supra-, Mountainous- and Oro-Mediterranean and it is characterized by a wide variety of landscapes, including valleys, forests, rivers, gorges, rocky cliffs and mountains.

Three hundred and twenty plant species have been recorded, with 82 species restricted to the eastern Mediterranean, six endemic to Lebanon, Syria and Palestine, 17 to Lebanon and Syria, nine to Lebanon, Syria and Turkey, 10 to Lebanon and 2 threatened species according to experts' opinion (IUCN Important Plant Areas of the south and east Mediterranean region, 2011). The Qammouaa-Dinnyeh Jurd Hermel IPA is classified for the following threatened species:

- Alkanna prasinophylla.
- Astragalus angulosus.
- Cousinia libanotica.
- Erophila gilgiana.
- Helichrysum virgineum.
- Melissa inodora.
- Ranunculus schweinfurthii.
- Silene grisea.
- Stachys hydrophilia.

The northern part of the Project site lies within the Western Akroum Key Biodiversity Area (KBA),[7] designated for Cilician fir *Abies cilicica,* an endemic species with a restricted range. The Karm Chbat Forest Nature Reserve, shown in more detail in **Figure 13-4** was created in October 1995 (Ministerial Decision No. 14) and covers an area of approximately 520ha at an elevation of 1,400m - 1,900m.

[3] Fifth National Report of Lebanon, To the Convention on Biological Diversity, August 2015.
[4] C.L. Anderson, Identifying important plant areas: A site selection manual for Europe, and a basis for developing guidelines for other regions of the world, Plantlife International, 2002.
[5] IUCN Important Plant Areas of the south and east Mediterranean region, 2011.
[6] Setting conservation priorities for Lebanese flora—Identification of important plant areas, Magda Bou Dagher-Kharrat, Hicham El Zein, Germinal Rouhan, Journal for Nature Conservation Volume 43, June 2018.
[7] BirdLife International (2019) The World Database of Key Biodiversity Areas. Developed by the Key Biodiversity Areas Partnership: BirdLife International, IUCN, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Global Wildlife Conservation, NatureServe, Royal Society for the Protection of Birds, World Wildlife Fund and Wildlife Conservation Society. Downloaded from http://www.keybiodiversityareas.org on 28/02/2019.

Figure 13-3 Designated Sites

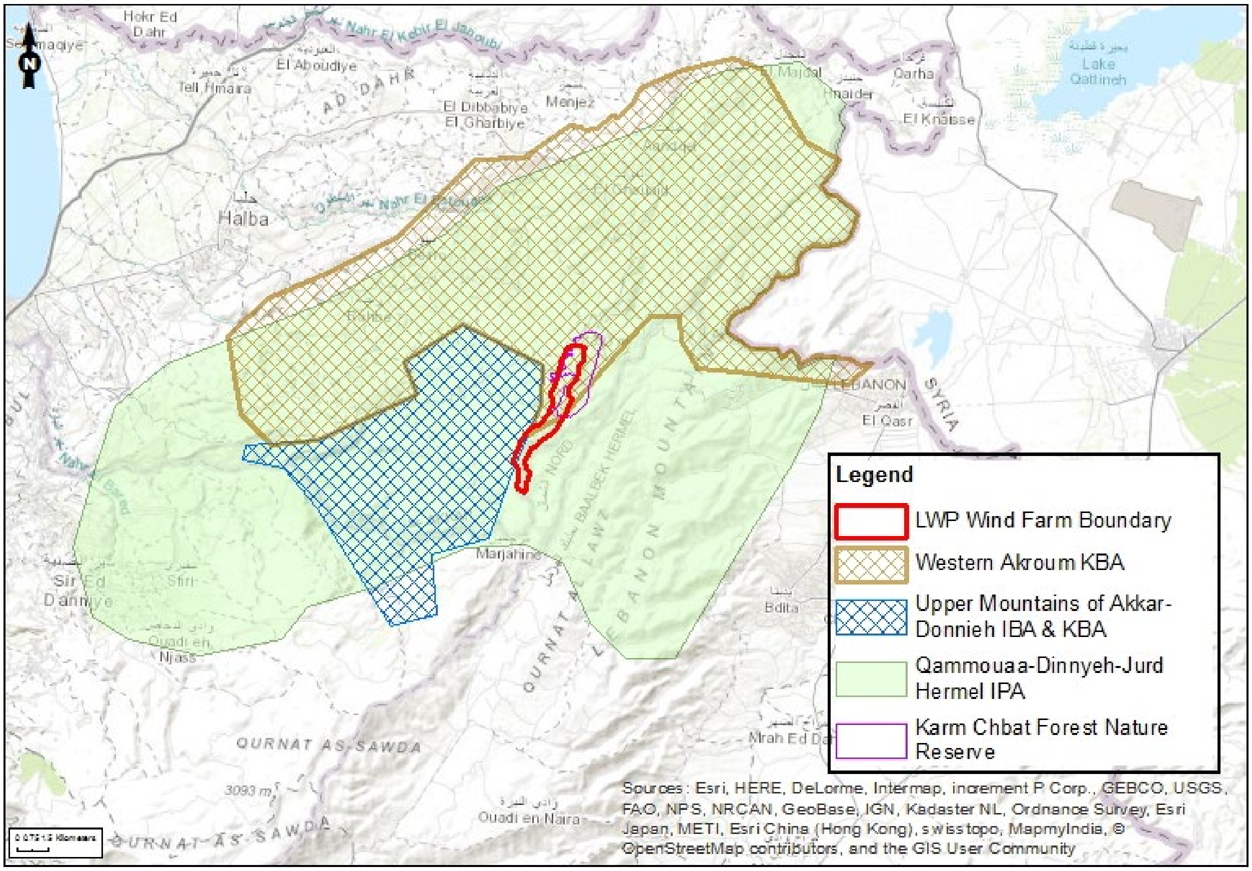
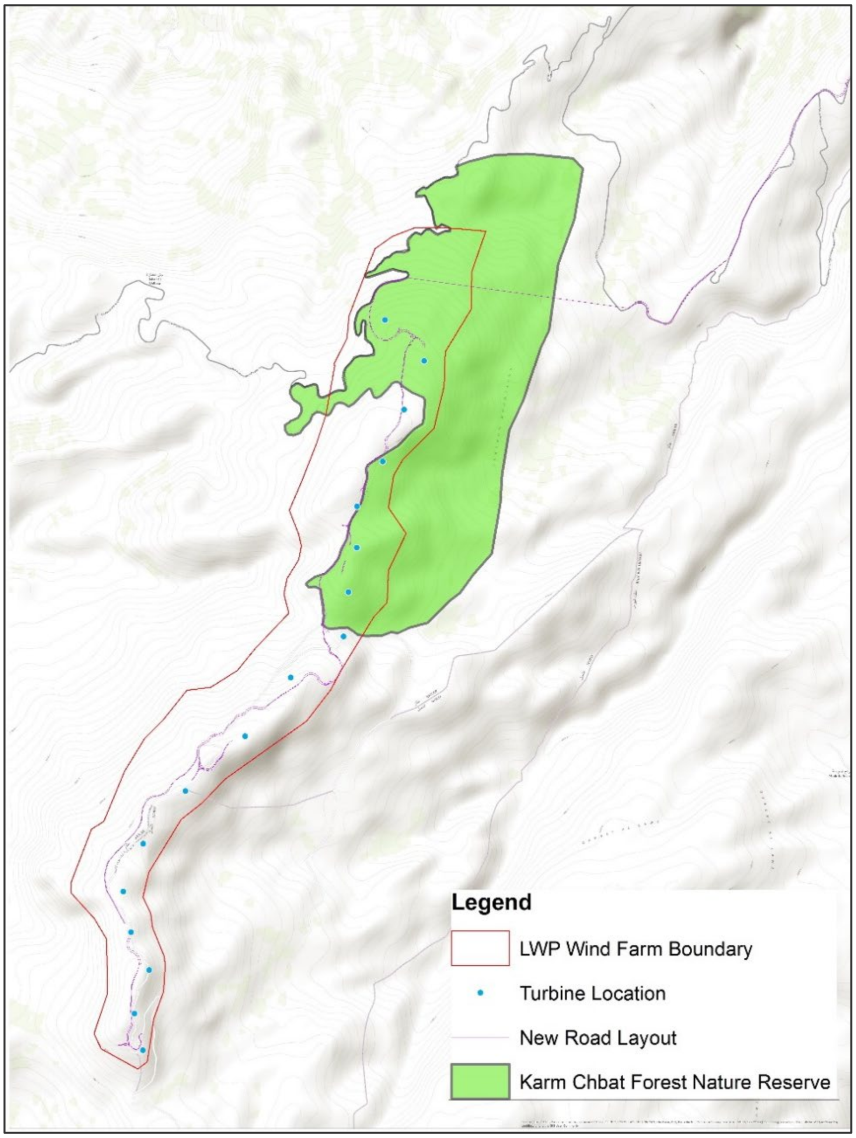


Figure 13-4 Location of Karm Chbat Nature Reserve in Relation to the Project Site



The Karm Chbat Nature Reserve is a protected area identified by the MOE, but this is not an international designation.

The Aandqet Forest Proposed Reserve, which is currently unconfirmed and undesignated, and therefore not shown on **Figure 13-3**, and for which a variety of studies have been completed, lies approximately 2km to the north of the Project site. The forest extends for most of the Oudine Valley for would be managed as an ongoing resource but with nature conservation a core component of that management.

The surveyed area extends between the upper middle mountain zone (Eu-Mediterranean) and the high mountain zone (Supra-Mediterranean), as indicated by the tree species observed on the Project site. Sparse coniferous forests, Shrublands and Rocky land. The floral species encountered in each of the habitats (based on literature review complemented by field observations) and their IUCN status are provided in **Table 13-1**.

Table 13-1 Flora Species Present in Each Habitat within the Project Area Based on Literature Review and Casual Field Observations

Habitat	Species	IUCN Status*	IUCN Trend*
Sparse coniferous (*Abies* sp. or *Juniperus* sp.) forests	Abies cilicica	Near threatened	Decreasing
	Juniperus drupacea	Least concern	Stable
	Juniperus excelsa	Least concern	Stable
	Alkanna prasinophylla	NA	NA
	Astragalus angulosus	NA	NA
	Cousinia libanotica	NA	NA
	Erophila gilgiana	NA	NA
	Helichrysum virgineum	NA	NA
	Clinopodium libanoticum	Endangered	Unknown
	Ranunculus schweinfurthii	Vulnerable	Stable
	Silene grisea	NA	NA
	Stachys hydrophila	NA	NA
	Alyssum libanoticum Nyaradi	NA	NA
Shrublands	Juniperus drupacea	Least concern	Stable
	Quercus calliprinos bushes	Least concern	Stable
	Viola libanotica	Endangered	Unknown
	Milk-vetch Astragalus sp.	NA	NA
	Condalia warnockii kearneyana	NA	NA
	Inula crithmoides	NA	NA
	Acantholimon libanoticum	NA	NA
	Alyssum libanoticum Nyaradi	NA	NA
Rocky land	Milk-vetch Astragalus sp.	NA	NA
	Acantholimon libanoticum	NA	NA
	Arabis caucasica	NA	NA

Figure 13-5 shows an overview of habitat types recorded across the entire survey site. The high-level mapping is only indicative of the broad habitats present on the site and may differ at a smaller scale. Observations during a site visit by SLR in May 2019 revealed that habitat types are more varied and heterogenous than the broad habitat mapping suggests ,e.g. areas classified as bare rock contain more herbaceous species than is indicated by the broad level mapping. More detailed habitat mapping and species records will be provided following further flora surveys.

Figure 13-5 Overview Habitat Map of Project Area

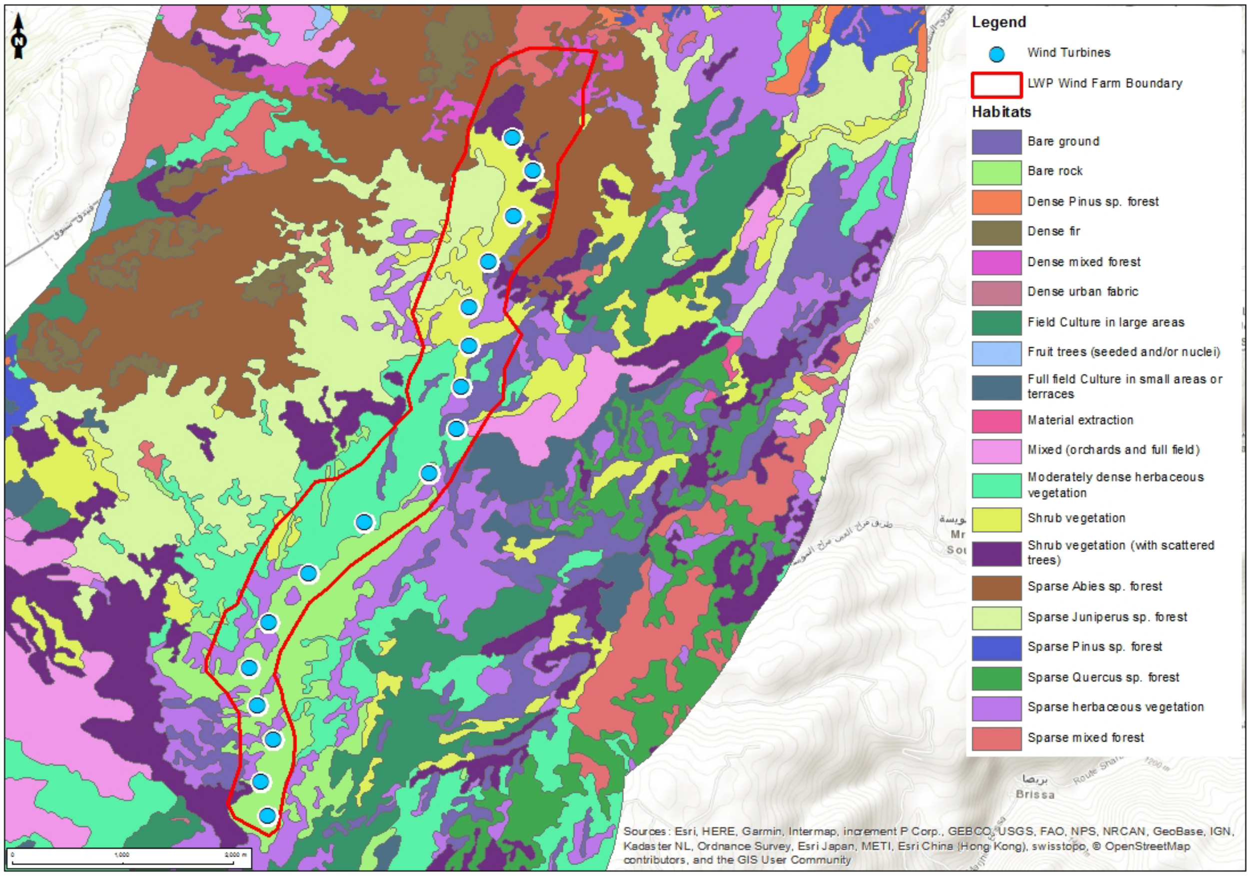


Table 13-2 provides the area of the habitats recorded in the middle study zone.

Table 13-2 Habitat Types and Area in Middle Study Zone

Habitat Type	Area (ha)
Bare ground	453
Bare rock	244
Dense fir	484
Dense mixed forest	41
Dense *Pinus sp*. forest	72
Dense *Quercus sp*. forest	10
Dense urban fabric	15
Field culture in large areas	674
Fruit trees (seeded and/or nuclei)	26
Full field culture in small areas or terraces	198
Material extraction	5
Mixed (orchards and full field)	680
Moderately dense herbaceous vegetation	1,084
Shrub vegetation	416
Shrub vegetation (with scattered trees)	592
Sparse *Abies sp*. forest	825
Sparse herbaceous vegetation	976
Sparse *Juniperus sp*. forest	780
Sparse mixed forest	357
Sparse *Pinus sp*. forest	253
Sparse *Quercus sp*. forest	320
Urban sprawl on full field culture	1
Urban sprawl on orchards	12
Urban sprawl on sparse forest	1
Bare ground	453
Total	8,519

The floral species encountered during flora surveys at the subsections of the Project site (as indicated in the **Figure 13-1** series) are listed in **Table 13-3**, along with their degree of abundance. The latter trees are all native trees commonly encountered throughout the study area.

Table 13-3 Abundance of Floral Species Encountered at Subsections of Project Site

Location	Species	Abundance*	IUCN Status*	IUCN Trend*
A1	Abies cilicica	Moderate	Near threatened	Decreasing
	Juniperus drupacea	Uncommon	Least concern	Stable
	Juniperus excelsa	Uncommon	Least concern	Stable
A2	Juniperus excelsa	Uncommon	Least concern	Stable
	Abies cilicica	Uncommon	Near threatened	Decreasing
	Juniperus drupacea	Uncommon	Least concern	Stable
A3	Juniperus excelsa	Uncommon	Least concern	Stable
	Acantholimon libanoticum	Moderate	NA	NA
	Milk-vetch *Astragalus* sp.	Moderate	NA	NA
A4	Condalia warnockii kearneyana	Uncommon	NA	NA
	Inula crithmoides	Moderate	NA	NA
	Juniperus excelsa (small bushes)	Uncommon	Least concern	Stable
	Acantholimon libanoticum	Uncommon	NA	NA
	Juniperus excelsa	Very Uncommon	Least concern	Stable
A5	No flora	-	-	-
A6	No flora	-	-	-
A7	No flora	-	-	-
B1	Juniperus drupacea (small)	Uncommon	Least concern	Stable
	Milk-vetch Astragalus sp.	Moderate	NA	NA
	Condalia warnockii kearneyana	Moderate	NA	NA
B2	no flora	-	-	-
B3	Milk-vetch Astragalus sp.	Common	NA	NA
	Inula crithmoides	Moderate	NA	NA
	Quercus calliprinos bushes	Uncommon	Least concern	Stable
	Condalia warnockii kearneyana	Moderate	NA	NA
B4	Milk-vetch Astragalus sp.	Common	NA	NA
B5	Milk-vetch Astragalus sp.	Common	NA	NA
	Condalia warnockii kearneyana	Uncommon	NA	NA
	Acantholimon libanoticum	Uncommon	NA	NA
C1	Milk-vetch Astragalus sp.	Common	NA	NA
C2	No flora	-	-	-
C3	Milk-vetch Astragalus sp.	Common	NA	NA
C4	No flora	-	-	-

*Note: Very uncommon: <5; Uncommon: 5 to 20; Moderate: 20 to 40; Common: >40. IUCN status and trend from www.iucnredlist.org

A list of the observed species along with their degree of abundance at each sub-road section are provided in **Table 13-4**.

Table 13-4 List of Floral Species Encountered Along New Road Alignment

Location	Species	Abundance	IUCN Status*	IUCN Trend*
a1	*Inula crithmoides*	Approx. 15	NA	NA
a2	*Inula crithmoides*	Approx. 10	NA	NA
a3	No flora	-	-	-
a4	No flora	-	-	-
a5	Pine trees *Pinus sp.*	Approx. 7	NA	NA
a6	*Juniperus drupacea*	Approx. 4	Least concern	Stable
a7	*Juniperus drupacea*	Approx. 10	Least concern	Stable
	Juniperus excelsa	Rare	Least concern	Stable
a8	*Pine trees Pinus sp.*	Approx. 8	NA	NA
b1	*Quercus libani*	Approx. 3 trees	Least concern	Decreasing
b2	*Juglandaceae*	Approx. 30 trees	NA	NA
	Punica granatum	Approx. 15 trees	Least concern	Unspecified
	Ficus carica	Approx. 20 trees	Least concern	Unspecified
b3	*Olea europaea*	Approx. 30 trees	Data deficient	Decreasing
b4	*Quercus libani*	Uncommon	Least concern	Decreasing
	Quercus calliprinos	Moderate	Least concern	Stable

*Note: from www.iucnredlist.org

Similar to the turbine sites, all species encountered along the new road alignment are native species commonly encountered across the study area. Two endangered species and one vulnerable species have the potential to be present on the Project site based on their reported presence within the Qammouaa-Dinnyeh Jurd Hermel IPA, which entirely overlaps the site. No records of the species were made during the field surveys. Cilician fir, a near threatened species which is the key features of the Western Akroum KBA, occurs on the site. The records for that tree species are from survey locations A1 and A2 situated at the northernmost end of the project site near Turbines seven and eight. Those locations are within the shrubland (with scattered trees) habitat type that is situated next to the sparse *Abies sp*. forest habitat type. It is within these two habitats types that Cilician fir is considered to occur.

One of the threatened species that led to the classification of the area as an IPA likely occurs in the plots surveyed that will be occupied by the Project, including its access roads. A milk-vetch *Astragalus* species was recorded, but is suspected to be *Astragalus angulosus*, an endemic species. Eight other threatened species typically occur in the sparse coniferous forest habitat type found within the northernmost part of the Project site, which largely coincides with the area of the Karm Chbat Nature Reserve.

Photographic Documentation

Photographic documentation of all species encountered in the study area is provided in **Figures 13-6a-6t**.

Figures 13-6a-t Photographs of Flora Observed in Study Area

a - *Juniperus excelsa*

b - *Abies cilicia*

c - *Juniperus drupacea*

d - *Quercus libani*

e - *Quercus calliprinos*

f - Salvia officinalis

g – *Prunis ursina*

h - *Pistacia mutica*

i - *Juglandaceae*

j - *Pyrus pyraster*

k - Milk-vetch *Astragalus sp*.

l - *Inula crithmoides*

m - *Condalia warnockii kearneyana*

n - *Olea oleaster*

o - *Prunus dulcis*

p - Pine Tree *Pinus sp.*

q - *Punica granatum*

r - *Ficus carica*

s - *Olea europaea*

t - *Acantholimon libanoticum*

13.1.2 Terrestrial Fauna

13.1.2.13 Methodology

A literature review was undertaken reviewing published reports sourced online. Survey results at locations within a 10km buffer of the proposed development have been considered relevant to the proposed development.

A baseline assessment for mammals within the Project Site has been delayed due to heavy snow cover. Nevertheless, given their proximity to the Lebanon Wind Power site, the baseline data collected as part of the assessments for the Sustainable Akkar and Hawa Akkar windfarms has been considered to inform a preliminary baseline for Lebanon Wind Power. Species recorded within those wind farm sites are thus considered likely to also occur within the Project site, given spatial proximity and similarity of habitat types. Additional data has also been gathered from camera trap surveys further from the Project site.

13.1.2.14 Findings

Mammals

This section details the species recorded at five locations in the local and regional area around the Project site and provides a good picture of the species likely or possibly occurring on the Project site. A mammal survey was undertaken at Hawa Akkar wind farm, to the north-east of the proposed development, as provided in **Appendix K**.

A camera trapping survey was undertaken at Jabal Moussa Biosphere Reserve, approximately 62km southeast of the proposed development, from March 2008 to May 2009. That site reaches maximum elevations of 1,700m, which coincides with the lower altitudes of the Project site. Thirteen (13) species were recorded during the survey. A similar camera trapping survey was undertaken at Tannanine Cedars Nature Reserve, approximately 40 km southeast of the Project site, from April 2005 to September 2006. Thirteen (13) species were recorded during the survey.

A camera trapping survey was undertaken at Horsh Ehden Nature Reserve, approximately 29km southeast of the proposed development, from December 2008 to August 2009. The site covers between 1,300m and 1,950m above sea level, which is a similar altitude to the lower parts of the proposed development. Twelve (12) species were recorded during the survey.

The signs or sightings of six mammal species (excluding bats) were recorded at the proposed Sustainable Akkar wind farm site immediately north of the Project. Similarly, 10 species (excluding bats) were recorded as part of the Hawa Akkar wind farm assessment. Both surveys were completed in 2018. The results of all of the surveys are summarised in **Table 13-5**, along with their IUCN status. All of the species listed have the potential to be present within the project site.

No incidental sightings of mammals were recorded during other surveys on the Project site.

In order to update this baseline, a mammal survey will be completed on the Project site in early Summer 2019 and involve a walkover to search for signs and installation of camera traps.

Table 13-5 Mammal Species Encountered on Comparable Sites

Species		Source of Data HA: Hawa Akkar 2018 SA: Sustainable Akkar 2018 JM: Jabal Moussa Biosphere Reserve 2008/09 TC: Tannanine Cedars Nature Reserve 2005/06 HE: Horsh Ehden Nature Reserve 2008/09						IUCN Status and Trend [8]
		HA	SA	JM	TC	HE	Records from Literature Reviews	
Order Eulipotyphla								
Southern white-breasted hedgehog	*Erinaceus concolor*	N	N	Y	Y	Y	Y	Least concern, unknown
Order Carnivora								
Grey Wolf	*Canis lupis*	N	N	Y	Y	N	Y	Least concern, stable
Golden (common) Jackal	*Canis aureaus syriacus*	Y	N	N	Y	Y	Y	Least concern, increasing
Red fox	*Vulpes vulpes*	Y	Y	Y	Y	Y	Y	Least concern, stable
Beech (stone) marten	*Martes foina (syriaca)*	Y	Y	Y	Y	Y	Y	Least concern, stable

[8] www.iucnredlist.org

Species		Source of Data HA: Hawa Akkar 2018 SA: Sustainable Akkar 2018 JM: Jabal Moussa Biosphere Reserve 2008/09 TC: Tannanine Cedars Nature Reserve 2005/06 HE: Horsh Ehden Nature Reserve 2008/09						IUCN Status and Trend [8]
		HA	SA	JM	TC	HE	Records from Literature Reviews	
Least weasel	*Mustela nivalis*	N	N	Y	N	Y	Y	Least concern, stable
Marbled polecat	*Vormela peregusna*	N	N	N	N	N	Y	Vulnerable, Decreasing
Eurasian badger	*Meles meles*	N	N	Y	Y	N	Y	Least concern, stable
Striped (Barbary) hyaena	*Hyaena hyaena*	Y	Y	Y	Y	Y	Y	Near threatened, Decreasing
Wild cat	*Felis silvestris*	N	N	Y	Y	Y	Y	Least concern, Decreasing
Order Hyracoidea								
Rock hyrax	*Procavia capenis*	N	N	Y	N	N	Y	Least concern, stable
Order Artiodactyla								
Wild boar	*Sus scrofa*	Y	N	Y	Y	Y	Y	Least concern, unknown
Order Lagomorpha								
Cape hare	*Lepus capensis*	N	N	N	N	Y	Y	Least concern, decreasing

Species		Source of Data HA: Hawa Akkar 2018 SA: Sustainable Akkar 2018 JM: Jabal Moussa Biosphere Reserve 2008/09 TC: Tannanine Cedars Nature Reserve 2005/06 HE: Horsh Ehden Nature Reserve 2008/09						IUCN Status and Trend [8]
		HA	SA	JM	TC	HE	Records from Literature Reviews	
Order Rodentia								
Caucasian (common, Persian or red) squirrel	*Sciurus anomalus syriaca*	Y	N	Y	Y	Y	Y	Least concern, decreasing
Indian crested porcupine	*Hystrix indica*	Y	Y	Y	Y	Y	Y	Least concern, stable
Eastern broad toothed field-mouse	*Apodemus mystacinus*	Y	Y	Y	N	N	Y	Least concern, stable
Black (house, grey or common) rat	*Rattus rattus*	N	N	N	Y	N	Y	Least concern, stable
Mole Rat Species [9]	*Spalax sp.*	N	N	N	Y	N	Y	N/A

[9] Considered likely to be Palestine mole rat *(Nanno) Spalax ehrenbergi*, a least concern species with a declining population.

Reptiles

Three species of reptile are considered likely to be present within the Project site as their known ranges occur close by to the south. These species and their IUCN status are provided in **Table 13-6**. These reptile species occur in alpine areas with sparse vegetation, which is the habitat type found at the highest elevations of the Project site.

Table 13-6 Reptile Species Typically Encountered in Habitats Present on Project Site

Name	IUCN Status*	IUCN Trend*
Lebanese viper Montivipera bornmuelleri	Endangered	Decreasing
Fraas' lizard Parvilacerta fraasii	Endangered	Decreasing
Unnamed lizard Phoenicolacerta kulzeri	Endangered	Decreasing

*Note: from www.iucnredlist.org

In consultation with SLR, it is not intended to complete any reptile surveys on the Project site as there is abundant suitable habitat and it has been assumed that the species are likely to be present and efforts should focus on avoidance of damage to habitats or incidental or intentional killing of any reptiles.

Invertebrates

The invertebrates typically encountered in the habitats present on the Project site and their IUCN status are provided in **Table 13-7**.

Table 13-7 Invertebrate Species Typically Encountered in Habitats Present on Project Site

Name	IUCN Status*	IUCN Trend*
False Apollo *Archon apollinus*	Near threatened	Unspecified
Unnamed butterfly *Polyommatus ellisoni*	Data deficient	Unknown
Unnamed butterfly *Polyommatus larseni*	Data deficient	Unknown
Unnamed butterfly *Polyommatus isauricoides*	Data deficient	Unknown

*Note: from www.iucnredlist.org

13.1.2.15 Summary

The baseline assessment has identified a number of key biodiversity features that require further consideration within the assessment. These are summarised in **Table 13-8**. Potential impacts on the features are detailed in **Section 14.2**.

Table 13-8 Summary of Importance of Biodiversity Features

Feature	Importance	Justification
Western Akroum Key Biodiversity Area	International	This KBA, along with the Eastern Akroum KBA in Syria, contains the range of the endemic tree species Cilician fir *Abies cilicica* and is considered to be of international importance.
Designated sites (Qammouaa-Dinnyeh-Jurd Hermel IPA)	International	The IPA contains the largest continuous stands of natural forests in Lebanon and is classified for the presence of several threatened species. As such, this site is considered to be of international importance.
Designated sites (Karm Chbat Forest Nature Reserve)	National	Karm Chbat Nature Reserve is a protected area within Lebanon for the presence of coniferous forests. Large stands of natural forest are uncommon in Lebanon and, as such, this site is considered to be of national importance.
Dense forest (including fir *Abies sp.*, mixed and pine *Pinus sp.*)	National	Forestry provides habitat for a broad range of species, such as birds and bats. Large stands of natural forest are uncommon in Lebanon and the areas within the site boundary contain near threatened species, such as Cilician fir *Abies cilicica*. As a result, this habitat is considered to be of national importance.
Sparse forest (including fir *Abies sp.*, *Juniperus sp.*, mixed and pine *Pinus sp.*)	National	Forestry provides habitat for a broad range of species, such as birds and bats. Large stands of natural forest are uncommon in Lebanon and the areas within the site boundary contain a near threatened species, Cilician fir *Abies cilicica*, an endangered species, *Clinopodium libanoticum* and a vulnerable species, Schweinfurth's buttercup *Ranunculus schweinfurthii*. As a result, this habitat is considered to be of national importance
Moderately dense and sparse herbaceous vegetation	Local	Contributes to the biodiversity value of the Project site and provides habitat for birds, invertebrates and mammals but the value is unlikely to extend beyond the local area.
Shrub vegetation (including shrub vegetation with scattered trees)	National	Contributes to the biodiversity value of the Project site and provides habitat for nesting birds. Contains the endangered species Lebanon violet *Viola libanotica*, which would be vulnerable to further change. As a result, this habitat is considered to be of national importance.
Reptiles	International	Three endangered species of reptile Lebanese viper *Montivipera bornmuelleri*, Fraas' lizard *Parvilacerta fraasii* and the unnamed lizard *Phoenicolacerta kulzeri* might be found on site. All have decreasing populations and, as such, are vulnerable to change. As a result, reptiles are considered to be of international importance.
Mammals	Regional	The species present are unknown, however based on those known from the area, it is possible that there could be populations of regional importance.

13.2 Assessment of Potential Impacts

In order to follow best practice guidance on ecological impact assessment[10], the biodiversity impact assessment follows a similar approach to the other assessments within this ESIA. Features are evaluated, and impacts are characterised in a similar fashion. However, rather than a matricized approach which provides a scale of impact significance from negligible to critical, it follows an approach of identifying whether an impact would lead to an "ecologically significant effect" for the feature, e.g. species or habitat type. An ecologically significant effect is an effect that either undermines or, in the case of a positive impact, supports biodiversity conservation objectives for 'important ecological features' (as explained in **Section 14.1**) or for biodiversity in general.

13.2.1 Feature Evaluation

Habitats and species (i.e. biodiversity features) identified within the study area have been assigned values using the standard CIEEM scale that classifies biodiversity features within a defined geographic context[11]. The classification uses recognized and published criteria[12,13] where the biodiversity features are assessed in relation to their size, diversity, naturalness, rarity, fragility, typicalness, connectivity with surroundings, intrinsic value, recorded history and potential value. **Table 13-9** describes the frame of reference that has been used for the impact assessment.

13.2.1.13 Criteria for Characterizing Impacts

The potential impacts upon biodiversity features have been considered in relation to the Project. The impacts have been assessed without consideration of any specific mitigation measures that might be employed. The assessment of likely impacts has been made in relation to the baseline conditions of the study area. The likely impacts of development activities upon biodiversity features have been characterized as set out in **Section 14.2.2** and as detailed in **Table 13-10**.

It is noted that the assessment only describes those characteristics relevant to understanding the impact and determining the significance of the effect.

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[10] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.

[11] Ibid

[12] Ratcliffe, D. (1977), *A Nature Conservation Review*. Cambridge: Cambridge University Press.

[13] Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010), *Valuing Bats in Ecological Impact Assessment*. In Practice. December 2010 pp23-25. Winchester: CIEEM.

Table 13-9 Geographic Importance

Geographic Importance	Examples
International	Internationally designated sites including Important Bird Areas (IBA) other Key Biodiversity Areas (KBA) Ramsar Site, Biogenetic Reserve, World Heritage Site, Biosphere Reserve, and potential Ramsar Sites; discrete areas which meet the published selection criteria for international designation, but which are not themselves designated as such. Resident or regularly occurring populations of species which may be considered at an international level, the loss of which would adversely affect the conservation status or distribution of the species at an international level; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
National	Nationally designated sites, Nature Reserves Marine Nature Reserve; discrete areas which meet the published selection criteria for national designation, but which are not designated as such. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across Lebanon or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Regional	Viable areas of key habitat identified as being of Regional value or smaller areas of such habitat which are essential to maintain the viability of a larger whole. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the region; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Local	Features of local value include areas of habitat or populations/communities of species considered to appreciably enrich the habitat resource within the immediate surrounding area, for example, species-rich hedgerows. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the immediate surrounding area; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.

Table 13-10 Impact Characterization

Parameter	Description
Direction	Impacts are either adverse (negative) or positive.
Magnitude	This is defined as high, moderate, low or negligible, with these being classified using the following criteria: High: Total/near total loss of a population due to mortality or displacement or major reduction in the status or productivity of a population due to mortality or displacement or disturbance. Total/near total loss of a habitat. Medium: Partial reduction in the status or productivity of a population due to mortality or displacement or disturbance. Partial loss of a habitat. Low: Small but discernible reduction in the status or productivity of a population due to mortality or displacement or disturbance. Small proportion of habitat lost. Negligible: Very slight reduction in the status or productivity of a population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. Slight loss of habitat that is barely discernible from the habitat resource as a whole.
Extent	The area over which an impact occurs, i.e. the impact's area of influence.
Duration	The time for which the impact is expected to last prior to recovery of the biodiversity feature or replacement of the feature by similar resource (in terms of quality and/or quantity). This is expressed as a short term, medium term, or long-term effect relative to the biodiversity feature that is impacted.
Reversibility	Irreversible impacts: permanent changes from which recovery is not possible within a reasonable time scale or for which there is no reasonable chance of action being taken to reverse it. Reversible impact: temporary changes in which spontaneous recovery is possible or for which effective mitigation (avoidance/cancellation/reduction of impact) or compensation (offset/recompense/offer benefit) is possible.
Frequency and timing	The number of times an activity occurs will influence the resulting effect (if appropriate, described as low to high and quantified, where possible). The timing of an activity or change may result in an impact if it coincides with critical life-stages or seasons e.g. the badger breeding season.

13.2.1.13 Significance Criteria

Impact significance was evaluated using the approach specified in Annex 9 of Decision 261/1 (June 2015) for the review of EIA studies at the MOE, whereby various sources of impacts are addressed for the Project's different implementation phases.

Significant effects are assessed with reference to the geographical importance of the biodiversity feature. However, the scale of significance of an effect may not be the same as the geographic context in which the feature is considered important. For example, an effect on a species which is on a national list of species of principal importance for biodiversity may not have a significant effect on its national population.

The potential for significant effects, in the absence of mitigation, has been determined with reference to the geographic conservation importance and the criteria in **Table 13-9**. By referring to the criteria in **Table 13-10**, the assessment seeks to characterize the magnitude of the effects in space and time.

Mitigation and/or compensation is proposed for all effects considered to be significant. Where appropriate, as a good practice measure, additional controls and/or compensation may be proposed.

Residual effects are characterized as either positive or adverse and either significant or not significant, taking account of mitigation and/or compensation proposals.

13.2.2 During Construction

13.2.2.13 Habitats

This section assesses the potential impacts of the Project on the terrestrial ecology (flora) at the Project site and in the surrounding area during construction.

Construction activities have the potential to degrade or destroy terrestrial habitat either directly through excavation, compaction, or modification (e.g. vegetation removal) or indirectly as a result of dewatering or from the accidental release of fuels, lubricants or other chemicals.

The construction of turbine foundations, access tracks and the substation would cause permanent habitat loss. Habitat loss and modification includes all areas replaced and potentially modified by project infrastructure, e.g. turbine foundations and permanent hardstanding, access tracks and the substation site.

Table 13-11 sets out the area potentially lost or modified for each habitat type as a result of construction of the proposed development (including underground cable connection).

Table 13-11 Potential Habitat Loss and Modification

Habitat Type	Total Habitat Within Middle Study Zone (ha)	Estimated Loss Modification (ha)*	Estimated Loss/ Modification (%)
Bare ground	453	c. 3	≤1
Bare rock	244	c. 12	c. 5
Dense mixed forest	41	≤1	c. 1
Dense *Pinus sp*. forest	72	≤1	c. 1
Field culture in large areas	674	c. 2	≤1
Full field culture in small areas or terraces	198	≤1	≤1
Moderately dense herbaceous vegetation	1084	c. 11	c. 1
Shrub vegetation	416	c. 13	c. 3
Shrub vegetation (with scattered trees)	592	c. 3	≤1
Sparse *Abies sp*. forest	825	c. 3	≤1
Sparse herbaceous vegetation	976	c. 9	≤1
Sparse *Juniperus sp*. forest	780	c. 2	≤1
Sparse mixed forest	357	≤1	≤1
Sparse *Pinus sp*. forest	253	c. 3	c. 1
Total	6,567	c. 67	

The potential habitat loss and modification is an estimate based on the broad level mapping of the habitat areas considered to be present in the Project site. These figures are likely to represent a worse-case scenario and would be confirmed following the completion of specific flora surveys to be undertaken in Summer 2019. The findings will be used to inform mitigation.

Total habitat loss and modification from the proposed development could total approximately 67 ha out of 6,567 ha (1%) within the site boundary, i.e. the overall habitat loss as a result of the proposed development is likely to be low and in itself is not likely to constitute an ecologically significant effect. However, the following sections consider the importance of certain habitat types and sensitive features and the potential significance of any effects resulting from habitat loss impacts.

Karm Chbat Nature Reserve Habitat Loss

Total habitat losses or modifications from the proposed development potentially total approximately 18ha out of 473ha within the Karm Chbat Nature Reserve, i.e. the overall habitat loss or modification as a result of the proposed development is likely to be negligible and in itself does not constitute an ecologically significant effect on this feature of national importance. However, important plant species are believed to occur in the sparse coniferous forest areas. At present, it is considered that c. 1% of this habitat type could be affected as a result of the proposed development.

As only a very small part of that habitat type has the potential to contain these species, it is not considered likely to lead to an ecologically significant effect.

Cilician Fir Supporting Habitats

Two habitat types support Cilician fir, the endemic tree species for which the large Western Akroum KBA was established. Approximately c.3 ha (≤3%) of the total area of the sparse *Abies sp*. forest habitat type within the mid-zone is likely be lost or modified as a result of the proposed development. That loss/modification is not likely lead to an ecologically significant effect.

Scattered Cilician firs were also recorded within the shrub vegetation with scattered trees habitat type. Notwithstanding the fact that only a very small part of that habitat type will contain the fir trees, the loss or modification of c.3 ha of that habitat type, or ≤1% of the total area within the mid-zone, is not likely to lead to an ecologically significant effect.

Even in combination, the loss is not likely to be significant, not least as there are large areas of dense *Abies sp*. forest elsewhere in the mid-zone that are not impacted in any way by the development.

However, as the species is the named feature of a KBA, as detailed in **Section 14.1.1.2**, measures will be taken to offset any losses of the species as a result of the proposed development.

Endangered and IPA Species – Sparse Coniferous Forest

The sparse coniferous habitat has the potential to support an endangered species, *Clinopodium libanoticum*, and the following nine IPA species:

- Alkanna prasinophylla.
- Astragalus angulosus.
- Cousinia libanotica.
- Erophila gilgiana.
- Helichrysium virgineum.
- Ranunculus schweinfurthii.
- Silene grisea; and
- Stachys hydrophilia.

Approximately 8 ha of the total area of the sparse coniferous forest habitat type (including sparse *Abies sp.* forest, sparse *Juniperus sp.* forest and sparse *Pinus sp.* forest) within the mid-zone is likely to be lost or modified as a result of the proposed development. Notwithstanding the fact that only a very small part of that habitat type will contain the endangered and IPA species, the potential loss or modification of ≤1% of the total area within the mid-zone is not likely to not lead to an ecologically significant effect.

However, as the species are endangered and the named features of the IPA, as detailed in **Section 14.1.2.2**, measures will be taken to offset any losses of the species as a result of the proposed development.

Endangered and IPA Species - Shrublands

The shrubland habitat supports an endangered species, *Viola libanotica*, and supports an *Astragalus sp.* considered likely to be the IPA species *Astragalus angulosus*. Up to approximately. 16 ha of the total area of shrubland habitat (including shrub vegetation and shrub vegetation with scattered trees) within the mid-zone could be lost or modified as a result of the proposed development. However, this is likely to be an overestimate as the high-level mapping being used in advance of completion of detailed habitat survey does not include features such as tracks or borrow pit upon which, impacts of habitat loss would be negligible. Notwithstanding the fact that only a very small part of that habitat type will contain the endangered and IPA species, the potential loss or modification of $\leq$2% of the total area within the mid-zone would is not likely to lead to an ecologically significant effect.

However, as the species are endangered and a named feature of the IPA, as detailed in **Section 14.1.2.2**, measures will be taken to offset any potential losses of the species as a result of the proposed development.

Endangered and IPA Species – Rocky land

The rocky habitat has the potential to support an endangered species, *Clinopodium libanoticum*, and supports an *Astragalus sp.* considered likely to be the IPA species *Astragalus angulosus*. A total of c. 12ha of the total area of rocky habitat (bare rock) within the mid-zone could potentially be lost or modified as a result of the proposed development. Notwithstanding the fact that only a very small part of that habitat type will contain the endangered and IPA species, the loss of c.5% of the total area within the mid-zone is not likely to lead to an ecologically significant effect.

However, as the species are endangered and a named feature of the IPA, as detailed in **Section 14.1.2.2**, measures will be taken to offset any losses of the species as a result of the proposed development.

13.2.2.14 Terrestrial Fauna

Loss or Disturbance of Resting Places

Faunal species typically inhabit locations for sleeping, breeding and/or hibernating (hereafter "resting places") either underground or within vegetation, e.g. in a tree. The construction of the proposed development has the potential to damage or destroy resting places within vegetation and underground.

The loss (destruction) of a resting place would be an adverse one-time, high magnitude permanent direct impact upon the individual or population of a species inhabiting the resting place and cause them to seek shelter elsewhere, in possibly less favourable locations where it would be necessary to find or construct a new resting place. Without detailed survey data, it is difficult to establish the sensitivity of the faunal species as that would depend on factors such as the species present, the numbers of individuals using the resting place and the type of resting place being lost, e.g. breeding or hibernation. The impact would be limited in extent to the individual or population using the resting place.

Assuming a likely worst-case scenario based on the species identified in the mammal desk study, that the species impacted is of regional importance and the resting place forms a key part of the species' life cycle, the impact would result in a significant ecological effect.

For reptiles, were any of the three endangered reptile species to be impacted by the loss of a resting place, those species are of international importance and as any resting place likely forms a key part of the species' life cycle, given how mobile reptiles are but how dependent they are on breeding (egg laying) locations or hibernation locations, the impact would result in a significant ecological effect.

Impacts associated with disturbance of a resting place rather than loss of the resting place would be similar but likely to be of moderate or low magnitude depending on the type of impact. A disturbance impact would occur as a result of construction noise, construction light or habitat alteration in the vicinity of the roost and could result in an ecologically significant effect.

However, it is considered that both types of impact are reversible, i.e. mitigation measures are possible which would avoid or reduce the impacts and ensure that even if any residual effects occur, they would not be significant.

Mitigation measures for terrestrial fauna are provided in the ESMP and include pre-construction surveys to identify presence of terrestrial fauna species and their key habitats and locations.

13.2.3 During Operation

13.2.3.13 Habitats

No impacts leading to significant ecological effects are considered to exist.

13.2.3.14 Terrestrial Fauna

No impacts leading to significant ecological effects are considered to exist.

13.2.4 During Decommissioning

Decommissioning impacts are considered to be similar to, but less than, those described for the construction phase. No ecologically significant effects are predicted.

13.2.5 Critical and Natural Habitats Assessment

A Critical and Natural Habitats Assessment for the Project is currently being undertaken, involving additional survey assessment, and findings will be used to inform mitigation.

14. BATS

14.1 Assessment of Baseline Conditions

14.1.1 Methodology

Information regarding bats was obtained through literature review and habitat observations made during the ornithology survey. Knowledge of bat diversity and distribution in Lebanon is limited, with baseline information based largely on reviews of records, field studies and museum specimens[1]. No bats or bat caves were observed at the Lebanon Wind Power Project site. This is likely due to the high elevation of the Project site, which falls between 1,000m and 2,000m above sea level, and the corresponding absence of woodlands.

Bat surveys commenced on the Project site in May 2019 and will last for one year, following best practice methodologies.[2,3] The findings of these surveys will inform mitigation.

Consequently, for the purpose of this assessment, the baseline assessment undertaken within the study area of Sustainable Akkar wind farm situated 5km to the north of the Project site has been consulted and applied to the Project site in order to provide a preliminary baseline for this assessment in the interim. Given the proximity of Sustainable Akkar to the Project site, the incidental records and bat assessment are considered as indicative of likely species diversity and distribution within the Project site, allowing for the formulation of a preliminary baseline until surveys are undertaken on the Project site. The bat survey is presented in **Appendix L**.

14.1.2 Findings

According to known records[4], the distribution of these bat species in Lebanon is strongly associated with the countries' varied altitudinal gradient; varying from low coastal regions to the west, the mountainous areas of Mount Lebanon and Anti-Lebanon ranges to the north and east and the Beqaa plains to the south. Species most frequently recorded at lower altitudes include; Egyptian fruit bat, Mediterranean horseshoe bat, Blasius's horseshoe bat, Botta's serotine and greater mouse-tailed bats. At medium altitudes, where habitat is dominated by coniferous and mixed woodlands, records of greater mouse-eared, long-fingered and bent-winged bats are most frequent. Records of serotine and Savi's pipistrelle were recorded at higher altitudes where habitats consist of mixed woodland and alpine scrub. Records of common pipistrelle, Kuhl's pipistrelle, noctule, free-tailed bat, lesser mouse-eared bat, Natterer's bat, Geoffroy's bat, greater horseshoe bat and lesser horseshoe bat appear across the majority of the gradient, suggesting a wider altitudinal range.

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[1] Benda, P., Abi-Said, m., Bou Jaoude, I., Karanouh, R., Lucan, R K., Sadek, R., Sevcik, M., Uhrin, M. and Horacek, I. (2016) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 13. Review of distribution and ectoparasites of bats in Lebanon. Acta Soc. Zool. Bohem. 80: 207-316.

[2] L. Rodrigues *et al*. (2014) *Guidelines for consideration of bats in wind farm projects* EUROBATS: Publication Series No.6.

[3] https://www.nature.scot/bats-and-onshore-wind-turbines-survey-assessment-and-mitigation.

[4] Benda, P., Abi-Said, m., Bou Jaoude, I., Karanouh, R., Lucan, R K., Sadek, R., Sevcik, M., Uhrin, M. and Horacek, I. (2016) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 13. Review of distribution and ectoparasites of bats in Lebanon. Acta Soc. Zool. Bohem. 80: 207-316.

According to comprehensive reviews of records and field studies[5], 21 species of bat are known to occur within Lebanon. These species and their commonality and conservation status are detailed in **Table 14-1**.

Table 14-1 Bat Species in Lebanon from Available Literature

Species		Commonality in Lebanon*	Conservation Status**
Rousettus aegyptiacus	Egyptian fruit bat	Frequent	Lc/ Stable
Rhinopoma microphyllum	Greater mouse-tailed bat	Rare	Lc/ Stable
Rhinolophus ferrumequinum	Greater horseshoe bat	Common	Lc/ Decreasing
R. hipposideros	Lesser horseshoe bat	Common	Lc/ Decreasing
R. Euryale	Mediterranean horseshoe bat	Common	Nt/ Decreasing
R. blasii	Blasius' horseshoe bat	Rare	-
Myotis myotis	Greater mouse-eared bat	Rare	Lc/ Stable
M. blythii	Lesser mouse-eared bat	Rare	Lc/Decreasing
M. nattereri	Natterer’s bat	Frequent	Lc/ Stable
M. emarginatus	Geoffroy’s bat	Rare	Lc/ Stable
M. mystacinus	Whiskered bat	Rare	Lc/ Unknown
M. capaccinii	Long-fingered bat	Rare	Vu/ decreasing
Eptesicus serotinus	Serotine	Common	Lc/Unknown
E. anatolicus,	Botta’s serotine	Rare	Lc/Unknown
Hypsugo savii	Savi’s pipistrelle	Common	Lc/ Stable
Pipistrellus pipistrellus	Common pipistrelle	Common	Lc/ Stable
P. kuhlii	Kuhl's pipistrelle	Common	Lc/ Unknown
Nyctalus noctula	Noctule	Rare	Lc/ Unknown
Plecotus macrobullaris	Alpine long-eared bat	Rare	Lc/ Decreasing
Miniopterus schreibersii	Bent-winged bat	N/A	Nt/ Decreasing
Tadarida teniotis	European free-tailed bat	Rare	Lc/ Unknown

*Based on distributions noted in Dietz, *et al* (2007) and records reported in Benda, *et al* (2016).

** ICUN status: Vu= Vulnerable, Nt= Near threatened Lc= Least concern, r = rare, c= common, endemic or endangered on the National level.

[5] Benda, P., Abi-Said, m., Bou Jaoude, I., Karanouh, R., Lucan, R K., Sadek, R., Sevcik, M., Uhrin, M. and Horacek, I. (2016) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 13. Review of distribution and ectoparasites of bats in Lebanon. Acta Soc. Zool. Bohem. 80: 207-316.

As part of the baseline assessment for Sustainable Akkar, the following surveys were undertaken:

- August to October 2018 - Bat activity surveys using active and passive bat detectors; Mist netting; and Roost inspections.
- December to March 2018 - Hibernation surveys (two visits to each hibernaculum); Bat activity surveys using active and passive bat detectors.

Ten species were recorded within the study area for Sustainable Akkar, situated 5km north of the Project site, as detailed in **Table 14-2**.

Table 14-2 Bat Species Recorded within Study Area for Sustainable Akkar

Species	Species Ecology in Lebanon	Baseline Survey Results
Common pipistrelle	Largely sedentary species. Summer and winter roosts are not normally over 20km apart. Roosts in crevices within trees/buildings/rocks. Commonly found across a wide altitudinal gradient in Lebanon. Records occur throughout Lebanon but are concentrated to the west, namely the western slopes of Mount Lebanon. **Approximate altitudinal range** of species recorded in Lebanon (min-max)* = 13m-2,170m	Most common species recorded as part of the Sustainable Akkar assessment. Detected by both passive and active detectors and during mist netting surveys.
Kuhl's pipistrelle	Common in Lebanon. Records are widespread but most frequently observed in the west of the country. Roosts occur mainly in buildings and cracks in rock faces. Records suggest a more limited altitudinal range than other pipistrelle species in Lebanon, with most records occurring below 1,000m, suggesting a preference for lower altitudes. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 15m-1,446m	Second most commonly recorded species as part of the Sustainable Akkar assessment. Recorded via passive and active detectors and during mist netting surveys.
Savi's pipistrelle	Believed to be common and widespread throughout Lebanon, with most records observed in the west and along the main ridge of the Lebanon mountains. Records occur across a wide altitudinal range but suggest a clear preference for higher altitudes. This species roosts in small crevices (i.e. buildings, rock faces) and tends to forage across a mosaic of habitat types, including meadows, waterbodies and human settlements. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 42m-2,170m	Recorded as part of the Sustainable Akkar assessment via active bat detectors, mostly close to water sources. Less frequent than other pipistrelle species recorded on the site.
Common noctule	Records for Lebanon are sparse and mostly recorded on the western slopes of the Mt Lebanon range, across a broad altitudinal range. Typically found roosting in trees within hardwood forests and rock crevices. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 56m-163 m	Recorded as part of the assessment for Sustainable Akkar via passive detectors at high altitudes close to the proposed wind turbine locations.

Species	Species Ecology in Lebanon	Baseline Survey Results
European free-tailed bat	Records from central and northern Lebanon. Species is believed to be widespread. Recorded across a wide altitudinal range across Lebanon. Typically forages over woodland, roosting in rock crevices. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 92m-2,005m	Recorded as part of the Sustainable Akkar assessment via passive detectors situated within 6km of the Project site.
Species	**Species Ecology in Lebanon**	**Baseline Survey Results**
Serotine	Records show this species to be common throughout Lebanon and generally focused along the Mt Lebanon range. This species tends to forage over open habitats in mid-range altitudes. Roosts are generally found in caves and buildings. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 15m-1,494m	Recorded frequently as part of the Sustainable Akkar wind farm assessment across the site via active and passive bat detectors and during mist netting surveys.
Greater horseshoe bat	Large number of records observed throughout Lebanon, scattered across the altitudinal gradient but tending to more montane areas. Typically roosting in caves and mines, foraging at low heights in highly variable landscapes, including woodland and dense scrub habitat. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 5m-1,720m	Recorded within Sustainable Akkar wind farm study site via active bat detectors near broadleaved woodland habitat. Roosts were located in caves during the hibernation surveys. None of these roosts were present when caves were visited for a second time.
Lesser horseshoe bat	Similar to greater horseshoe bats where they are frequently recorded throughout Lebanon, scattered across the altitudinal gradient but tending to more montane areas. Typically roosting in caves and mines, foraging at low heights in highly variable landscapes, such as woodland and dense scrub habitat. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 45m-1,770m	Recorded as part of the Sustainable Akkar assessment in caves and oak woodland using active bat detectors.
Greater mouse-eared bat	Records of this species in Lebanon are scarce, however they are believed to be widespread[6]. Recorded across coastal regions and on the western slopes of the Mt Lebanon range. Records are distributed across a very narrow range, tending to lower altitudes. This species tends to forage at low	A large colony was recorded within Sustainable Akkar wind farm study site during the hibernation surveys (Dec-Mar 2018). The

[6] *Benda, P., Abi-Said, m., Bou Jaoude, I., Karanouh, R., Lucan, R K., Sadek, R., Sevcik, M., Uhrin, M. and Horacek, I. (2016) Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 13. Review of distribution and ectoparasites of bats in Lebanon. Acta Soc. Zool. Bohem. 80: 207-316.*

Species	Species Ecology in Lebanon	Baseline Survey Results
	heights, roosting in buildings/structures in summer and moving to caves/mines in winter. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 140m-1,175m	colony was believed to be the largest discovered in Lebanon to date. However, prior to the second survey visit, the colony had been destroyed. Nevertheless, this species was also recorded using active detectors during bat activity surveys within the study area.
Long-fingered bat	Records suggest this species is widespread across Lebanon, with a narrow altitudinal range, preferring mid-range altitudes in summer before moving to higher altitudes to roost in winter. **Approximate altitudinal range** of species recorded in Lebanon (min-max) = 42m-1,285m	Recorded as part of the Sustainable Akkar assessment during hibernation surveys and via active bat detectors during activity surveys.

*Based on comprehensive review of survey records in Lebanon (Benda, et al., 2016)

Common pipistrelle, Kuhl's pipistrelle and serotine were the most frequently recorded species across the Sustainable Akkar study area, recorded using active and passive bat detectors and during mist net surveys. Savi's pipistrelle were also recorded using active detectors, typically close to water sources. Common noctule were recorded at higher altitudes using passive bat detectors. Similarly, European free-tailed bats were recorded via passive detectors located at the southern extent of the Project site. Long-fingered bats were also recorded across the site via both active and passive detectors and also during hibernation surveys.

Greater and lesser horseshoe bats were recorded across the site via active and passive bat detectors, namely foraging above woodland habitat and during hibernation surveys. Various cave roosts of greater horseshoe bat were also found within the study area. However, these colonies were not recorded during the second survey visit. It is not clear whether or not these colonies were disturbed or had simply moved to alternative roost sites as horseshoe bats tend to roost at higher altitudes in winter and lower altitudes in summer.

Cave roosts of lesser horseshoe bat were also recorded during hibernation surveys. Additionally, a large colony, thought to be the biggest recorded in Lebanon to date, of greater mouse-eared bats was recorded in a cave within the study area during hibernation surveys. This colony was found to have been destroyed upon the second survey visit. This species was, however, also recorded across the site via active bat detector surveys.

14.1.3 Summary

The baseline assessment has identified a number of key biodiversity features which require further consideration within the assessment. These are summarised in **Table 14-3**. Potential impacts on the features are detailed in **Section 11.2**.

Table 14-3 Summary of Importance of Biodiversity Features

Feature	Importance	Justification
Bats	National	Although, no specific legislation protects bat species in Lebanon, there are two near threatened and one vulnerable species likely to be present in the Project site which could be vulnerable to further changes in their population. As there is a lack of data on the bat species present within the Project site, bats are considered to be of national importance following the precautionary principle and due to their vulnerability to further change.

14.2 Assessment of Potential Impacts

14.2.1 Methodology

In order to follow best practice guidance on ecological impact assessment[7], the biodiversity impact assessment follows a similar approach to the other assessments within this ESIA. Features are evaluated, and impacts are characterised in a similar fashion. However, rather than a matricised approach which provides a scale of impact significance from negligible to critical, it follows an approach of identifying whether an impact would lead to an "ecologically significant effect" for the feature, e.g. species or habitat type. An ecologically significant effect is an effect that either undermines or, in the case of a positive impact, supports biodiversity conservation objectives for 'important ecological features' (as explained in **Section 15 Ornithology**) or for biodiversity in general.

14.2.1.1 Feature Evaluation

Habitats and species (i.e. biodiversity features) identified within the study area have been assigned values using the standard CIEEM scale that classifies biodiversity features within a defined geographic context[8]. The classification uses recognized and published criteria[9,10] where the biodiversity features are assessed in relation to their size, diversity, naturalness, rarity, fragility, typicalness, connectivity with surroundings, intrinsic value, recorded history and potential value. **Table 14-4** describes the frame of reference that has been used for the impact assessment.

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7 CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.
8 Ibid
9 Ratcliffe, D. (1977), *A Nature Conservation Review*. Cambridge: Cambridge University Press.
10 Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010), *Valuing Bats in Ecological Impact Assessment*. In Practice. December 2010 pp23-25. Winchester: CIEEM.

Table 14-4 Geographic Importance

Geographic Importance	Examples
International	Internationally designated sites including Important Bird Areas (IBA) other Key Biodiversity Areas (KBA) Ramsar Site, Biogenetic Reserve, World Heritage Site, Biosphere Reserve, and potential Ramsar Sites; discrete areas which meet the published selection criteria for international designation, but which are not themselves designated as such. Resident or regularly occurring populations of species which may be considered at an international level, the loss of which would adversely affect the conservation status or distribution of the species at an international level; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
National	Nationally designated sites, Nature Reserves Marine Nature Reserve; discrete areas which meet the published selection criteria for national designation, but which are not designated as such. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across Lebanon or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Regional	Viable areas of key habitat identified as being of Regional value or smaller areas of such habitat which are essential to maintain the viability of a larger whole. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the region; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Local	Features of local value include areas of habitat or populations/communities of species considered to appreciably enrich the habitat resource within the immediate surrounding area, for example, species-rich hedgerows. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the immediate surrounding area; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.

14.2.1.1 Criteria for Characterizing Impacts

The potential impacts upon biodiversity features have been considered in relation to the Project. The impacts have been assessed without consideration of any specific mitigation measures that might be employed. The assessment of likely impacts has been made in relation to the baseline conditions of the study area. The likely impacts of development activities upon biodiversity features have been characterized as set out in **Section 15 Ornithology** and as detailed in **Table 14-5**.

It is noted that the assessment only describes those characteristics relevant to understanding the impact and determining the significance of the effect.

Table 14-5 Impact Characterization

Parameter	Description
Direction	Impacts are either adverse (negative) or positive.
Magnitude	This is defined as high, moderate, low or negligible, with these being classified using the following criteria: High: Total/near total loss of a population due to mortality or displacement or major reduction in the status or productivity of a population due to mortality or displacement or disturbance. Total/near total loss of a habitat. Medium: Partial reduction in the status or productivity of a population due to mortality or displacement or disturbance. Partial loss of a habitat. Low: Small but discernible reduction in the status or productivity of a population due to mortality or displacement or disturbance. Small proportion of habitat lost. Negligible: Very slight reduction in the status or productivity of a population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. Slight loss of habitat that is barely discernible from the habitat resource as a whole.
Extent	The area over which an impact occurs, i.e. the impact's area of influence.
Duration	The time for which the impact is expected to last prior to recovery of the biodiversity feature or replacement of the feature by similar resource (in terms of quality and/or quantity). This is expressed as a short term, medium term, or long term effect relative to the biodiversity feature that is impacted.
Reversibility	Irreversible impacts: permanent changes from which recovery is not possible within a reasonable time scale or for which there is no reasonable chance of action being taken to reverse it. Reversible impact: temporary changes in which spontaneous recovery is possible or for which effective mitigation (avoidance/cancellation/reduction of impact) or compensation (offset/recompense/offer benefit) is possible.
Frequency and timing	The number of times an activity occurs will influence the resulting effect (if appropriate, described as low to high and quantified, where possible). The timing of an activity or change may result in an impact if it coincides with critical life-stages or seasons e.g. the badger breeding season.

14.2.1.1 Significance Criteria

Impact significance was evaluated using the approach specified in Annex 9 of Decision 261/1 (June 2015) for the review of EIA studies at the MOE, whereby various sources of impacts are addressed for the Project's different implementation phases. Significant effects are assessed with reference to the geographical importance of the biodiversity feature. However, the scale of significance of an effect may not be the same as the geographic context in which the feature is considered important.

For example, an effect on a species which is on a national list of species of principal importance for biodiversity may not have a significant effect on its national population.

The potential for significant effects, in the absence of mitigation, has been determined with reference to the geographic conservation importance and the criteria in **Table 14-4**. By referring to the criteria in **Table 14-5**, the assessment seeks to characterize the magnitude of the effects in space and time.

Mitigation and/or compensation is proposed for all effects considered to be significant. Where appropriate, as a good practice measure, additional controls and/or compensation may be proposed.

Residual effects are characterized as either positive or adverse and either significant or not significant, taking account of mitigation and/or compensation proposals.

14.2.2 During Construction

Mammals can be affected by wind power projects in various ways: habitat fragmentation and destruction, noise effects, visual impacts, vibration and shadow flicker effects, increase of direct mortality on wind farm roads, among others (de Lucas et al. 2005; Santos et al. 2010; Lovich and Ennen 2013). Impacts vary according to the nature of the site, and lifecycle stage of the installation.

Bats are the most affected by wind farms among other mammals. Many international studies have demonstrated the effect of wind turbines and the prevailing environmental conditions on some bat species. For example, Rydell et al. (2014) reported the negative effect of wind turbines in Northwestern Europe on certain bat species, and Arnett et al. (2008) described bat fatalities from 21 post-construction sites in the USA and Canada. Kunz et al. (2007) estimated that bats are killed at the rate of 30-40 bats per turbine per year in the Appalachian Mountains in eastern United States.

Bats are highly sensitive by nature. Even though they live the longest relative to their size (typically up to 30 years), but they are characterized by very special niche requirements and slow reproduction rates. Bats give birth to a single "baby" (or pup) per year, which makes them among the slowest reproducers with respect to their size.

These characteristics put the bats among the most threatened species of mammals in the world. In Lebanon all bat species are at risk from habitat destruction, putting fire in caves, hunting, drying of wetlands, elimination of their feeding sites, and excessive use of pesticide (Horáček et al. 2008, 2009, Benda et al. 2016).

Wind turbines can induce bat mortality either through 1) collision; or 2) barotrauma (Arnett et al. 2008, Baerwald et al. 2008, Grodsky et al. 2011). Several hypotheses propose that bats are killed by barotrauma caused by rapid air pressure reduction near the moving blades (Arnett et al 2008, Kunz et al. 2007). However recent research into the likelihood of barotrauma impacts has concluded that for an impact to occur, bats would have to be so close to a turbine blade as to be more at risk from collision (Rollins et al, 2012, Lawson et al 2018).

In recent years, many studies were conducted on bat fatalities in connection to wind projects. Bats have different behaviors and flight styles, which is why they are affected in varying degrees by wind turbines (Rydell et al. 2010, Camina 2012, Amorim et al. 2012). Bat species that fly and forage in open space like the Pipistrellus spp. and those that migrate long distances at high altitude like the Nyctalus spp. are more at risk of collision with the wind turbines. On the other hand, gleaning bats that fly close to vegetation like the Rhinolophus spp. face less risk of collision with wind turbines.

Some animals might adjust their behavior, but habitat fragmentation and destruction, human activity, sound pollution and opening of roads will expose these species to more threats. In addition, lack of resources including feeding, denning, roosting and hibernating sites will affect their population size.

14.2.2.1 Loss or Disturbance of Roosts

Bat species typically nest in one of three main roost types, trees, natural features such as caves or features constructed by humans, such as houses, bridges or mines. The construction of the proposed development has potential to damage or destroy just one of those potential roost features on the Project site, namely caves. The loss (destruction) of an active roost feature would be an adverse one-time, high magnitude, permanent, direct, impact upon the population(s) of bats using the roost feature and cause them to forage elsewhere, in possibly less favorable habitats[11].

The impact would be limited in extent to the roost feature being lost. Without detailed survey data, it is difficult to establish the sensitivity of the bat population(s) as that would depend on factors such as the species present, the numbers of bats using the roost and the type of roost being lost, e.g. maternity or hibernation. None of the species present are endangered or endemic, however, other surveys in the area have identified large roosts of some species, potentially some of the largest in Lebanon.

Assuming a likely worst-case scenario that the roost present is of national importance, the impact would be near certain to result in a significant ecological effect. Impacts associated with disturbance of a roost rather than loss of the roost would be similar but likely to be of moderate or low magnitude depending on the type of impact. A disturbance impact would occur as a result of construction noise, construction light or habitat alteration in the vicinity of the roost and could result in an ecologically significant effect.

However, it is considered that both types of impact are reversible, i.e. mitigation measures are possible which would avoid or reduce the impacts and ensure that even if any residual effects occur, they would not be significant.

Full details of all mitigation measures for bats are provided in **Section 21 Summary of Impact and Mitigation** and include pre-construction surveys to identify roost locations.

14.2.2.2 Loss of Foraging Habitat

Both permanent and temporary loss of bat foraging habitat during construction is possible. It is likely to be limited to the extreme northern part of the Project site where construction activities could result in changes in vegetation cover and any associated flying invertebrate resource. On the majority of the Project site situated on higher ground along the mountain ridge, as detailed elsewhere in this ESIA, the predominantly westerly winds can reach up to 35 m/s and typically exceed the 7 m/s speed above which bat activity has been found to reduce greatly. at which bats might be expected to be flying. The permanent loss of foraging areas, e.g. felling of areas of forest or clearance of shrubland, would be an adverse one-time, high magnitude, permanent, direct impact upon the population(s) of bats feeding in

[11] Bach, L. and Rahmel, U., 2004. Summary of wind turbine impacts on bats—assessment of a conflict. Bremer Beiträge für Naturkunde und Naturschutz, 7, pp.245-252.

the area of lost habitat and would cause them to seek alternative foraging locations. Without detailed survey data, it is difficult to establish the sensitivity of the bat population as that would depend on factors such as the species present, the numbers of bats using the foraging area and for how much of the year and whether that is during particularly sensitive periods, e.g. the breeding season when female bats need to gather sufficient prey to be of sufficient health to feed dependent young. The impact would extend to all populations of bats which use the foraging resource.

Assuming a worst-case scenario that the population(s) of bats using the foraging habitat is (are) of national importance, the impact would result in a significant ecological effect. Impacts associated with temporary loss of a foraging area, e.g. temporary construction infrastructure upon areas of sparse herbaceous vegetation, rather than the permanent loss of the foraging area would be similar but likely to be of moderate or low magnitude. It is considered possible that it could result in an ecologically significant effect.

However, it is considered that such impacts are unlikely on the Project site. However, were they to occur, both types are reversible, i.e. mitigation measures are possible which would avoid or reduce the impacts and ensure that even if any residual effects occur, they would not be significant.

Full details of all mitigation measures for bats are provided in **Section 22** and include pre-construction surveys to identify foraging locations.

14.2.3 During Operation

14.2.3.1 Collision Risk

The operation of a wind farm can have direct impacts on bats, the severity of which can be determined by the ecology of each species. Bat species that occupy higher altitudes and species that tend to fly at greater heights whilst foraging or migrating, such as *Pipistrellus* or *Nyctalus* species, are at greater risk of turbine collision during operation than low flying species that tend to remain at lower altitudes, such as horseshoe and *Myotis* species. **Table 14-6** summarises the level of collision risk with turbines of the bat species considered likely to occur within the Project site.

Table 14-6 Collision Risk Level for Each Species Likely to Occur Within the Study Site Based on Species Ecology

High Risk	Medium Risk	Low Risk
Common pipistrelle	Serotine	Greater horseshoe
Kuhl’s pipistrelle		Lesser horseshoe
Savi’s pipistrelle		Greater Mouse-eared
Common noctule		Long-fingered
European free-tailed		

Commonly recorded throughout Lebanon, greater and lesser horseshoe bats tend to forage close to the ground, therefore collision risk is considered to be low for these species. However, as this species tends to move to higher altitudes to roost during winter months, the risk of collision could be greater as colonies undertake this migration. Data on bat migrations in Lebanon are limited therefore this cannot be confirmed.

The typical activity of both *Myotis* species, long fingered and greater mouse-eared bats, makes these species low risk for collision. Both species have narrow altitudinal ranges and these species typically forage below typical collision heights.

Serotines are considered to be of a medium collision risk as this species is known to reach collision height when foraging. This species prefers to forage over woodland and open habitats at mid-range altitudes.

Common, Kuhl's and Savi's pipistrelle species are considered to be at high risk of collision, with wide altitudinal ranges, typically reaching collision height whilst foraging. European free-tailed bat has a high collision risk and this species typically forages at height (10-300m) and can reach altitudes of 3,000m[12] when migrating between summer and winter roosts.

Common noctules are at a high risk of collision as their activity patterns coincides with typical collision zones for turbines. This species covers large distances whilst foraging (up to 26km) above 100m and are commonly reported to be the most frequently recorded fatality at wind farm sites[13]. As such, collision risk for bats has the potential to be an adverse, high-magnitude long term impact for many of the bat species likely to be present at the Project site, populations of which are considered to be potentially up to national importance.

Without information on the levels of activity by those species found on the Project site, as well as the populations in the area, it is not possible to draw conclusions on whether or not the predicted collision risk for each species would result in an ecologically significant effect or whether any fatalities might not result in significant effects on those populations.

It is important to note that the levels of bat activity across the entire Project site are expected to differ considerably, with most activity expected to occur in the northern part of the project site where the trees, shrubs and dense herbaceous vegetation occurs and less in the middle and southern part which are at a higher altitude and dominated by rock habitats with scattered short vegetation.

Whilst it is not possible to conclude that there will not be ecologically significant effects on any of the bat species likely to be present, based on the habitats and wind speeds across much of the Project site, it is considered unlikely that bats would be present other only occasionally. However, it is considered that the impact of collision risk is reversible, i.e. mitigation measures are possible which would avoid or reduce the impacts and ensure that even if any residual effects occur, they would not be significant.

[12] Williams, T. C., Ireland, L. C. & Janet M. Williams, J. M. 1973. High Altitude Flights of the Free-Tailed Bat, *Tadarida brasiliensis*, Observed with Radar. Journal of Mammalogy, 54:807-821.

[13] Rodrigues, L., L. Bach, M.J. Dubourg-Savage, B. Karapandza, D. Kovac, T. Kervyn, J.Dekker, A. Kepel, P. Bach, J. Collins, C. Harbusch, K. Park, B. Micevski, J. Minderman.2015. Guidelines for consideration of bats wind farm projects – Revision 2014.
EUROBATS Publication Series No. 6 (English version). UNEP/EUROBATS Secretariat,Bonn, Germany, 133pp.

Full details of all mitigation measures for bats are provided in **Section 22** and include pre-construction surveys to identify bat activity and provide the necessary information to allow a full assessment of potential collision risk to be completed. Potential mitigation measures would include changes in cut-in speeds and temperature considerations to avoid key climatic situations when bat activity is typically highest.

14.2.4 During Decommissioning

Decommissioning impacts are considered to be similar to, but less than, those described for the construction phase. No ecologically significant effects are predicted.

14.2.5 Critical and Natural Habitats Assessment

A Critical and Natural Habitats Assessment for the Project is currently being undertaken. The findings will inform mitigation.

15. ORNITHOLOGY

15.1 Assessment of Baseline Conditions

15.1.1 Methodology

A desk study was undertaken and comprised a review of previous reports (including bird monitoring) carried out for the area. Data was also used from existing publications on survey methodologies and key issues relating to wind farms, with the aim of forming an understanding of species composition, spatial patterns, timing and peaks in activity. In addition, critically endangered or endangered bird species that might inhabit the three study zones were also identified. The desk study was supplemented by the implementation of an avian baseline study which included the following components:

- 20-minute point count survey targeting breeding passerines and small birds.
- Raptor nest survey incorporating an aerial survey to locate raptor nests on/within 5km of the site.
- Transect strip survey targeting raptors and non-breeding birds, especially during the autumnal passage.
- Migration period Vantage point surveys.

The assessment considered species recorded within the study area, species utilizing the study area seasonally (either during breeding or non-breeding season) and species which move through the study area as part of northerly or southerly migrations. The ornithology assessment used the same definitions of Immediate, Middle and Far Zone as defined earlier. The study area boundaries are currently being refined as part of the ESIA process; however, the use of the existing study area is not considered to be a material gap in this assessment.

Sampling intensity for the study area was designed to document avian use and behavior by habitat within the study area. Surveys were conducted weekly and, depending on the weather, at least two observers were at the Project site two days per week.

Survey periods were scheduled to cover the full range of daylight hours. During a set of surveys, each selected plot was repeatedly visited. Observation days were divided into two periods, morning (6am-12pm) and afternoon (12pm-6pm), with each station being surveyed outside the breeding season for 15 minutes during one of these periods.

The surveys were conducted by Ghassan Ramadan-Jaradi (senior ornithologist). Additional well-renowned Lebanese birdwatchers (Fouad Itani, Bassel Jumaa, Antoine Faissal, Michel Sawwan) contributed to the bird surveys at the Project site and/or its surroundings. Additionally, two trained people from the local community were used in the survey work.

The phenological status and trends of bird species that may need long term monitoring was retrieved from the experience and publications of the expert, from the records of the 16 vantage point survey visits, 17 visits by the senior ornithologist to the Project site, 96 visits of the trainees to the Project site, and from literature, where necessary. The trainees used a field sheet prepared by the ornithologist.

At the beginning of the campaign, the ornithologist delivered training to the trainees on the identification of species, filling in the field sheet, and the application of the different methods described in this report. At the end of each survey day, each observer was responsible for inspecting his data forms for completeness, accuracy, and legibility. The study team leader periodically reviewed data forms to ensure completeness and legibility and asked for the correction of any problems. The survey team leader reviewed species records and rejected records of species unlikely to be recorded on the site or at the wrong time of year. Any changes made to the data forms were signed and dated by the person making the change.

The ornithology survey and further description of the training process provided by the lead consultant is provided in **Appendix M**.

Point Count Survey

The 20-minute point count method consists of recording all bird species present during a 20-minute time period in the most characteristic habitats of a given area.[1] A 20-minute period is used to ensure the safety of eggs and chicks as most parent birds leave or return to nests within a 20-minute period. This method is semi-quantitative and allows frequencies and densities of avian populations breeding in the site to be estimated.

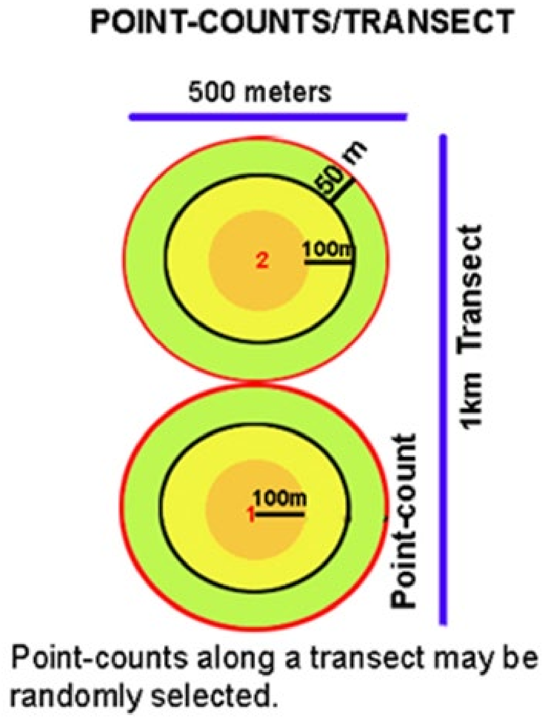
Changes in abundance of a species are estimated using changes in the frequency of this species over a series of point counts. The study considered bird species in the three study zones (the Project immediate study zone, middle study zone, and furthest study zone), including resident species, species utilizing the study area seasonally (either during the breeding or non-breeding season and species that only move through the study area as part of northerly or southerly migrations.

The baseline assessment focused on identifying species of "special concern" (endangered, threatened, near-threatened, endemic, rare, flag species, and extirpated species, if any). These species are considered indicator species since they are more sensitive to habitat changes than other species, especially more common ones. An example of how point counts are located along a transect is shown on **Figure 15-1**.

The bird expert completing the surveys was familiar with the identification of birds not only through sightings but also through their calls and songs from a distance. The points along the transect were located around the three meteorological masts that will be replaced by wind turbines. When the surveys were undertaken, the exact number and location of wind turbines was not known. It was, however, established that the turbines would fall around the masts.

[1] Ramadan-Jaradi, 1975; Ramadan-Jaradi, 1984.

Figure 15-1 Point Counts Along a Transect of 1km



This resulted in 10-point counts at each visit. The locations of the point counts are shown on **Figure 15-2**. They were used to count the number of species and their populations during wintering, breeding and spring migration and covered a distance of 4.91km^2 through 23 point counts. Accordingly, the remaining points were randomly selected and followed a stratified sampling model: one at the entrance, two between Masts 1 and 2, two between Masts 2 and 3, and two beyond Mast 3, as shown in **Table 15-1**.

Raptor Nest Survey

Information was gathered on species nesting in the area, including nest locations, nesting season (timing), and nest success. The focal species for the nesting surveys were common kestrel *Falco tinnunculus* (resident) and short-toed snake eagle *Circaetus gallicus* (summer breeding). All are known to breed in the vicinity of the study area. The trainees were trained on their identification and their reproduction behavior and calls when they bring food to the nest.

Figure 15-2 Distribution of Point Counts Prior to a Stratified Random Selection

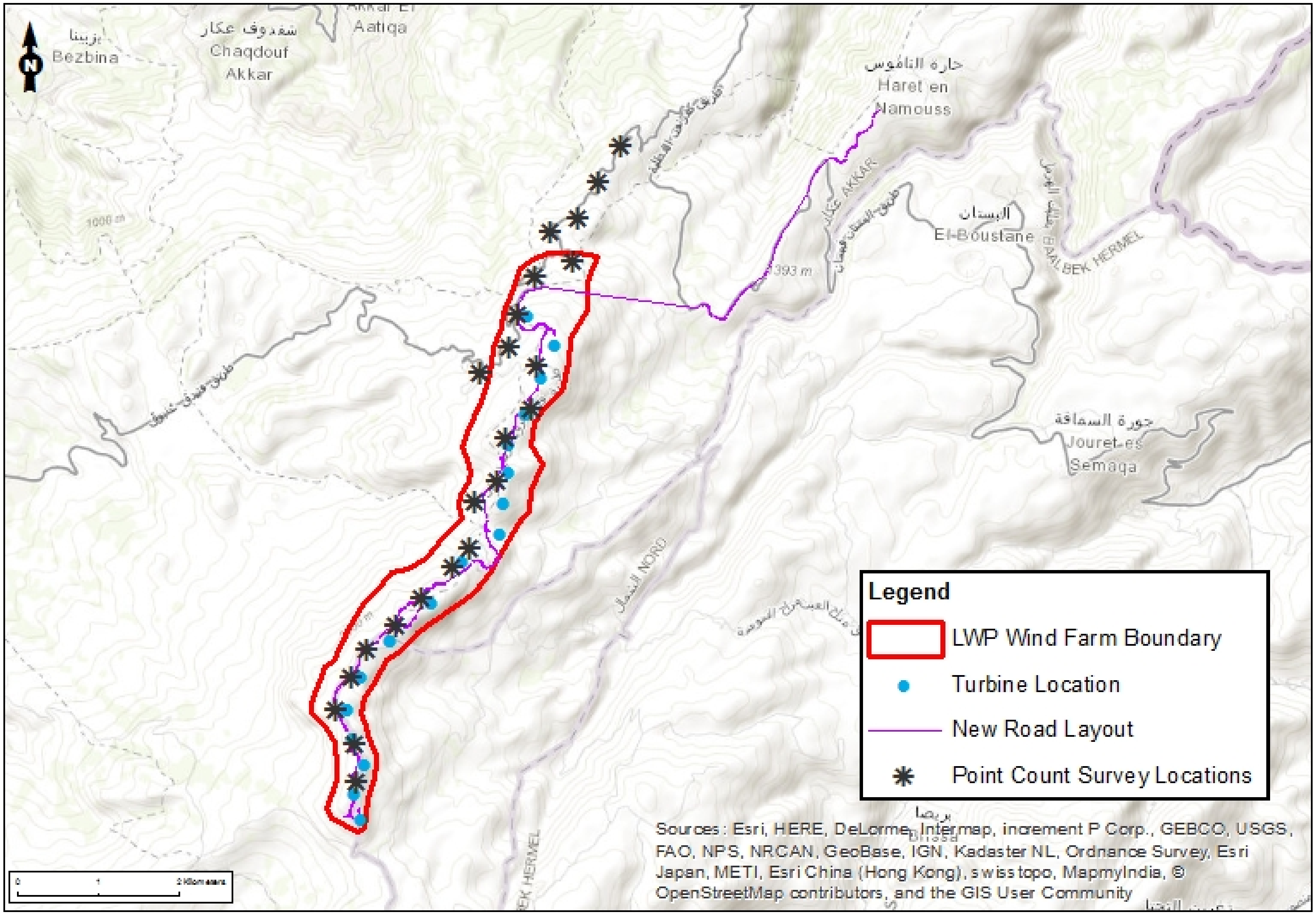


Table 15-1 Randomly Selected Point Counts

Month				M1									M2							M3				
	PC#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Jul	V1		2	3			6			9			12		14	15				19	20		22	
Aug	V2		2	3		5	6						12	13				17		19			22	23
Sep	V3	1		3					8	9			12				16		18	19		21	22	
Sep	V4	1		3	4						10		12		14	15				19	20			23
Oct	V5	1		3			6					11	12			15		17		19	20	21		
Oct	V6		2	3		5				9			12				16		18	19			22	23
Nov	V7	1		3			6	7					12	13		15				19	20			23
Dec	V8		2	3					8		10		12		14				18	19		21	22	
Jan	V9		2	3	4							11	12	13				17		19	20		22	
Feb	V10		2	3	4			7					12	13	14					19	20	21		
Mar	V11	1		3	4				8				12			15		17		19	20		22	
Mar	V12	1		3			6				10		12				16	17		19		21		23
Apr	V13		2	3		5				9			12				16		18	19	20		22	
Apr	V14	1		3			6	7					12		14				18	19			22	23
May	V15		2	3					8			11	12	13	14					19	20			23
May	V16		2	3	4					9			12			15			18	19		21	22	
Jun	V17	1		3		5					10		12				16		18	19	20	21		

*Note: M: mast; V: visit; PC: point count

Transect Strip Survey

The transect strip is completed along a linear path where the observer counts and records species and their populations on both sides of the transect and overhead. It was used during the fall migration, where the observer drove northward at very slow speed and stopped from time to time to observe and identify the encountered species. At every visit, 20 transect strips were surveyed, covering as much as 10km^2.

Owl Listening Survey

Four visits were made to the forest at the northern end of the current Project site[2] to listen for calling owls. Visits were made on the following dates and times:

- 11 February 2018, 1715-1900.
- 13 March 2018, 1742-1900.
- 10 April 2018, 1904-2030.
- 08 May 2018, 1926-2030.

Vantage Point Surveys

Five vantage points were used to provide information on the time spent flying over the study area, the relative use of different parts of the area, the proportion of time different species spent flying at different heights (above, below and through the rotor swept area) and directions. Vantage points were located on hills to provide maximum coverage of the area, with 2km viewsheds covering all of the turbine locations, as shown in **Figure 15-3**.

Surveys were undertaken in three migration periods, Autumn 2017, Spring 2018 and Autumn 2018. Each VP location was surveyed twice during each migration period:

- Surveys in Autumn 2017 and Spring 2018 lasted 12 hours each, with two visits resulting in 24 hours of survey effort per VP during each Autumn 2017 and Spring 2018.
- Surveys in Autumn 2018 lasted 8 hours each, with two visits resulting in 16 hours of survey effort per VP during Autumn 2018.

This resulted in a total of 64 hours of survey effort per VP (24 hours in spring and 40 hours in autumn) over the three migration periods, as shown in **Table 15-2**. Observation days were divided into three periods: three hours after sunrise, two hours at noon and three hours before sunset). Surveys were rescheduled if fog was present.

An overall summary of the distribution of visits and the number of survey hours per month, season and year is provided in **Table 15-3**.

[2] The locations surveyed were within the area of turbines one – six, which are no proposed to be constructed as part of the project., i.e. the surveys were completed outside of the Project site. However, they were completed within the same forest as extends onto the Project site and the absence of owls suggests that owls might be unlikely to be using the similar habitats further south.

Figure 15-3 Area Covered by Each Vantage Point

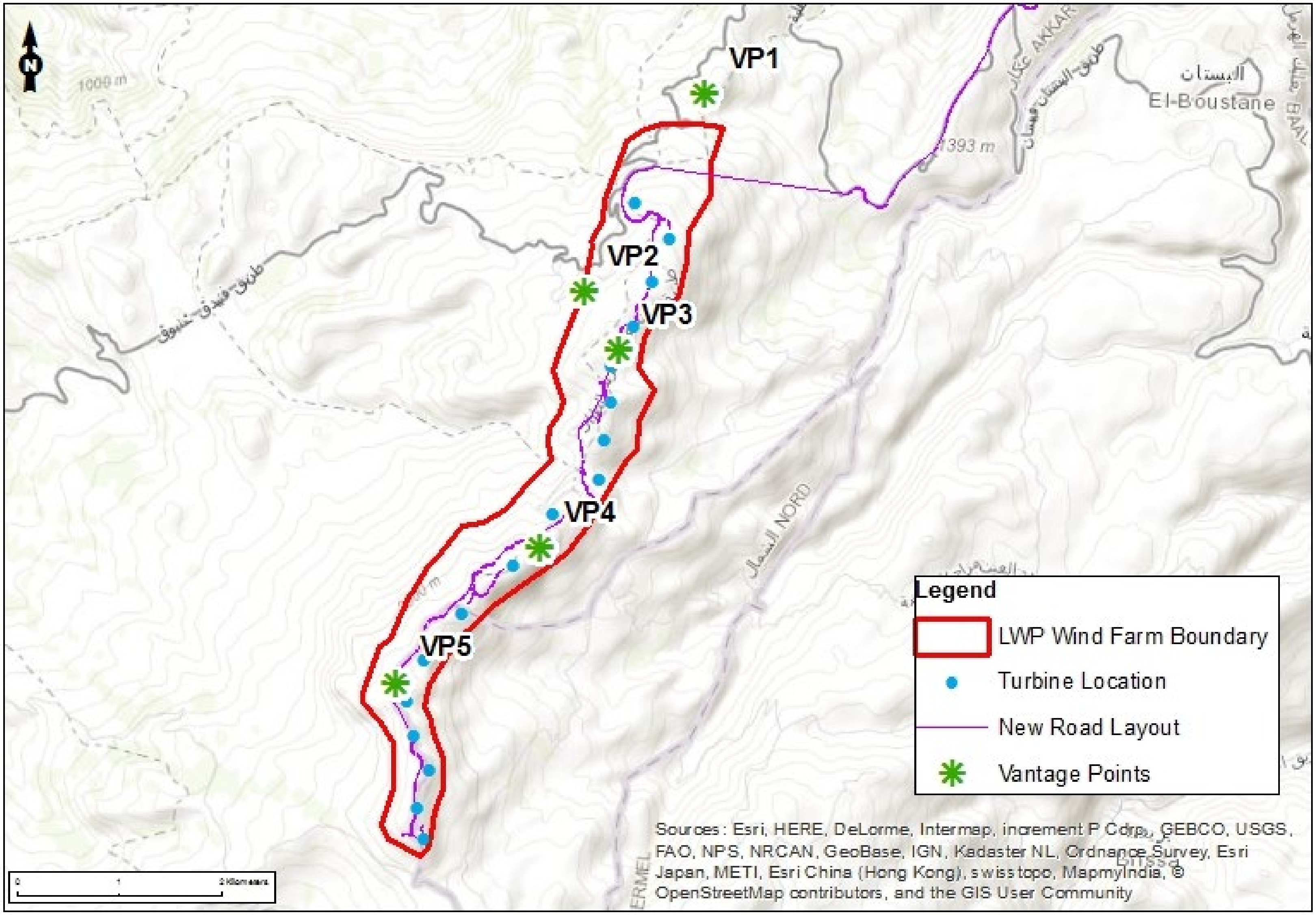


Table 15-2 Vantage Point Observations

Month	Aug	Sep	Oct	Mar	Apr	May	Aug	Sep	Oct
Years of observations	2017	2017	2017	2018	2018	2018	2018	2018	2018
VP numbers	1, 2, 3, 4 & 5			1, 2, 3, 4 & 5			1, 2, 3, 4 & 5		
Number of visits	2			2			2		
No. of observers	1	2	2	2	2	1	2	1	1
No. of observation hours	12 each visit	12 each visit	12 each visit	12 each visit	12 each visit	12 each visit	8 each visit	8 each visit	8 each visit

Table 15-3 Overall Distribution of Visits

Status/ Period												
Rearing/ Secretive												
Migration/ wintering												
Fall migration												
Spring migration												
Breeding												
Winterers												
Residents												
Surveys by the Author	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Years of surveys	2017	2017	2018	2018	2018	2018	2017	2017	2017	2017	2017	2017
Number of Visits	1	1	2	2	2	1	1	2	2	2	1	1
No. of Survey Hours	8	8	16	16	16	8	8	16	16	16	8	8

Status/ Period												
Surveys by the Trainees Two trained locals worked two days per week on the Project site.												
Years of Surveys	2018	2018	2018	2018	2018	2018	2017	2017	2017	2017	2017	2017
No. of Visits	8	8	8	8	8	8	8	8	8	8	8	8
No. of Survey Hours	64	64	64	64	64	64	64	64	64	64	64	64

15.1.2 Findings

The Mountains of Akkar-Donnieh Important Bird Area (IBA) is located immediately adjacent to the Project site, overlapping it by approximately 200 m for part of the Project's western boundary as shown in **Figure 15-4**. It contains habitats very similar to those found within the Project site, namely fir, pine and juniper dominated woodland types with high altitude sparsely vegetated alpine areas. The IBA trigger species are mostly small resident or breeding song birds:

- Sombre tit *Poecile lugubris*.
- Upcher's warbler *Hippolais languida*.
- Western rock nuthatch *Sitta neumayer*.
- White-throated robin *Irania gutturalis*.
- Finsch's wheatear *Oenanthe finschii*.
- Pale sparrow (also known as pale rock sparrow or pale rockfinch) *Carpospiza brachydactyla*.
- Syrian serin *Serinus syriacus*.

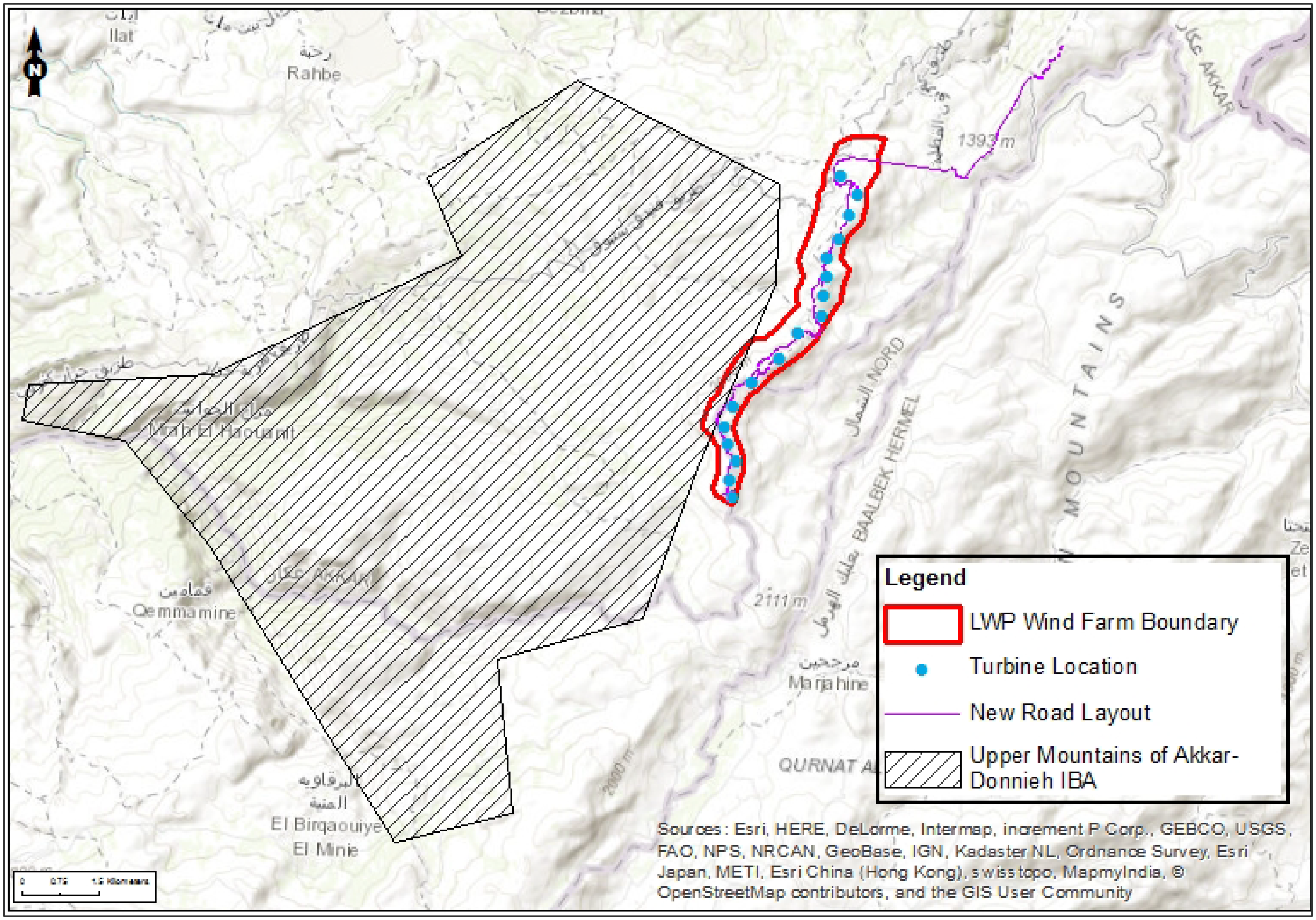
It is also noted that up to 50,000 soaring birds pass through the area each year, with the IBA being more important in the autumn when large flocks of levant sparrowhawk *Accipiter brevipes*, great white pelican *Pelecanus onocrotalus*, common crane *Grus grus* and white stork *Ciconia ciconia* pass over it[3].

The citation also lists the following species, although they are not classed as IBA trigger species:

- Tawny owl *Strix aluco*.
- Masked shrike *Lanius nubicus*.
- Sardinian warbler *Sylvia melanocephala*.
- Black-eared wheater *Oenanthe hispanica*.
- Crimson-winged finch *Rhodopechys sanguineus*.
- Black-headed bunting *Emberiza melanocephala*.

3 BirdLife International (2019) Important Bird Areas factsheet: Upper Mountains of Akkar-Donnieh. Downloaded from http://www.birdlife.org on 04/03/2019.

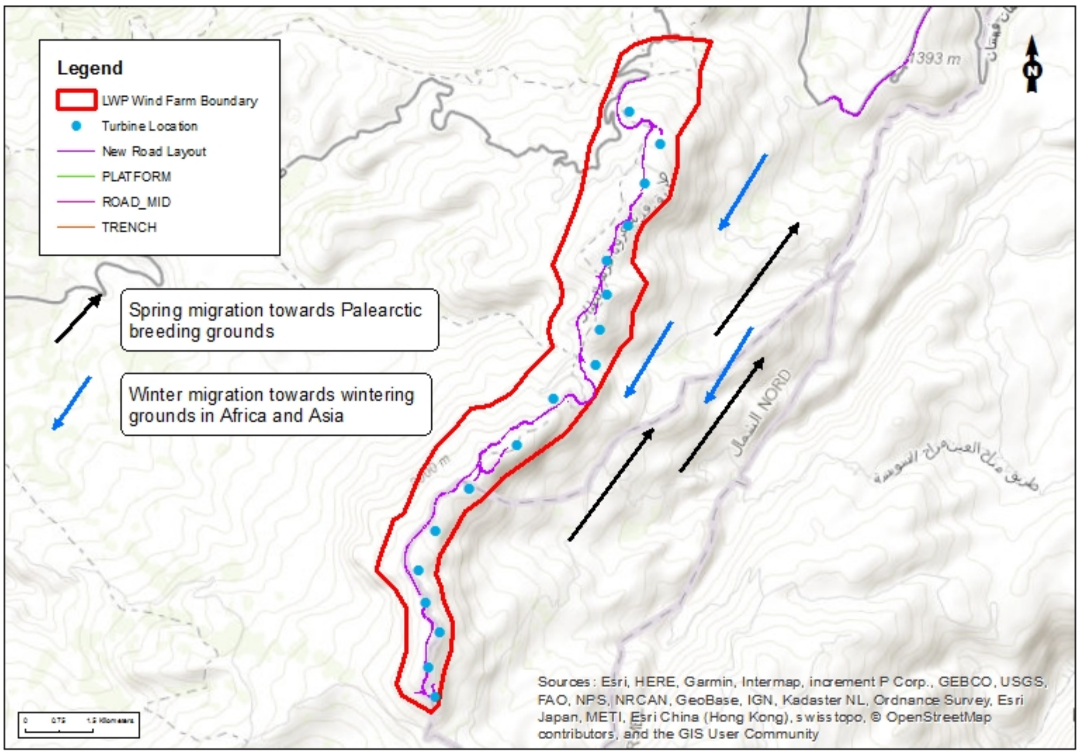
Figure 15-4 Upper Mountains of Akkar-Donnieh Relative to the Project



Flyways of Migratory Birds

Figure 15-5 shows the flyways of migratory birds. The study area crossed by the multicolored transect line is located to the west of the southern exit of the Oudine Valley (the dark blue line shows the topography of the area). The Oudine Valley is a bottleneck for migratory birds as they tend to fly through the valleys that cross the perpendicular mountainous hills ahead of them. In fact, the Oudine Valley leads the birds to a shallower valley along its direction NNE-SSW. This shallow valley continues south until it joins the Wadi Al Arayish of Zahleh, and it constitutes one of the main flyways of soaring migratory birds in Lebanon (Beale and Ramadan-Jaradi, 2001).

Figure 15-5 Indicative Flyways of Migratory Birds Near Study Area



The black and white arrows show the typical migration routes based on the records of the SPNL (BirdLife Intl. Partner) Center during the five years between 2012-2016. The top of the figure faces north-west. As such, the white arrows show spring migration of birds into their palearctic breeding grounds, with the black arrows showing their return journeys in autumn towards wintering grounds in Africa or Asia. The multicolored line corresponds to the line of the Lebanon Wind Power wind farm. The blue horizontal line shows the topography. The house represents the bird center of SPNL (BirdLife Partner).

At night, when the thermals that birds use to migrate are not present, birds will land and roost in trees or on the ground. At dawn the birds then start to fly again, using thermals that can then function again due to the warming effect of the sun. A key roosting location is located to the east and south-east of the proposed development.

Occurrence and Movement of Breeding Species

The occurrence of the 27 breeding bird species is affected by the time/season and altitude. The summer breeders arrive late and may start breeding at the lowest altitude before having a second brood at a higher altitude. For example, this is the case for the red-backed shrike *Lanius collurio*, which was observed at the Project site only from mid-May onwards. The localities of the higher densities of a species reflect the habitats of preference for this species.

The resistance of the breeding bird species to the higher wind levels on the Project site compared to the other study zones varies from one species to another. For example, rock bunting, western black redstart, horned lark, rock sparrow and wheatears *Oenanthe sp.* protect themselves by nesting in holes, cracks of rocks or in excavated small depressions below the rocks. They represent the species found at higher altitudes. Other species like the goldfinch, greenfinch *Carduelis chloris*, chaffinch *Fringilla coelebs*, and Eurasian blackbird *Turdus merula* need to nest in trees. Their high density is limited to the furthest zone. Lesser whitethroat breeds in a variety of habitats but at higher altitudes, the warbler nests in thick bushes of small juniper trees above 1,900m.

The wintering bird species (1/5 of the total avifauna recorded) are rare due to the harsh weather and because most of the breeding birds (common linnet, chaffinch, and goldfinch) descend to lower altitudes in winter. As for the migratory species, their occurrence is related to the corridors that are represented by the valleys and located outside the study area (see above). The wind blows most of the year, but it is at its minimum speed in September-October, a period during which the soaring birds are more numerous (adults and juveniles) and also benefit from the “thermals” instead of the “uplifts”. As such, they would fly high (even above the Lebanon Wind Power wind farm) before the thermals dissipate at higher altitudes.

Peaks of Passage of Vulnerable Birds

The present study and previous studies conducted by the ornithologist provide the periods of passage and the periods of peaks for the recorded soaring birds during the spring and autumn migration seasons, as shown in **Table 15-4** and **Table 15-5**. The peaks have not changed during the last two decades.

A total of 74 avian species and an additional three unidentified raptors[4] and seven unidentified passerines (mainly warblers and buntings) were observed during the surveys. Where species are considered to be potentially at risk to collision risk, further descriptions been given of the flight activity recorded.

Table 15-4 Spring Passage and Peaks for Some Soaring and Semi-soaring Birds

Spring Migration	March				April				May				June			
Lesser Spotted Eagle																
Levant Sparrowhawk																
Short-toed Snake Eagle																
Egyptian Vulture																

Note: Spring passage= light grey; Peaks= dark grey

[4] One harrier species, one eagle species and one buzzard species.

Table 15-5 Autumn Passage and Peaks (for Some Soaring and Semi-soaring Birds

Autumn Migration	August				September				October				November			
Lesser Spotted Eagle																
Honey Buzzard																
Levant Sparrowhawk																
Steppe Buzzard																
White Pelican																
White Stork																
Short-toed Snake Eagle																
Common Crane																
Greater Spotted Eagle																
Imperial Eagle																

Note: Autumn passage= light grey; Peaks= dark grey

Resident/Sedentary Species

Out of the 17 resident/sedentary breeding species, one (western black redstart *Phoenicurus ochruros*) is also a summer breeding species. The characteristic species of the highest areas of the Project site are:

- Rock sparrow *Petronia petronia*.
- Rock bunting *Emberiza cia*.
- Horned lark *Eremophila alpestris*.

Table 15-6 presents the list of the 17 resident/sedentary species breeding in the study area and their distribution over the Project site, mid and furthest zones. Passerines were by far the most dominant group; horned lark, rock bunting, rock sparrow and common linnet *Linaria cannabina* were the most abundant in the Project site (at the top of hills) and the coal tit *Periparus ater* was the most dominant below 1,700m in all zones (Ramadan-Jaradi, pers. comm.).

The only resident/sedentary species which is considered to have the potential to be at risk from collision with the turbines is common kestrel.

Table 15-6 List of Resident/Sedentary Species Breeding in the Study Area

Species Details	Photograph*
English name: Chukar partridge Scientific name: *Alectoris chukar* Status on the site: Rare resident. Does not breed in the Project site. Usually heard from a distance. Appeared in mid and furthest zones.	
English name: Common kestrel Scientific name: *Falco tinnunculus* Status on the site: One or two couples were frequently seen throughout the study area. Few appeared on passage and in winter. Present in Project site, mid and furthest zones. Kestrel flights were recorded during the migration season VP surveys in August 2017 and March, April, May, August, September and October 2018. The 16 flights recorded involved 23 birds, with no groups of more than three birds. Of the 23 birds recorded, five were recorded at collision risk height, with two of these also crossing the site. Kestrels were recorded during the year-round PC surveys in July, August, September and October 2017 and in March, April and May 2018. The 11 records involved 15 birds. Of these 15 birds, four were recorded at collision risk height, with two of these also crossing the site. Common kestrel are common and widespread in Lebanon. The population of common kestrels using the site are considered to be of site importance, a comprise four birds (the two couples described above).	
English name: Hooded crow Scientific name: *Corvus cornix* Status on the site: Resident. Not uncommon but was breeding out with the Project site in the mid and furthest zones.	

Species Details	**Photograph***
English name: Northern raven Scientific name: *Corvus corax* Status on the site: Known to be a rare resident breeding in Lebanon. Four were seen once in the mid-zone.	
English name: Great tit Scientific name: *Parus major* Status on the site: Uncommon resident and breeds in the furthest zone. Appeared scarcely in the Project site and mid-zone.	
English name: Coal tit Scientific name: *Periparus ater* Status on the site: Common resident and was breeding in all zones below 1,500m.	
English name: Horned lark Scientific name: *Eremophila alpestris* Status on the site: Not an uncommon breeding resident in the Project site and mid-zone above 1,500m.	

<table>
<tr><th>Species Details</th><th>Photograph*</th></tr>
<tr><td>English name: Winter wren

Scientific name: Troglodytes troglodytes

Status on the site: A resident species but recorded only at the entrance to the study area at 1,200m.</td><td>
</td></tr>
<tr><td>English name: Western rock nuthatch

Scientific name: Sitta neumayer

Status on the site: Uncommon resident breeding below 1,500m. Appeared in all zones. Important Bird Area trigger species.</td><td></td></tr>
<tr><td>English name: Eurasian blackbird

Scientific name: Turdus merula

Status on the site: Common resident breeding in the furthest zone below 1,500m.</td><td>
</td></tr>
<tr><td>English name: Western black redstart

Scientific name: Phoenicurus ochruros semirufa

Status on the site: Uncommon resident or summer breeder in the Project site and mid-zone up to 2,000m.</td><td></td></tr>
</table>

Species Details	Photograph*
English name: Rock sparrow Scientific name: *Petronia petronia* Status on the site: Common resident breeder in the Project site and mid-zone up to 2,400m.	
English name: Common chaffinch Scientific name: *Fringilla coelebs* Status on the site: Common resident breeder in the furthest zone. Dispersal in all zones up to 1,500m.	
English name: Greenfinch Scientific name: *Carduelis chloris* Status on the site: Common resident breeder in the furthest zone up to 1,400m.	
English name: Goldfinch Scientific name: *Carduelis carduelis* Status on the site: Common resident breeder in the furthest zone up to 1,400m.	

Species Details	Photograph*
English name: Common linnet Scientific name: *Linaria cannabina* Status on the site: Common resident breeder in all zones up to 2,000m.	
English name: Rock bunting Scientific name: *Emberiza cia* Status on the site: Common resident breeder in the Project site and mid-zone up to 2,400m.	

*Note: Courtesy of Dr. Ghassan Ramadan Jaradi

Summer Breeding Species

Nine summer breeding species were recorded. The most dominant were the common swift *Apus apus* and the lesser whitethroat *Sylvia curruca*. The summer breeding species recorded and their distribution over the Project site, mid and furthest zones are presented in **Table 15-7**.

The only summer breeding species considered have the potential to be at risk from collision with the turbines is short-toed snake eagle.

No owls were heard or seen, and no signs of owl activity were recorded.

Passage Migrants, Winter Visitors and Summer Visitors

Table 15-8 presents the spring passage migrant species, autumn passage migrants and the winter visitor species. The species status and the degree of occurrence (common, uncommon, scarce, rare and very rare) are based on the visits from January and February 2017, the visits of July to December 2017, and the visits of the spring migration season. Of the species recorded, 19% are common, 34% are uncommon, 25% are scarce, 11% are rare, and 11% are very rare.

Whilst the number of species passing in autumn is approximately double the number of those passing in spring, the latter are also, in their majority, rare. The rarity of species during the spring passage compared to that of the autumn passage is quite marked. Species accounts for the migratory species vulnerable to wind farm collisions (migratory raptors, storks, pelicans and cranes) are given in **Table 15-9**.

Table 15-7 List of Summer Breeding Species in the Study Area

Species Details	Photograph
English name: Short-toed snake eagle **Scientific name:** *Circaetus gallicus* **Status on the site:** There are two territories known within the mid zone, the closest nest site being more than 3km from the Project site. The species was seen over the mid-zone and Project site whilst searching for food, and during the autumn passage. Short-toed snake eagle flights were recorded during the migration season VP surveys in August 2017 and March, April, August, September and October 2018. The 10 flights recorded involved 24 birds, with no groups of more than seven birds. Of the 24 birds recorded, three were recorded at collision risk height, with one of these also crossing the site. Short-toed snake eagle were recorded during the year-round PC surveys in August, September and October 2017 and in April and May 2018. The 14 records involved 28 birds. Of these 28 birds, five were recorded at collision risk height, with none of these also crossing the site. Short-toed snake eagle are a common summer visitor to Lebanon and are frequent on passage. Over a five year period in the mid-nineties an average of 3,368 birds were recorded migrating over Palestine77F79F[5]. These birds are an insignificant part of the estimated European population of 35,100 – 41,800[6]. The short-toed snake eagle using the Project site are considered to be of international importance.	
English name: Long-legged buzzard **Scientific name:** *Buteo rufinus* **Status on the site:** Long-legged buzzard flights were recorded during the migration season VP surveys in August and September 2017 and March, April and October 2018. The five flights recorded involved six birds, with no groups of more than two birds. Of the six birds recorded, none were recorded at collision risk height or crossing the site. Long-legged buzzard was recorded during the year-round PC surveys in July 2017. The records involved a single bird and was not recorded at collision risk height or crossing the site. Long-legged buzzard are a rare summer migrant species in Lebanon and recorded in very small numbers. Over a five year period in the mid-nineties an average of 44 birds were recorded	

[5] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[6] https://www.iucnredlist.org/species/22734216/95078150#population, Accessed on 18th February 2019.

Species Details	Photograph
migrating over Israel[7,8]. These birds are an insignificant part of the estimated world population of 139,000 – 226,000 (Birdlife International, 2015)[9]. The long-legged buzzards using the Project site are considered to be of regional importance.	
English name: Common swift **Scientific name:** *Apus apus* **Status on the site:** Common breeder in the mid-zone but the species appeared in all zones, especially during the autumn passage.	
English name: Red-backed shrike **Scientific name:** *Lanius collurio* **Status on the site:** Uncommon breeder in the furthest and mid-zones below 1,400m but the species appeared in all zones, especially during the autumn dispersal and passage.	
English name: Barn swallow **Scientific name:** *Hirundo rustica* **Status on the site:** Common breeder in the furthest zone but the species appeared in all zones, especially during the autumn passage.	

[7] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.

[8] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.

[9] https://www.iucnredlist.org/species/22736562/118864048#population, Accessed on 18th February 2019.

Species Details	Photograph
English name: Little swift **Scientific name:** *Apus affinis* **Status on the site:** Rare breeder in the furthest zone up to 2,000m.	
English name: Pallid swift **Scientific name:** *Apus pallida* **Status on the site:** Rare breeder in the mid and furthest zone up to 2,400m.	
English name: Lesser whitethroat **Scientific name:** *Sylvia curruca* **Status on the site:** Common breeder in all zones up to 2,100m.	
English name: Northern wheatear **Scientific name:** *Oenanthe oenanthe* **Status on the site:** Common breeder in the Project site and mid-zone up to 2,400m. Also present as a migrant and winterer.	

Species Details	Photograph
English name: Mistle thrush **Scientific name:** *Turdus viscivorus* **Status on the site:** Rare summer breeder in furthest zone up to 1,500m. Also present as a migrant and winterer.	

Table 15-8 List of Migratory Species and Winter Visitor Species

English Name	Scientific Name	STATUS in Lebanon*	DEGREE OF OCCURRENCE									
			Zones *	FB	PMS	PMA	WV	Common	Uncommon	Scarce	Rare	Very Rare
Western White Stork	*Ciconia ciconia*	PM	1,2,3			1				1		
Great White Pelican	*Pelecanus onocrotalus*	PM	1,2,3			1				1		
Common Kestrel	*Falco tinnunculus*	r, PM, WV	1,2,3		1	1	1		1			
Honey Buzzard	*Pernis apivorus*	PM	1,2,3			1			1			
Black Kite	*Milvus migrans*	pm, wv	2,3			1			1			
Egyptian Vulture (CR)	*Neophron percnopterus* ***(EN)***	pm	1,2	1	1							1
Eurasian Griffon Vulture	*Gyps fulvus*	pm, wv, r, b	1,2	1		1						1
Short-toed Snake Eagle	*Circaetus gallicus*	SB, PM	1,2,3		1	1		1				
Levant Sparrowhawk	*Accipiter brevipes*	PM	2,3	1	1	1		1				
Eurasian Sparrowhawk	*Accipiter nisus*	PM, wv	1,2,3		1	1					1	
Common Buzzard	*Buteo b. buteo*	PM, WV	1,2,3			1	1			1		
Steppe Buzzard	*Buteo b. vulpinus*	PM, WV	1,2,3			1			1			
Long-legged Buzzard	*Buteo rufinus*	r, PM, wv	1,2,3			1						1
Lesser Spotted Eagle	*Clanga pomarina*	PM, wv, s	1,2,3		1	1	1		1			
Greater Spotted Eagle	*Clanga clanga* ***(VU)***	pm, wv	2			1						1
Booted Eagle	*Aquila pennata*	sb, pm, wv	2,3			1				1		

English Name	Scientific Name	STATUS in Lebanon*	DEGREE OF OCCURRENCE									
			Zones *	FB	PMS	PMA	WV	Common	Uncommon	Scarce	Rare	Very Rare
Common Crane	*Grus grus*	PM, wv	1,2,3			1				1		
Common Cuckoo	*Cuculus canorus*	sb, PM	3		1	1			1			
European Nightjar	*Caprimulgus europaeus*	PM, ?sb	2,3	1		1				1		
Alpine Swift	*Tachymarptis melba*	pm	1,2,3		1	1					1	
Common Swift	*Apus apus*	SB, PM	2		1	1		1				
European Bee-eater	*Merops apiaster*	PM	1,2,3			1			1			
Eurasian Hoopoe	*Upupa epops*	R, sb, PM, wv	3			1	1			1		
Woodchat Shrike	*Lanius senator*	PM	2,3			1						1
Masked Shrike	*Lanius nubicus*	sb, PM	2,3			1			1			
Barn Swallow	*Hirundo rustica*	SB, PM, wv	3		1	1	1	1				
Common House Martin	*Delichon urbicum*	SB, PM	3		1	1		1				
Willow Warbler	*Phylloscopus trochilus*	PM	2,3			1				1		
Eurasian Blackcap	*Sylvia atricapilla*	sb, PM, WV	3		1	1	1		1			
Lesser Whitethroat	*Sylvia curruca*	SB, PM, ?wv	2,3		1	1			1			
Common Whitethroat	*Sylvia communis*	sb, PM	3			1				1		
Eurasian Blackbird	*Turdus merula*	R, pm, wv	1		1	1	1	1				
Fieldfare	*Turdus pilaris*	pm, wv	1,3			1	1			1		
Redwing	*Turdus iliacus*	pm, WV	1,2			1					1	
Song Thrush	*Turdus philomelos*	PM, wv	1,2,3		1	1	1		1			
Mistle Thrush	*Turdus viscivorus*	sb, pm, WV	1,2,3		1	1	1		1			

English Name	Scientific Name	STATUS in Lebanon*	DEGREE OF OCCURRENCE									
			Zones *	FB	PMS	PMA	WV	Common	Uncommon	Scarce	Rare	Very Rare
Isabelline Wheatear	*Oenanthe isabellina*	SB, PM, wv	1,2			1			1			
Northern Wheatear	*Oenanthe Oenanthe*	sb, PM, wv	1,2		1	1			1			
Black-eared Wheatear	*Oenanthe hispanica*	sb, PM	1,2		1	1			1			
Spotted Flycatcher	*Muscicapa striata*	sb, PM	3		1	1				1		
Alpine Accentor	*Prunella collaris*	pm	2,3			1					1	
Common Chaffinch	*Fringilla coelebs*	R, PM, WV	3		1	1	1	1				
European Greenfinch	*Carduelis chloris*	R, WV, pm	3		1	1	1	1				
European Goldfinch	*Carduelis carduelis*	R, WV, pm	3		1	1	1	1				
Corn Bunting	*Emberiza calandra*	R, PM, WV	2		1		1		1			
Ortolan Bunting	*Emberiza hortulana*	sb, PM	2		1	1				1		
Black-headed Bunting	*Emberiza melanocephala*	SB, PM	2,3			1					1	
Totals	***47***			**4**	**25**	**45**	**15**	**9**	**16**	**12**	**5**	**5**

*Notes: R= Resident with definite breeding record; SB= Breeding summer visitor; S= Non-breeding summer visitor; WV= Winter visitor; SPM= Spring passage migrant; APM= Autumn passage migrant; FB= Formerly bred: no breeding records since 1987; V= Vagrant; e= Extinct in Lebanon, if any; CR= Critically Endangered as per Birdlife International 2018; EN= Endangered as per Birdlife International 2018; VU= Vulnerable as per Birdlife International 2018; NT= Near Threatened as per Birdlife International 2018; Lower case abbreviations eg. r, sb, s, wv, pm=Species uncommon or rare; zone 1: Project site; zone 2: mid-zone; zone 3: furthest zone; question mark (?) indicates uncertain status.

Table 15-9 Species Accounts of Migratory Raptors

Species	Species Account
Western White Stork	White stork flights were recorded during the migration season VP surveys in August and September 2017 and March and September 2018. The five flights recorded involved 39 birds, with groups of two, four, seven, 11 and 15 birds recorded. Of the 39 birds recorded, six were recorded at collision risk height, with none of these also crossing the site. White stork was recorded during the year-round PC surveys in September 2017. The two records involved 34 birds. Of these 34 birds, none were recorded at collision risk height or crossing the site. White storks are a common summer migrant species in Lebanon and recorded in large numbers. Over a five-year period in the mid-nineties an average of 359,085 birds were recorded migrating over Israel[10, 11]. These birds are a significant part of the estimated European population of 447,000–495,000 (Birdlife International, 2015)[12]. The white storks using the Project site are considered to be of international importance.
Great White Pelican	White pelican flights were recorded during the migration season VP surveys in August 2017. The two flights recorded involved 34 birds, with groups of 11 and 23 birds. Of the 34 birds recorded, none were recorded at collision risk height or crossing the site. White pelican was recorded during the year-round PC surveys in September 2017. The sole record involved 20 birds. This group was recorded at collision risk height, but not crossing the wind farm site. Great white pelicans are a common summer migrant species in Lebanon and recorded in large numbers. Over a twenty-year period between 1993 and 2013 an average of 39,395 birds were recorded migrating over Israel[13, 14]. The estimated European population is between 9,700–11,100 birds (Birdlife International, 2015)[15], suggesting that the birds migrating over Lebanon include birds from other populations too. The great white pelicans using the Project site are considered to be of international importance.
Honey Buzzard	Honey buzzard flights were recorded during the migration season VP surveys in August and September 2017 and March, April, May, August, October and November 2018. The 13 flights recorded involved 83 birds, with no groups of more than 16 birds. Of the 83

[10] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[11] Van den Bossche, W., Berthold, P., Kaatz, M., Nowak, E. & Querner, U. (2002) Eastern European White Stork Populations: Migration Studies and Elaboration of Conservation Measures. German Federal Agency for Nature Conservation, BfN – Skripten
[12] https://www.iucnredlist.org/species/22697691/86248677#population, Accessed on 18th February 2019.
[13] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[14] Labinger, Z. & Hatzofe, O. (2014) Great White Pelican Migration over Palestine: Management of Ecological Demands and Conflicts with Inland Fisheries. Summary of the International Workshop.
[15] https://www.iucnredlist.org/species/22697590/132595920, Accessed on 18th February 2019.

Species	Species Account
	birds recorded, 77 were recorded at collision risk height, with 24 of these also crossing the site. Honey buzzard was recorded during the year-round PC surveys in August and September 2017 and in May 2018. The six records involved 53 birds. Of these 53 birds, 29 were recorded at collision risk height, with 28 of these also crossing the site. Honey buzzards are a common summer migrant species in Lebanon and recorded in large numbers. An average of 437,000 birds were recorded migrating over Israel[16,17]. These birds are a significant part of the estimated world population of 280,000–420,000 (Birdlife International, 2015)[18]. While it is noted that the global population has decreased between these population estimates, the clear pattern is that a significant proportion of the global population migrates over Lebanon. The honey buzzards using the Project site are considered to be of international importance.
Black Kite	Black kite flights were recorded during the migration season VP surveys in August 2017 and May and September 2018. The five flights recorded involved 14 birds, with no groups of more than six birds. Of the 14 birds recorded, three were recorded at collision risk height, with one of these also crossing the site. Black kite was recorded during the year-round PC surveys in August, September and October 2017 and in April and May 2018. The 14 records involved 28 birds. Of these 28 birds, none were recorded at collision risk height or crossing the site. Black kites are a summer migrant species in Lebanon and recorded in medium numbers. Over a five-year period in the mid-nineties an average of 1,636 birds were recorded migrating over Israel[19,20]. These birds are a significant part of the estimated European population of 162,000–218,000 (Birdlife International, 2015)[21]. The black kites using the Project site are considered to be of national importance.
Egyptian Vulture	An Egyptian vulture flight was recorded during the migration season VP surveys in September 2017. The flight recorded involved a single bird which was not recorded at collision risk height or crossing the site.

[16] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[17] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[18] https://www.iucnredlist.org/species/22694989/93482980#population, Accessed 18th February 2019.
[19] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[20] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[21] https://www.iucnredlist.org/species/22734972/95097654#population, Accessed on 18th February 2019.

Species	Species Account
	Egyptian vultures were not recorded during the year-round PC surveys. Egyptian vultures are listed as endangered on the IUCN red list[22]. Egyptian vultures are a rare summer migrant species in Lebanon and recorded in small numbers. Over a five-year period in the mid-nineties an average of 143 birds were recorded migrating over Israel[23, 24]. These birds are an insignificant part of the estimated European population of 6,000–9,400 (Birdlife International, 2015)[25]. The Egyptian vultures using the Project site are considered to be of regional importance.
Eurasian Griffon Vulture	A Griffon vulture flight was recorded during the migration season VP surveys in August 2018. The flight involved one bird. The bird recorded was flying at collision risk height but did not cross the site. A griffon vulture was recorded during the year-round PC surveys in May 2018. The bird was not recorded at collision risk height or crossing the site. Eurasian griffon vultures are a rare summer migrant species in Lebanon and recorded in very small numbers. Over a five-year period in the mid-nineties an average of 38 birds were recorded migrating over Israel[26, 27]. These birds are an insignificant part of the estimated European population of 64,800–68,800 (Birdlife International, 2015)[28]. The Eurasian griffon vultures using the Project site are considered to be of regional importance.
Levant Sparrowhawk	Levant sparrowhawk flights were recorded during the migration season VP surveys in August and September 2017 and March, April, August, September, October and November 2018. The 12 flights recorded involved 114 birds, with three groups of 20 or more birds. Of the 114 birds recorded, 22 were recorded at collision risk height, with 10 of these also crossing the site. Levant sparrowhawk was recorded during the year-round PC surveys in October 2017 and in April 2018. The three records involved 54 birds. Of these 54 birds, one was recorded at collision risk height and crossing the site. Levant sparrowhawk are a common summer migrant species in Lebanon and recorded in large numbers. An average of 44,000 birds

[22] BirdLife International 2017. Neophron percnopterus (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22695180A118600142. http://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22695180A118600142.en. Downloaded on 04 March 2019.
[23] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[24] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[25] https://www.iucnredlist.org/species/22695180/118600142, Accessed on 18th February 2019.
[26] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[27] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[28] https://www.iucnredlist.org/species/22695219/118593677#population, Accessed on 18th February 2019.

Species	Species Account
	were recorded migrating over Israel[29, 30]. These birds are a significant part of the estimated world population of 10,000–19,999 (Birdlife International, 2015)[31]. While it is noted that the global population has decreased between these population estimates, the clear pattern is that a significant proportion of the global population migrates over Lebanon. The levant sparrowhawk using the Project site are considered to be of international importance.
Eurasian Sparrowhawk	Eurasian sparrowhawk flights were recorded during the migration season VP surveys in August 2017 and May and October 2018. The three flights recorded each involved a single bird. Of the three birds recorded, none were recorded at collision risk height or crossing the site. A Eurasian sparrowhawk was recorded during the year-round PC surveys in September 2017. This record involved a single bird and was recorded at collision height passing through the site. Eurasian sparrowhawks are a summer migrant species in Lebanon and recorded in small numbers. Over a five-year period in the mid-nineties an average of 520 birds were recorded migrating over Israel[32, 33]. These birds are an insignificant part of the estimated European population of 805,000–1,160,000 (Birdlife International, 2015)[34]. The Eurasian sparrowhawks using the Project site are considered to be of regional importance.
Common Buzzard	Common buzzard flights were recorded during the migration season VP surveys in September 2017 and April, May and September 2018. The seven flights recorded involved 21 birds, with no groups of more than 8 birds. Of the 21 birds recorded, one was recorded at collision risk height and crossing the site. Common buzzard was recorded during the year-round PC surveys in September 2017. The three records involved five birds. Of these five birds, one was recorded at collision risk height and crossing the site. Common buzzards and steppe buzzard, which are a subspecies of common buzzards, are a summer migrant species in Lebanon and recorded in medium numbers. These birds are difficult to separate in the field and have been classed together in previous surveys. Over a five-year period in the mid-nineties an average of 1,835

[29] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[30] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[31] https://www.iucnredlist.org/species/22695499/131936047#population, Accessed on 18th February 2019.
[32] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[33] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[34] https://www.iucnredlist.org/species/22695624/93519953#population, Accessed on 18th February 2019.

Species	Species Account
	common/steppe buzzards were recorded migrating over Israel[35] [36]. These birds are an insignificant part of the estimated European population of 1,630,000–2,770,000 (Birdlife International, 2015)[37]. The common buzzards using the Project site are considered to be of regional importance.
Steppe Buzzard	Steppe buzzard flights were recorded during the migration season VP surveys in August 2017 and March, May and October 2018. The four flights recorded involved 10 birds, with no groups of more than three birds. Of the 10 birds recorded, all were recorded at collision risk height, with six of these also crossing the site. Steppe buzzard was recorded during the year-round PC surveys in September and October 2017. The eight records involved 29 birds. Of these 29 birds, five was recorded at collision risk height with no flights crossing the site. An estimate for the global population for steppe buzzard has been calculated as the global population estimate minus the European population estimate. It is understood that this will be a conservative estimate. The population estimate is 540,000–920,000 (Birdlife International, 2015)[38]. The steppe buzzards migrating through Lebanon are an insignificant part of this estimated population. The steppe buzzards using the project set are considered to be of regional importance.
Lesser Spotted Eagle	Lesser spotted eagle flights were recorded during the migration season VP surveys in August 2017 and March, May and October 2018. The five flights recorded involved 19 birds, with no groups of more than 12 birds. Of the 19 birds recorded, five were recorded at collision risk height, with two of these also crossing the site. Lesser spotted eagle was recorded during the year-round PC surveys in September 2017 and in March and April 2018. The six records involved nine birds. Of these nine birds, two were recorded at collision risk height, with none crossing the site. Lesser spotted eagles are a common summer migrant species in Lebanon and recorded in large numbers. Over a five-year period in the mid-nineties an average of 141,000 birds were recorded migrating over Israel[39], [40]. These birds are a significant part of the estimated world population of 44,900–60,500 (Birdlife International, 2015)[41]. While it is noted that the global population has decreased

[35] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[36] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[37] https://www.iucnredlist.org/species/61695117/119279994#population, Accessed on 18th February 2019.
[38] https://www.iucnredlist.org/species/61695117/119279994#population, Accessed on 18th February 2019.
[39] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[40] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[41] https://www.iucnredlist.org/species/22696022/93539187#population, Accessed on 18th February 2019.

Species	Species Account
	between these population estimates, the clear pattern is that a significant proportion of the global population migrates over Lebanon. The lesser spotted eagles using the Project site are considered to be of international importance.
Greater Spotted Eagle	Greater spotted eagle flights were recorded during the migration season VP surveys in May 2018. This flight of a single bird was not at collision risk height and did not cross the site. Greater spotted eagle was recorded during the year-round PC surveys in October 2017. The record involved a single bird not at collision risk height and did not cross the site. Greater spotted eagles are a rare summer migrant species in Lebanon and recorded in very small numbers. Over a five-year period in the mid-nineties an average of 45 birds were recorded migrating over Israel[42],[43]. These birds are an insignificant part of the estimated world population of 5,000–13,200 (Birdlife International, 2015)[44]. The greater spotted eagles using the Project site are considered to be of regional importance.
Imperial Eagle	No imperial eagles were recorded during the migration season VP surveys. Imperial eagle was recorded during the year-round PC surveys in October 2017. The record involved a single bird not at collision risk height and did not cross the site. Imperial eagles are a rare summer migrant species in Lebanon and were recorded in very small numbers. Over a five-year period in the mid-nineties an average of 9 birds were recorded migrating over Israel[45],[46]. These birds are an insignificant part of the estimated world population of 3,750–14,999 (Birdlife International, 2015)[47]. The imperial eagles using the Project site are considered to be of regional importance.
Booted Eagle	Booted eagle flights were recorded during the migration season VP surveys in August 2017 and March and October 2018. The three flights recorded involved three birds. Of the three birds recorded, none were recorded at collision risk height or crossing the site. Booted eagle was recorded during the year-round PC surveys in October 2017. The sole record involved a single bird, not at collision risk height or crossing the site.

[42] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[43] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[44] https://www.iucnredlist.org/species/22696027/110443604#population, Accessed on 18th February 2019.
[45] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[46] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[47] https://www.iucnredlist.org/species/22696048/117070289#population, Accessed on 18th February 2019.

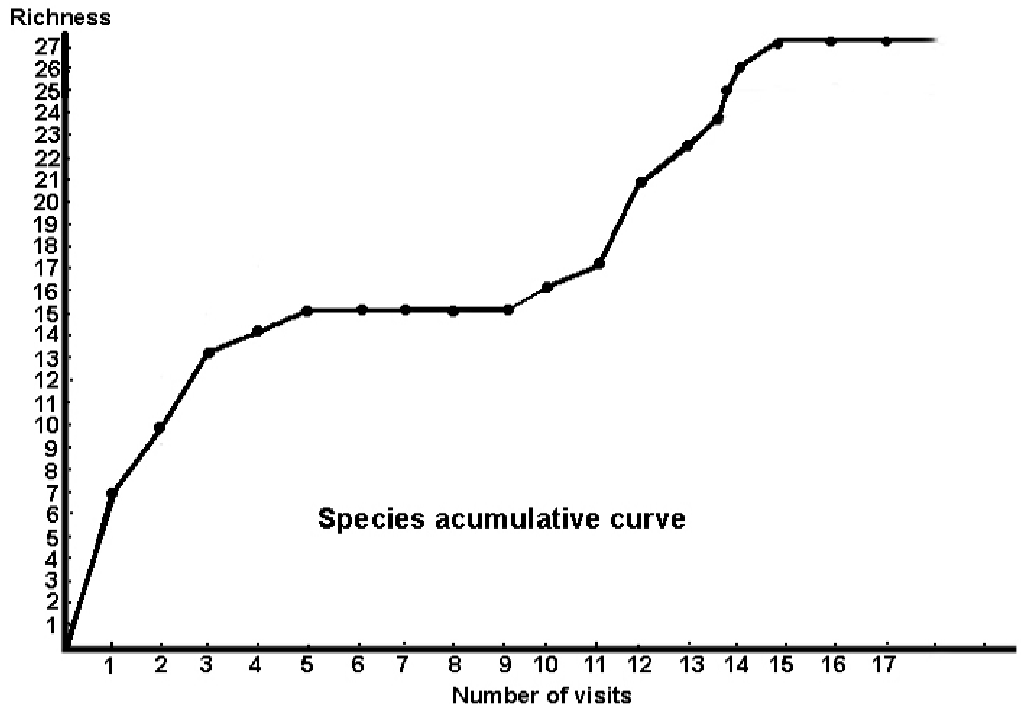
Species	Species Account
	Booted eagles are a rare summer migrant species in Lebanon and recorded in small numbers. Over a five-year period in the mid-nineties an average of 621 birds were recorded migrating over Israel[48, 49]. These birds are an insignificant part of the estimated world population of 149,000–188,000 (Birdlife International, 2015)[50]. The booted eagles using the Project site are considered to be of regional importance.
Common Crane	Common crane flights were recorded during the migration season VP surveys in March, April and September 2018. The five flights recorded involved 44 birds, with no group of more than 23 birds. Of the 44 birds recorded, 15 were recorded at collision risk height, with none of these also crossing the site. Common crane was recorded during the year-round PC surveys in October 2017. The record involved nine birds not flying at collision risk height and not crossing the site. Common cranes are a common summer migrant species in Lebanon and recorded in large numbers. Of the approximately 120,000 birds that migrate over south over Hungary[51], approximately 7,000 break off and migrate over Italy[52], leaving approximately 113,000 which continue to the middle east. These birds are a significant part of the estimated world population of 490,000–504,999 (Birdlife International, 2015)[53]. The common cranes using the Project site are considered to be of international importance.

Richness of Breeding Species

The total number of breeding species is 27 bird species (17 resident/sedentary and 10 summer breeding) obtained through the point counts method. A species accumulative curve was developed in order to test whether maximum species richness was reached. The species accumulation curve continued to increase until it reached the first final asymptote at the 5th visit, with the resident/sedentary species. The arrival of the summer breeders made the curve increase again until the second final asymptote at the 15th visit, as shown in **Figure 15-6**.

[48] Palestine is used as a proxy for Lebanon as it is on the same flyway and has been more thoroughly recorded for bird passage.
[49] Shirihai, Hadoram & Yosef, Reuven & Alon, Dan & Kirwan, Guy & Spaar, Reto. (2000). Raptor Migration in Palestine and the Middle East: A Summary of 30 Years of Field Research.
[50] https://www.iucnredlist.org/species/22696092/93543946#population, Accessed on 18th February 2019.
[51] Prange, H., (2005) The Status of the Common Crane (Grus grus) in Europe - Breeding, Resting, Migration, Wintering, and Protection. North American Crane Workshop Proceedings. 38.
[52] Mingozzi, Toni & Storino, Pierpaolo & Venuto, Gianpalmo & Alessandria, Gianfranco & Arcamone, Emiliano & Urso, Salvatore & Ruggieri, Luciano & Massetti, Luciano & Massolo, Alessandro. (2013). Autumn Migration of Common Cranes Grus grus Through the Italian Peninsula: New Vs. Historical Flyways and Their Meteorological Correlates. Acta Ornithologica. 48. 165-177. 10.3161/000164513X678810.
[53] https://www.iucnredlist.org/species/22692146/86219168#population, Accessed on 18th February 2019.

Figure 15-6 Cumulative Richness Curve of Birds at the Lebanon Wind Power Site



Since two species were recorded only once (a) during the 17 visits (n), the formula of the curve (a/n) indicates that, theoretically, 10 more visits are needed to obtain one more species (Ramadan-Jaradi, 1984).

Flight Heights and Flightlines for Priority Species

Table 15-10 shows the percentage of individuals/species in each of the altitudinal bands as observed from vantage points during autumn 2017, spring 2018 and autumn 2018. **Figure 15-07** shows indicative flightlines of priority species as observed during the field campaign.

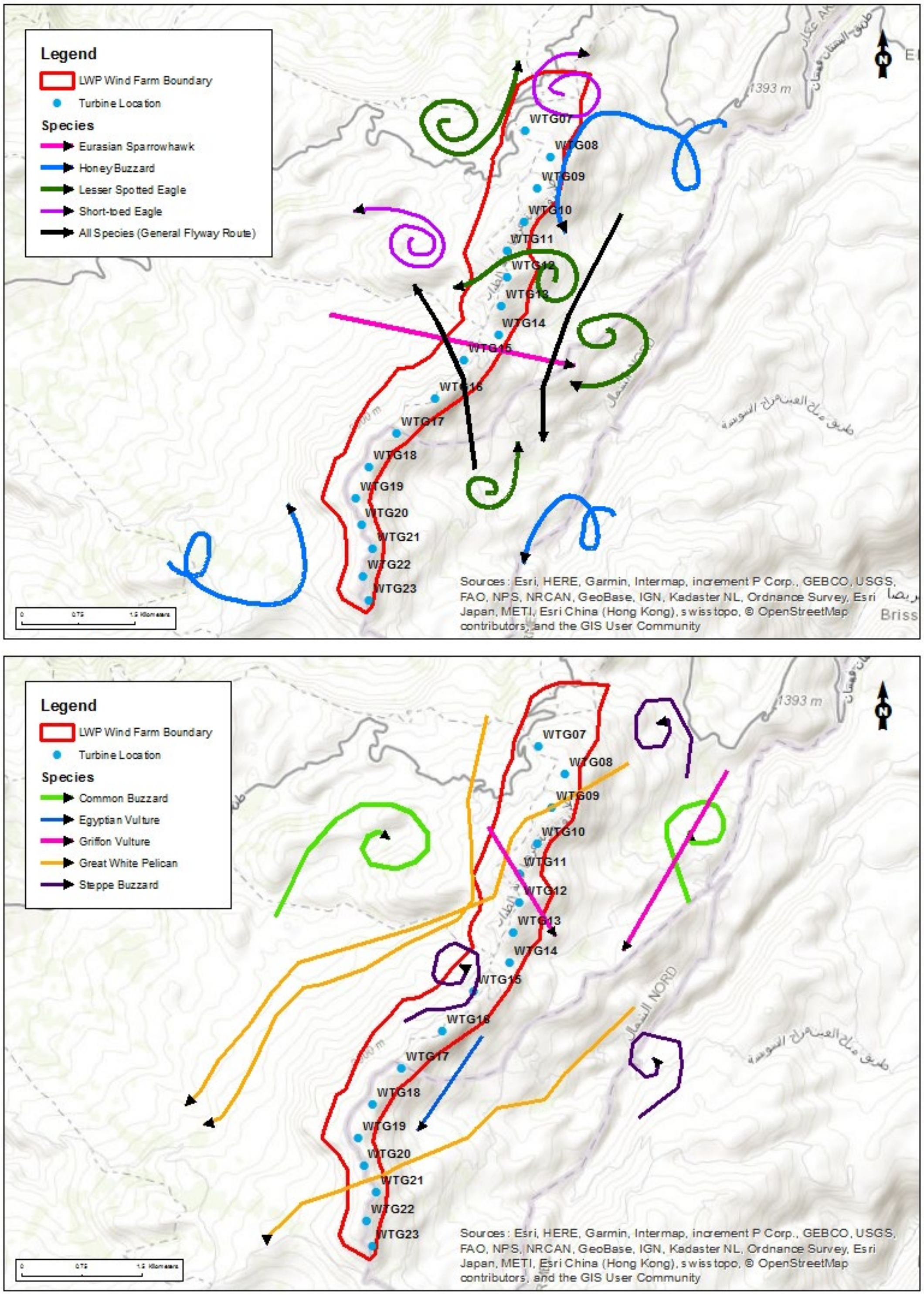
Based on the vantage point surveys, two species dominated the majority of observations: hooded crow *Corvus cornix* and common kestrel, not because of being an abundant species but due to their common and regular frequentation of the Project site with small or medium numbers. The hooded crow appeared with a mean frequency of 0.85 (per 20-minute unit) whereas the common kestrel was seen with a mean frequency of 0.82. These two species are followed in importance by another five species, including three residents (rock bunting, common linnet and horned lark) and two summer breeders (lesser whitethroat and common swift). Together, these seven species comprised nearly half the frequencies of all recorded species and 38% of birds observed during the vantage point surveys.

Table 15-10 Distribution of Percentage of Individuals of Each Priority Bird Species Recorded Per Height Band over Study Area, Including Project Immediate Study Zone, Middle Study Zone and Furthest Study Zone

Flight Heights of Soaring Species (m)	<50	50-100	100-150	150-200	200-300	300-400	400-500	500-600	600-700	700-800	≥800	Total %
Lesser Spotted Eagle (SA)			10		14	28	29		19			100
Honey Buzzard (SA)		4	19	30	22		25					100
Levant Sparrowhawk (SA)			13			52				35		100
Eurasian Sparrowhawk (A)			25			75						100
Short-toed Snake Eagle (SA)			23	19	19	9	10	20				100
Egyptian Vulture (A)									100			100
Griffon Vulture (A)			50								50	100
Common Buzzard (A)			16	24	31	11	18					100
Steppe Buzzard (A)		1	19			34	22	17	7			100
White Pelican (A)			41				59					100
White Stork (A)			19			81						100
Greater Spotted Eagle (A)							100					100
Common Kestrel (SA)		9	16	75								100
Long-legged Buzzard (SA)	2		31	37	26	4						100
Common Crane (A)			18		49	33						100
Booted Eagle (A)					100							100

*Note: S: recorded in Spring, A: recorded in Autumn and SA in both.

Figure 15-7 Indicative Flightlines of Priority Species



*Note: LSE: Lesser Spotted Eagle; HB: Honey Buzzard; LSH: Levant Sparrowhawk; ESH: Eurasian Sparrowhawk; STE: Short-toed Eagle; EV: Egyptian Vulture; GV: Griffon Vulture; CB: Common Buzzard; SB: Steppe Buzzard; GWP: Great White Pelican.

Rock bunting, common linnet and horned lark were characteristic of the Project site above 1,800m, where they were commonly recorded, but their distribution in a range between c.1,800m and c.2,100m has reduced their frequencies.

Lesser whitethroat is a summer breeding species from sea level to c.2,000m above sea level. This species is not like the rock bunting, common linnet and horned lark, which were limited in their distribution within the study area, as its distribution is limited to a certain period of time during the year (mainly May-June). The reason is that this species is flexible in choosing its breeding sites, which made it occupy the 6th rank among the species that dominated the majority of observations.

The most abundant raptor species observed were, in order, short-toed snake eagle, honey buzzard *Pernis apivorus*, levant sparrowhawk and lesser spotted eagle *Clanga pomarina* (in the Project site and mid-zone). On average, approximately one short-toed snake eagle was observed every four surveys, one honey buzzard every 3.8 surveys, one levant sparrowhawk every 3.5 surveys and one lesser spotted eagle every two surveys. The latter species are likely to nest in inaccessible areas located beyond the furthest study zone.

15.1.3 Summary

The baseline assessment has identified a number of key biodiversity features which require further consideration within the assessment. These are summarised in **Table 15-11**. Potential impacts on the features are detailed in **Section 16.2**.

Table 15-11 Summary of Importance of Biodiversity Features

Feature	Importance	Justification
Designated Site (Upper Mountains of Akkat Donnieh IBA) Migratory Bird Species	International	The IBA contains an assemblage of upland woodland birds as well as listing upwards of 50,000 migratory soaring birds passing through the area each year. The site is considered to be of international importance.

15.2 Assessment of Potential Impacts

15.2.1 Methodology

In order to follow best practice guidance on ecological impact assessment[54], the biodiversity impact assessment follows a similar approach to the other assessments within this ESIA. Features are evaluated, and impacts are characterised in a similar fashion. However, rather than a matricised approach which provides a scale of impact significance from negligible to critical, it follows an approach of identifying whether an impact would lead to an "ecologically significant effect" for the feature, e.g. species or habitat type. An ecologically significant effect is an effect that either undermines or, in the case of a positive impact, supports biodiversity conservation objectives for 'important ecological features' (as explained in **Section 16.2**) or for biodiversity in general.

[54] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.

Feature Evaluation

Habitats and species (i.e. biodiversity features) identified within the study area have been assigned values using the standard CIEEM scale that classifies biodiversity features within a defined geographic context[55]. The classification uses recognized and published criteria[56],[57] where the biodiversity features are assessed in relation to their size, diversity, naturalness, rarity, fragility, typicalness, connectivity with surroundings, intrinsic value, recorded history and potential value. **Table 15-12** describes the frame of reference that has been used for the impact assessment.

Criteria for Characterizing Impacts

The potential impacts upon biodiversity features have been considered in relation to the Project. The impacts have been assessed without consideration of any specific mitigation measures that might be employed. The assessment of likely impacts has been made in relation to the baseline conditions of the study area. The likely impacts of development activities upon biodiversity features have been characterized as set out in **Section 16.2** and as detailed in **Table 15-13**. It is noted that the assessment only describes those characteristics relevant to understanding the impact and determining the significance of the effect.

Significance Criteria

Impact significance was evaluated using the approach specified in Annex 9 of Decision 261/1 (June 2015) for the review of EIA studies at the MOE, whereby various sources of impacts are addressed for the Project's different implementation phases. Significant effects are assessed with reference to the geographical importance of the biodiversity feature.

However, the scale of significance of an effect may not be the same as the geographic context in which the feature is considered important. For example, an effect on a species which is on a national list of species of principal importance for biodiversity may not have a significant effect on its national population.

The potential for significant effects, in the absence of mitigation, has been determined with reference to the geographic conservation importance and the criteria in **Table 15-12**. By referring to the criteria in **Table 15-13**, the assessment seeks to characterize the magnitude of the effects in space and time.

Mitigation and/or compensation is proposed for all effects considered to be significant. Where appropriate, as a good practice measure, additional controls and/or compensation may be proposed.

Residual effects are characterized as either positive or adverse and either significant or not significant, taking account of mitigation and/or compensation proposals.

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[55] Ibid

[56] Ratcliffe, D. (1977), *A Nature Conservation Review*. Cambridge: Cambridge University Press.

[57] Wray, S., Wells, D., Long, E. and Mitchell-Jones, T. (2010), *Valuing Bats in Ecological Impact Assessment*. In Practice. December 2010 pp23-25. Winchester: CIEEM.

Table 15-12 Geographic Importance

Geographic Importance	Examples
International	Internationally designated sites including Important Bird Areas (IBA) other Key Biodiversity Areas (KBA) Ramsar Site, Biogenetic Reserve, World Heritage Site, Biosphere Reserve, and potential Ramsar Sites; discrete areas which meet the published selection criteria for international designation, but which are not themselves designated as such. Resident or regularly occurring populations of species which may be considered at an international level, the loss of which would adversely affect the conservation status or distribution of the species at an international level; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
National	Nationally designated sites, Nature Reserves Marine Nature Reserve; discrete areas which meet the published selection criteria for national designation, but which are not designated as such. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across Lebanon or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Regional	Viable areas of key habitat identified as being of Regional value or smaller areas of such habitat which are essential to maintain the viability of a larger whole. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the region; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.
Local	Features of local value include areas of habitat or populations/communities of species considered to appreciably enrich the habitat resource within the immediate surrounding area, for example, species-rich hedgerows. Resident or regularly occurring populations of species, the loss of which would adversely affect the conservation status or distribution of the species across the immediate surrounding area; or where the population forms a critical part of a wider population; or the species is at a critical phase of its life cycle.

Table 15-13 Impact Characterization

Parameter	Description
Direction	Impacts are either adverse (negative) or positive.
Magnitude	This is defined as high, moderate, low or negligible, with these being classified using the following criteria: High: Total/near total loss of a population due to mortality or displacement or major reduction in the status or productivity of a population due to mortality or displacement or disturbance. Total/near total loss of a habitat. Medium: Partial reduction in the status or productivity of a population due to mortality or displacement or disturbance. Partial loss of a habitat. Low: Small but discernible reduction in the status or productivity of a population due to mortality or displacement or disturbance. Small proportion of habitat lost. Negligible: Very slight reduction in the status or productivity of a population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. Slight loss of habitat that is barely discernible from the habitat resource as a whole.
Extent	The area over which an impact occurs, i.e. the impact's area of influence.
Duration	The time for which the impact is expected to last prior to recovery of the biodiversity feature or replacement of the feature by similar resource (in terms of quality and/or quantity). This is expressed as a short term, medium term, or long term effect relative to the biodiversity feature that is impacted.
Reversibility	Irreversible impacts: permanent changes from which recovery is not possible within a reasonable time scale or for which there is no reasonable chance of action being taken to reverse it. Reversible impact: temporary changes in which spontaneous recovery is possible or for which effective mitigation (avoidance/cancellation/reduction of impact) or compensation (offset/recompense/offer benefit) is possible.
Frequency and timing	The number of times an activity occurs will influence the resulting effect (if appropriate, described as low to high and quantified, where possible). The timing of an activity or change may result in an impact if it coincides with critical life-stages or seasons e.g. the badger breeding season.

Collision Risk Assessment

Collision risk models are used to predict the potential collision risk that a development presents to flying birds. There are many different models that have been proposed, each with their own strengths and weaknesses. This assessment has been undertaken following the "Band" Model"[58] developed by Scottish Natural Heritage. This model is the accepted method of collision risk assessment used on wind farm developments in the United Kingdom. It is a simple model with the only inputs relating to the bird species recorded and the design of the wind farm/individual turbines. For this reason, the model can be applied to the Project. The Band Model can be used to assess two scenarios:

1. Where birds are recorded making regular flights across a proposed wind farm location.
2. Where birds are recorded regularly using the airspace of a proposed wind farm location.

<u>Scenario 1: Birds Making Regular Flights Across the Project Site</u>

In this scenario, birds are transiting the Project site twice each year: Once migrating north in the spring, and again migrating south in the autumn. This method is relevant for all but two of the species for which collision risk is considered to present a potential risk. All species, apart from common kestrel and short-toed snake eagle, pass the Project site only during the spring and autumn migration seasons.

The data gathered during the two field survey programs, the VP and the point count surveys, were used to estimate the hourly activity rate for each species. The number of active daylight hours was calculated using the latitude of the Project site for March, April and May (the spring season) and for August, September and October (the autumn season). These were the months when the migration season VP surveys were undertaken.

The estimate of hourly activity was then multiplied by the hourly activity rate to provide an estimate of the number of birds passing through the Project site each year. The number was then decreased by calculating the probability of a bird being hit by a turbine blade. This is a complicated calculation that is based on a spreadsheet provided by SNH[59]. Traits like longer wingspans, longer body length or slower flights result in an increased likelihood of collision.

All of the above calculations assume no avoiding action on the behalf of the bird. Different species have different capabilities to avoid turbines based off their flight style and wing loading (i.e. the weight of the bird compared with the surface area of its wings). SNH provide guidance[60] for the use of avoidance rates, which is based on post-construction monitoring data from wind farms across the world. Where a specific avoidance rate is not provided, and a proxy species cannot be defined, a default avoidance rate of 98% is defined.

The estimate of collision mortality for a year is then calculated as follows:

Estimate of Flights Crossing the Wind Farm per Year	**x**	**Probability of Collision With a Turbine Blade**	**x**	**Avoidance Rate**	**=**	**Estimate of Collision Mortality**

[58] SNH (2000) Windfarms and Birds: Calculating a Theoretical Collision Risk Assuming No Avoiding Action. SNH Guidance.
[59] https://www.nature.scot/wind-farm-impacts-birds-calculating-probability-collision, accessed 14 February 2019.
[60] SNH (2018) Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model. SNH Guidance.

Scenario 2: Birds Using the Airspace of the Project Site

Common kestrels are resident within the Project site and short-toed snake eagles are summer visitors to the Project site, with both species assessed by the model that considers birds using the airspace of the Project site. In this scenario, the total time that a species spends flying at collision risk height within the Project site is calculated. This is scaled up, as in the previous method, to provide an estimate of total flight time across a year. This is multiplied by the total volume of the Project site that is swept by the turbine blades to calculate the bird occupancy of the rotor swept volume. This is then multiplied by the time it takes for a bird to pass through this rotor swept area to calculate the total number of birds passing through the rotor swept area per year.

Similar to Scenario 1, this number is reduced by multiplying by the probability of collision with a turbine blade and the avoidance rate as below:

Number of Birds Passing Through Rotors per Year	**x**	**Probability of Collision With a Turbine Blade**	**x**	**Avoidance Rate**	**=**	**Estimate of Collision Mortality**

Limitations and Assumptions

Limitations of the point count method occurred during breeding seasons due to the fact that on days of heavy bird movement, it was not possible to individually count the number of passing birds, and an estimate had to be made as a result. In addition, some birds were only identified through capture with a camera from a distance. During the wintering season, it was very difficult to advance above 1,400m to undertake surveys due to the snow covering the Project site. However, birds seen or heard from a distance were still recorded. The survey data provides raw counts of observations that are not standardized by the number of hours of observation but do provide an overall list of what was observed. These counts may likely contain duplicate sightings of the same birds.

The 64 hours of migration season VP data collected at each location is less than the minimum survey effort required in guidance from Scottish Natural Heritage[61], which sets out 72 hours collected across a full year, 36 hours in the breeding season and 36 hours in the non-breeding season. The data collected has already been supplemented by Point Count data collected over 17 visits, which includes visits in winter and summer months when VP surveys were not undertaken.

As a further method of validation, the data collected has been compared with that collected at the nearby Sustainable Akkar and Hawa Akkar wind farms. A similar level of bird survey was undertaken at Sustainable Akkar, located approximately 5 km to the north-east of Lebanon Wind Power, between 2013 and 2017 and a greater level of survey effort was undertaken at Hawa Akkar, located approximately 14km northeast of Lebanon Wind Power, between February 2018 and January 2019. Both of these sites are considered to be on the same flyway, the Oudine Valley bottleneck, as Lebanon Wind Power.

[61] SNH (2017) Recommended bird survey methods to inform impact assessment of onshore wind farms. SNH Guidance Series

15.2.2 During Construction

Impacts on Designated Sites

One species listed for the Mountains of Akkar-Donnieh IBA breeding species was recorded during the field surveys on the Project site, namely western rock nuthatch. These birds were recorded in all zones around the proposed development up to 1,500m. The main infrastructure at the site is located at 1,800m at its lowest point so the only construction that could impact upon western rock nuthatch is the construction of the access road and underground cable.

Both of these developments would involve a limited footprint and as they avoid the removal of any trees likely to be used by western rock nuthatch or any of the other IBA breeding bird species, the activities would not result in any impacts on the named IBA species and therefore there would not be an ecologically significant effect.

The IBA lists soaring birds and cranes (namely white stork, white pelican, Levant sparrowhawk and common crane) as another key feature. Those species have not been recorded on the Project site during field surveys, they pass through the area on migration. As such, potential construction impacts would be limited to disturbance such as noise and light, from construction activities.

Disturbance such as that would be a temporary, low magnitude indirect impact. The extent of light disturbance would be far greater than that of noise as it would attenuate to levels unlikely to disturb species migrating through and over the area. The species listed were typically recorded flying high through the area. As such no ecologically significant effect is predicted.

Habitat Loss

Both temporary and permanent habitat loss are predicted as a result of the construction of the proposed development. Permanent loss would occur in the footprint of the infrastructure of the proposed development and from the construction of new permanent access tracks. Temporary, short-term habitat loss would occur at turbine bases, outside of the permanent hardstanding, and from the construction of new temporary access tracks that would be reinstated after construction. Direct habitat loss is assessed in **Section 13 Biodiversity**.

Habitat loss is considered to result in an adverse indirect, low magnitude, short-term, reversible impact on the community of birds breeding on the Project site which is considered to be of local importance. It would be a temporary impact in all locations other than the footprint of the infrastructure and new permanent access tracks. No ecologically significant effect is predicted.

Nest Destruction

During the construction of the proposed development, nests could be destroyed directly by construction activities and some may be abandoned due to disturbance from construction vehicles. Nest destruction is an adverse, low magnitude, short-term, reversible impact on the locally important community of breeding birds. The extent of the impact would be wherever construction activities are required, such as at turbine bases, construction compound and laydown areas. Bird nest conservation importance varies dependent on the species and all nests are highly sensitive. This impact has the potential to result in a significant ecological effect.

However, it is considered that the impact is reversible, i.e. mitigation measures are possible which would avoid the impact and avoid any residual effects.

Full details of all mitigation measures for birds are provided in **Section 21 Summary of Impacts and Mitigation** and include vegetation removal outwith the breeding season and pre-clearance surveys to identify nesting locations if vegetation removal occurs during the breeding season.

Disturbance and Displacement

As well as the noise and sights associated with construction, birds could also be disturbed by the activities of personnel and vehicles. Disturbance of small breeding birds found on site as a result of construction activities would be an adverse, low magnitude, short-term impact on a community of birds considered to have local importance.

Given the relatively small footprint of the proposed development and the number of small breeding birds found on the site, this is not considered to be an ecologically significant effect.

The only species of raptors that were regularly recorded within the immediate zone around the project site are short-toed snake eagle and common kestrel. Both of these species could be displaced from the immediate zone during the construction of the proposed development. Based on their respective population sizes and distribution, short-toed snake eagle is considered to be a species of regional importance and common kestrel a species of local importance.

Disturbance from construction activities could cause both species to forage in alternative locations, either less favourable foraging areas on the margins of the Project site or locations further afield rather than the site itself. Displacement of these species would be an adverse, low magnitude, temporary, impact on both species, however this is not considered to be an ecologically significant effect.

15.2.3 During Operation

Collision Risk

Bird species using the airspace around the proposed development are vulnerable to colliding with the proposed development. Raptors and waterfowl are known to be particularly vulnerable to this collision risk[62]. A quantitative CRA has been undertaken for all vulnerable species. This has been undertaken using data collected from the migration season VP surveys and the year-round PC surveys and has been compared with similar assessments undertaken on data collected for Sustainable Akkar and Hawa Akkar Wind Farms.

Any predicted collision events would be adverse impacts, reversible at population scale. The likelihood of collision event, magnitude and duration of impact would vary by species.

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[62] Desholm, M. (2009). Avian sensitivity to mortality: Prioritising migratory bird species for assessment at proposed wind farms. Journal of Environmental Management. 90: 2672-2679.

Species-Specific Collision Risk

The results of the collision risk assessment are provided in **Table 15-14**. As collision risk estimates for common kestrel and short-toed snake eagle were calculated following a different method which accounts for those species' breeding presence in the wind farm area, estimates of "Bird Records per Hour" were not made.

Of the 18 species of bird recorded during the field surveys and considered vulnerable to collision with a wind turbine, only eight species were recorded flying at collision risk height within or across the site:

- Common buzzard.
- Eurasian sparrowhawk.
- Honey buzzard.
- Common kestrel.
- Lesser Spotted Eagle.
- Levant Sparrowhawk.
- Short-toed snake eagle.
- Steppe buzzard.

Common Buzzard/Steppe Buzzard[63]

A common buzzard flight crossing the site at collision risk height was recorded during the VP surveys and during the PC surveys, both flights involved a single bird. This is considered to represent a low level of flight activity. The mortality estimate of 0.2 birds per year is low and represents a 0.01% decrease to the combined common and steppe buzzard population crossing the site of 1,835 birds.

No ecologically significant effect is predicted associated with common buzzard collision risk.

Steppe buzzards were recorded crossing the site at collision risk height six times during the VP surveys. This is considered a low level of flight activity. The mortality estimate of 0.48 birds per year is considered low and represents a 0.03% decrease to the baseline population of common and steppe buzzard of 1,835 birds.

No ecologically significant effect has been predicted associated with common buzzard collision risk. In addition, no significant in combination impacts are predicted on *Buteo buteo*, the combined common and steppe buzzard population.

Eurasian Sparrowhawk

A single Eurasian sparrowhawk was recorded crossing the site at collision risk height during the PC surveys. This is considered to represent a low level of flight activity. The mortality estimate of 0.09 birds per year is low and represents a 0.02% decrease to the population using the site of 520 birds.

No ecologically significant effect is predicted associated with Eurasian sparrowhawk collision risk.

[63] Steppe buzzard *Buteo buteo vulpinus* is a subspecies of Common buzzard *Buteo buteo*. There are differences in appearance and behaviour (Steppe buzzards are strongly migratory) but due to the similarities, the two have been considered together here.

Table 15-14 Collision Risk Assessment per Species

Species	Total VP Records	VP Records at CRH and Crossing Site	Total PC Records	PC Records at CRH and Crossing Site	Bird Records per Hour	Bird Through Rotors in a Year	Chance of Collision with Blade	Avoidance Factor	Mortality Estimate	Population Estimate	% Loss
Black Kite	14	0	7	0	0	0	0	0	0	1,636	0
Booted Eagle	3	0	1	0	0	0	0	0	0	621	0
Common Buzzard	21	1	5	1	0.03	67.02	14.8	98	0.20	1,835	0.0108
Common Crane	44	0	9	0	0	0	0	0	0	113,000	0
Egyptian Vulture	1	0	0	0	0	0	0	0	0	143	0
Eurasian Sparrowhawk	3	0	1	1	0.01	33.51	13.3	98	0.09	520	0.0171
Greater Spotted Eagle	1	0	1	0	0	0	0	0	0	45	0
Griffon Vulture	1	0	1	0	0	0	0	0	0	38	0
Honey Buzzard	83	24	53	28	0.75	1742.65	13.9	98	4.84	437,000	0.0011
Imperial Eagle	0	0	1	0	0	0	0	0	0	9	0
Kestrel	23	2	15	2	N/A	94.59	15.0	95	0.71	4	17.7364
Lesser Spotted Eagle	19	2	9	0	0.03	67.02	12.3	98	0.16	141,000	0.0001
Levant Sparrowhawk	114	10	54	1	0.16	368.64	11.7	98	0.86	44,000	0.0020
Long-legged Buzzard	6	0	1	0	0	0	0	0	0	44	0
Short-toed Snake Eagle	24	1	28	0	N/A	13.61	13.7	98	0.04	3,368	0.0011
Steppe Buzzard	10	6	29	0	0.09	201.07	12.0	98	0.48	1,835	0.0263
White Pelican	34	0	20	0	0	0	0	0	0	39,395	0
White Stork	39	0	34	0	0	0	0	0	0	359,085	0

Honey Buzzard

Honey buzzard were the raptor species recorded most frequently crossing the site at collision risk height during both surveys, with 24 birds recorded during the VP surveys and 28 birds recorded during the PC surveys. This is considered a moderate level of flight activity. The mortality estimate of 4.84 birds per year is moderate and represents a decrease of 0.001% to the population using the site of 437,000 birds. While it is understood that the population using the site has likely decreased, it is considered certain to remain above the level at which a decrease of 4.84 birds per year could be considered a significant decrease.

No ecologically significant effect is predicted associated with honey buzzard collision risk.

Common Kestrel

Common kestrel were recorded crossing the site at collision risk height during the VP surveys and during the PC surveys, with two birds recorded during each survey, four in total. This is considered a low level of flight activity. The mortality estimate of 0.71 birds per year is low but would represent a 17.74% reduction in the baseline population of four birds. This would represent a major impact on a feature of site importance. It is likely that collision risk would be reduced by the effect of displacement on common kestrel.

As common kestrel are only considered to be a feature of site importance, this impact is not considered to represent an ecologically significant effect.

Lesser Spotted Eagle

Two lesser spotted eagle flights were recorded crossing the site at collision risk height. This is considered a low level of flight activity. The mortality estimate of 0.16 birds per year is considered low and represents a decrease of 0.0001% to the baseline population of 141,000 birds.

No ecologically significant effect is predicted associated with lesser spotted eagle collision risk.

Levant Sparrowhawk

Levant sparrowhawk were recorded crossing the site at collision risk height ten times during the VP surveys and once during the PC surveys. This is considered a moderate level of flight activity. The mortality estimate of 0.86 birds per year is considered low and represents a decrease of 0.002% to the baseline population of 44,000 birds.

No ecologically significant effect is predicted associated with Levant sparrowhawk collision risk.

Short-toed Snake Eagle

Short-toed snake eagle were recorded crossing the site at collision risk height once during the VP surveys. This is considered a low level of flight activity. The mortality estimate of 0.04 birds per year is considered low and represents a 0.001% decrease to the baseline population of 3,368 birds.

No ecologically significant effect is predicted associated with short-toed snake eagle collision risk.

Comparative Analysis Results

The results of the comparative analysis between Lebanon Wind Power and Sustainable Akkar are shown in **Table 15-15**. This analysis was undertaken by comparing the number of birds predicted to fly through the rotor swept area, or the collision risk window, in a year for each wind farm, as predicted during the collision risk analysis.

Table 15-15 Comparative Analysis Results

Species	LWP: Number of Birds through Rotor Swept Area in a Year	SA: Number of Birds through Rotor Swept Area in a Year
Common Buzzard	67.02	0
Common Crane	0	44.21
Eurasian Sparrowhawk	33.51	44.21
Honey Buzzard	1742.65	110.53
Kestrel	94.59	342.88
Lesser Spotted Eagle	67.02	287.39
Levant Sparrowhawk	368.64	0
Long-legged Buzzard	0	44.21
Short-toed Eagle	13.61	1214.18
Steppe Buzzard	201.07	22.11
White Stork	0	88.43

As can be seen in the table, the suite of species observed crossing the site at collision risk height is similar, with common crane, long-legged buzzard and white stork only recorded at Sustainable Akkar and common buzzard and Levant sparrowhawk only recorded at Lebanon Wind Power. The level of variation for each species between wind farms is small. The only species for which there is considered to be significant variation is honey buzzard (1,742.65 birds per year at Lebanon Wind Power as opposed to 110.53 birds per year at Sustainable Akkar) and short-toed snake eagle (13.61 birds per year at Lebanon Wind Power as opposed to 1,214.18 at Sustainable Akkar).

These variations can be explained by species specific flight patterns associated with the different topographies of the two wind farms. Lebanon Wind Power is a high ridge, lacking in tree cover and suitable for species gaining height during migration such as honey buzzard and Levant sparrowhawk. The high short-toed snake eagle activity at Sustainable Akkar fits with its lower altitude and its suitability for reptile species which are preyed upon by short-toed snake eagles. Data for Hawa Akkar has been preliminarily reviewed but has not been run through a Collision Risk Assessment. From an early review the data appears similar in composition to the other two wind farms.

The results of the comparative analysis confirm that the levels of flight activity across the three projects is consistent and that the collision risk analysis undertaken, and the conclusions based upon these analyses are appropriate.

Disturbance and Displacement

Disturbance associated with the operation of the proposed development has the potential to cause an adverse, low magnitude, long-term, impact on the locally important community of bird species occupying the proposed development and the surrounding area. Birds can be disturbed by the activities of personnel and vehicles during the operation of the proposed development and also by visual and noise disturbance from the turbines themselves. However, those disturbance sources are likely to be limited and resident birds are likely to habituate to them. No ecologically significant effect is predicted.

The only species of raptor that were regularly recorded within the immediate zone were common kestrel and short-toed snake eagle. Both of these species could be displaced from the immediate zone during the operation of the proposed development. Disturbance from the presence of construction workers and vehicles and from visual and noise disturbance from the turbines could cause both species to forage away from the site. This would result in an adverse, low magnitude, long-term, impact on both species. Short-toed snake eagle is a species of Regional importance and common kestrel are of site importance. However, based on the location of the territories which lie a number of kilometres from the Project site, operational disturbance impacts on these features are not considered to result in ecologically significant effects.

Barrier Effects

The proposed development may result in a barrier effect on the movement of bird species with the vertical configuration of turbines creating an actual or perceived barrier which bird species may not cross or would need to habituate to crossing.

Such adverse impacts would be of low magnitude to the species inhabiting the immediate zone but potentially of moderate magnitude to any species that might use the area around the Project site for migration.

Field surveys have not recorded high levels of migratory bird activity within the wind farm footprint at collision risk height. Importantly, the migratory corridors run in a largely north-south alignment similar to that along which the proposed development would be constructed. A

s such, the proposed development would not create a barrier perpendicular to the direction of most flights. The impact would be of limited extent but permanent for the life of the proposed development.

No ecologically significant effects are predicted.

15.2.4 During Decommissioning

Decommissioning impacts are considered to be similar to, but less than, those described for the construction phase. No ecologically significant effects are predicted.

15.2.5 Critical and Natural Habitats Assessment

A Critical and Natural Habitats Assessment for the Project is currently being undertaken for the Project. The findings will be used to inform the mitigation.

16. SOCIOECONOMIC CONDITIONS

16.1 Baseline Methodology

As the Project will potentially impact: 1) landowners for lease and acquisition of parcels for the Project, the Hawa Akkar and Sustainable Akkar wind farms; 2) noise, shadow flicker and visual receptors within 3km of the Project; 3) villages along the transport corridor; 4) potential workers drawn from nearby communities. As such, socio-economic baseline data was obtained from the following sources:

The Project:

- Literature review of the Akkar Region.
- Surveys by the Developer of landowners of parcels leased or acquired for the Project in Fnaidek, Rweimeh Village and Karm Chbat.
- Surveys of households and SMEs in Quobaiyat and Fnaidek. The sample household survey is provided in **Appendix F**.
- Surveys of noise, shadow flicker and visual receptors of the Project.
- Socioeconomic data for villages where land is being leased or acquired (including the CRO Office to be leased in Jabal-Akroum Kfartoun), as well as along the transport corridor provided by Statistics Lebanon.
- Information provided by key informant interviews.

From the ESIA for the Hawa Akkar wind farm:

- Literature review.
- In depth interviews with heads of municipalities and other officials for Chadra, Machta Hassan, Machta Hammoud and Mqaible.
- 200 face-to-face interviews with heads of households in Chadra, Machta Hammoud and Mqaible (i.e. representing villages for parcels for lease and acquisition for the Hawa Akkar wind farm internal track), as well as Machta Hammoud, Khat El-Petrol, Sahle, Andqet, Quobaiyat, Wadi Khaled (it is noted that Khat El-Petrol, Quobaiyat and Wadi Khaled are not within the DAOI of Hawa Akkar).
- Socioeconomic data for villages where land is being leased or acquired, as provided by Statistics Lebanon.

From the ESIA for the Sustainable Akkar wind farm:

- Literature review.
- Surveys by the developer of landowners where land is being leased or acquired in Aandqet, Rweimeh Village and Kfartoun. It is noted that the information for Rweimeh Village for the Sustainable Akkar Project is as provided for the Project; hence, there are a total of 7 villages in the DAOI.

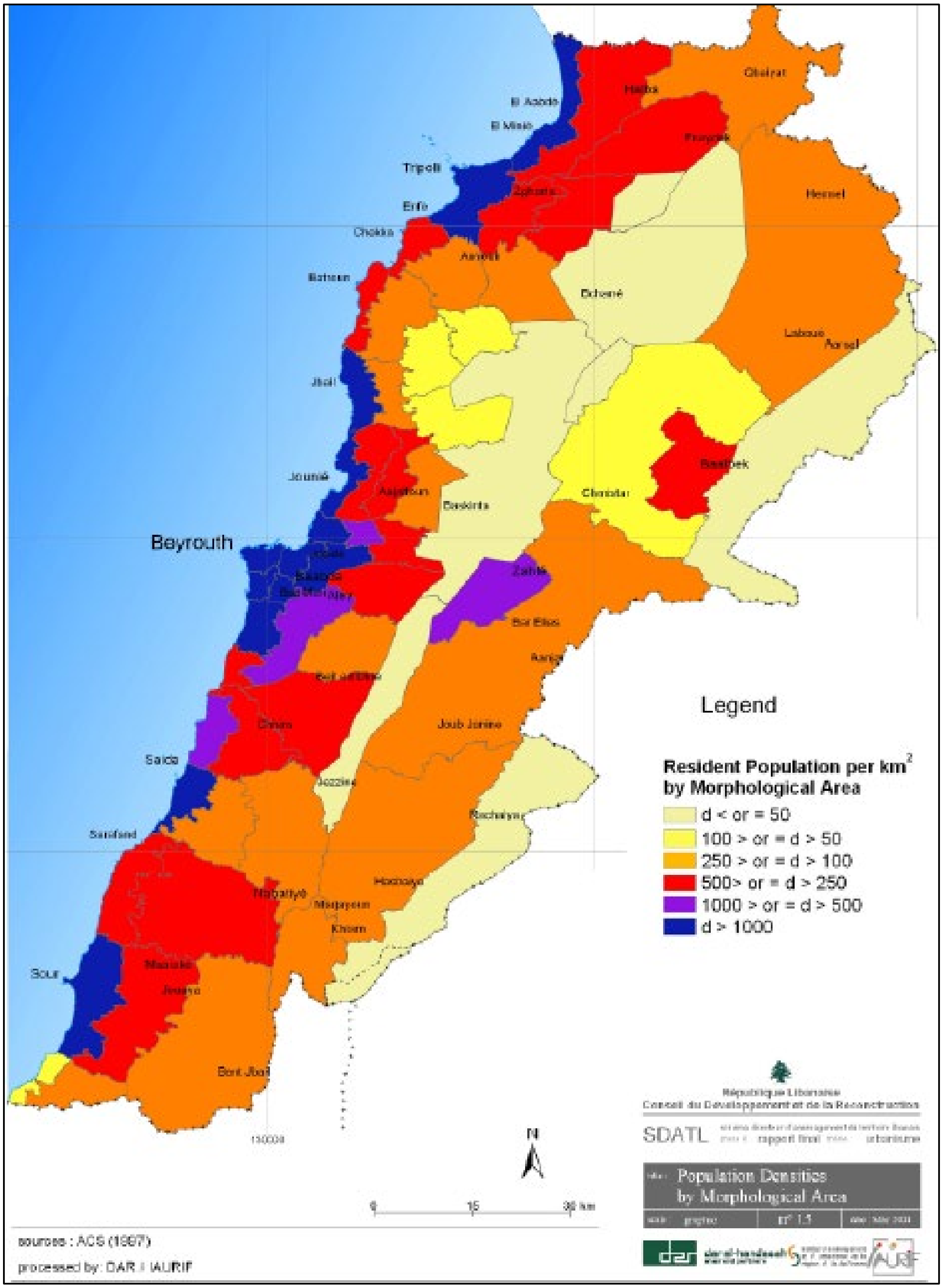
Further, it is noted that the Village of Jawz, located 1.5km east of the Project, is considered part of Rweimeh Village. Socioeconomic data for Rweimeh Village will incorporate the 7 houses located there. Houses in Jawz were considered in the noise, shadow flicker and visual assessment through the assessment of closer houses. As Receptors 73, 78 and 85 were below noise levels, and shadow flicker and visual was considered for receptors closer to the site and found to have a Medium impact, nothing further afar was modelled. (refer to **Section 17 Community Health, Safety and Security**).

16.2 Baseline Findings

16.2.1 Akkar Region

The population density of Lebanon is shown in **Figure 16-1**.

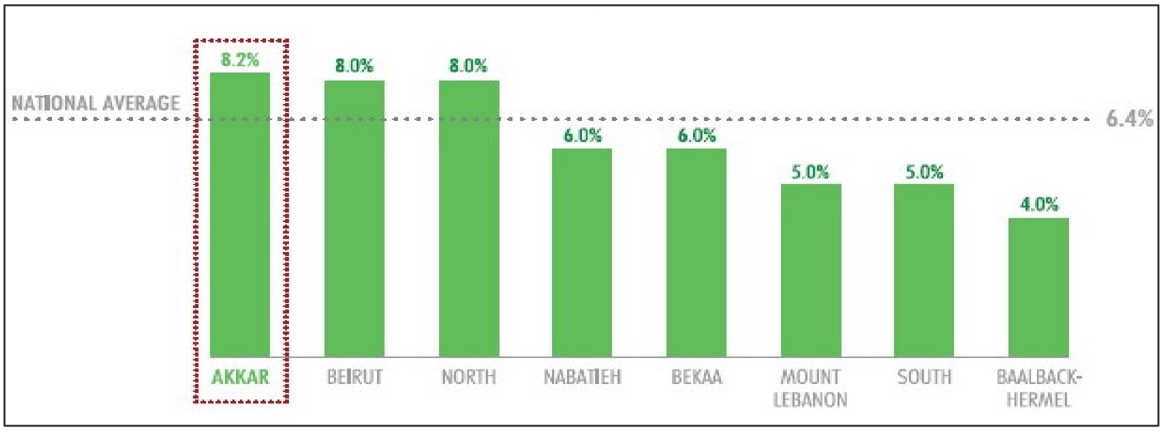
Figure 16-1 Population Densities of Lebanon



The Akkar Governorate has a population of around 400,000 inhabitants with a population density of around 500 people/km^2, one of the lowest among all the Governorates in Lebanon. It is recognized as one of the most deprived regions in the country with a high unemployment rate, poor infrastructure, and limited access to basic public services such as electricity. In fact, a majority of Lebanese in the region are facing deterioration in livelihoods, and the business climate and job market are negatively affected by the crisis where local skills have been substituted by Syrian labor.

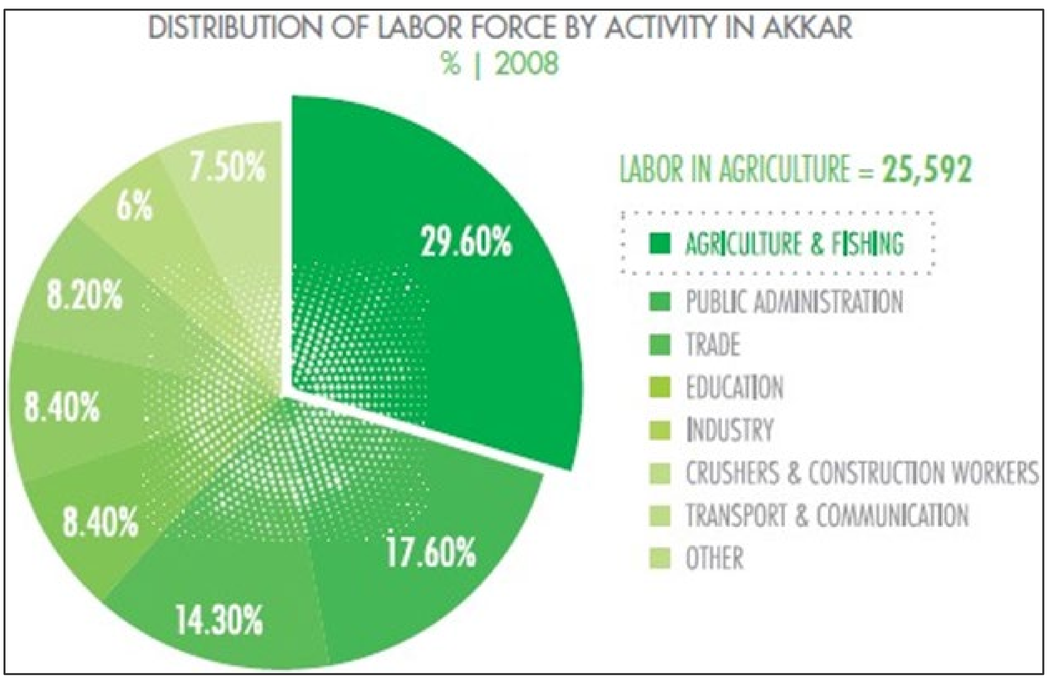
The estimated unemployment rate is 8.2% compared to a national average of 6.4%, as shown in **Figure 16-2**.

Figure 16-2 Akkar Governorate Unemployment Rate in 2009



Agriculture and fishing are the main sources of employment, employing 29.6% of the labor force on a full time or part time basis, in addition to public administration and armed forces (17.6%), trade, industry and construction, as shown in **Figure 6-3**.

Figure 6-3 Distribution of Labor Force by Activity in Akkar in 2008



The agricultural sector in the area is underdeveloped, with the main crops planted in Akkar being wheat, barley, soya, corn, apples and olives. Rain fed cultivation is often practiced due to lack of irrigation networks, government supply network and water harvesting or collection systems. Most land is owned by farmers who work on their land or lease it to other farmers from the same region. Since 2013, cyclical weather patterns and increased demand on local water resources led to reported 50% declines in yield for some 42% of Lebanese crops. The net effect nationally, according to a FAO/Ministry of Agriculture study has been a decrease of 20-40% in farm-gate prices.

It is estimated that 18% of the total Lebanese labor force come from North Lebanon and Akkar, the second highest share in the country after Mount Lebanon. The Akkar labor force has been dominated by males due to gender disparity. Males from the Akkar region account for an estimated 26.2% of the national labor force. Females account for just 5.2%, which is well below the national average of 14.8%.

In terms of education, there are numerous schools in the Akkar region as well as 18 universities offering degrees of business, law and engineering programs. Schools and other support infrastructure is summarized in **Table 16-1**:

Table 16-1 Social Infrastructure of the North Lebanon Region

Infrastructure	North Region	Akkar Region
Public Schools	265	163
Public Hospitals	32	21
Social Development Centers	23	19
Municipalities	140	121
Unions of Municipalities	7	6
Informal Settlements	145 hosting 10,888 of registered Syrian refugees	439 hosting 28,162 of registered Syrian refugees

The presence of refugees places a burden on Akkar governorate particularly on the sectors of education, healthcare, housing, household assets, energy, water supply, sanitation, roads and transport. Living conditions of Syrian refugees are summarized in **Table 16-2**.

Table 16-2 Living Conditions of Syrian Refugees

	Substandard Shelters	Informal Settlements	Collective Shelters
Syrian Refugees	54.5%	39.8%	2.5%

16.2.2 Villages in the Direct and Indirect Area of Influence

Socioeconomic data is currently being obtained from Statistics Lebanon for the 8 villages in the DAOI:

- Fnaidek.
- Rweimeh Village.
- Karm Chbat.
- Jabal-Akroum Kfartoun.
- Chadra.

- Mqaible.
- Machta Hammoud.
- Aandqet.

In addition, individual receptors of noise, shadow flicker and visual impacts are currently being surveyed by the Developer.

The IAOI comprises the village along the existing transport corridor between the Tripoli seaport and the Project and extends up to 15km from the Project footprint to include sites and monuments of national importance potentially affected by the Project's visual impact.

Socioeconomic data collection and survey are currently being undertaken. It is noted that socioeconomic data provided by Statistics Lebanon for Rweimeh Village, Karm Chbat, Jabal-Akroum Kfartoun, Chadra, Mqaible, Machta Hammoud and Aandqet, as well as villages along the transport corridor, are currently being evaluated for the Project. In addition, the Developer is currently undertaking surveys from landowners and noise, shadow flicker and visual receptors as the individuals who will be experiencing the potential impacts from the Project. The following sections will be amended, as for Fnaidek below, to present socioeconomic data for the villages in the DAOI and the IAOI.

Further, it is anticipated that the data provided by Statistics Lebanon, as well as the surveys undertaken by the Developer, will provide more robust and accurate information than that currently provided herein and as based on the limited number of households surveyed in Fnaidek and Quobaiyat. For this reason, it is anticipated that the data currently presented will be replaced and better focus the assessment and inform mitigation as follows:

- More detailed information will be provided for the 8 villages in the DAOI.
- The household survey and SME information presented in this section will be replaced by the survey data collected from the landowners for land parcels leased and acquired, as well as the noise, shadow flicker and visual receptors, as the individuals who will be experiencing the potential impacts from the Project.
- Socioeconomic data will be provided for the villages along the transport route.

Nonetheless, the currently available data is provided herein.

16.2.3 Household Survey

A household survey campaign was implemented to: 1) support the collection of social demographic data; 2) understand access to energy, consumption, and how the lack of a reliable energy supply may affect livelihoods; 3) attitudes of the local population (households and small to medium enterprises (SMEs)) toward the Project and expectations around better energy supply. The household survey targeted the surrounding villages of Quobaiyat, Fnaidek and Rweimeh Village. The total number of surveys was 408, divided between Fnaidek and Quobaiyat, with a total of 176 in Fnaidek (88 households and 88 active SMEs) and 232 in Quobaiyat (180 households and 52 active SMEs).

Income Level

The baseline assessment of both villages revealed that household size and occupation vary slightly from one village to another. For example, Quobaiyat is mainly a summer getaway for most of its residents who are mostly working in larger cities, such as Tripoli or Beirut. Fnaidek enjoys a more permanent residency. This relates to the income level of each village.

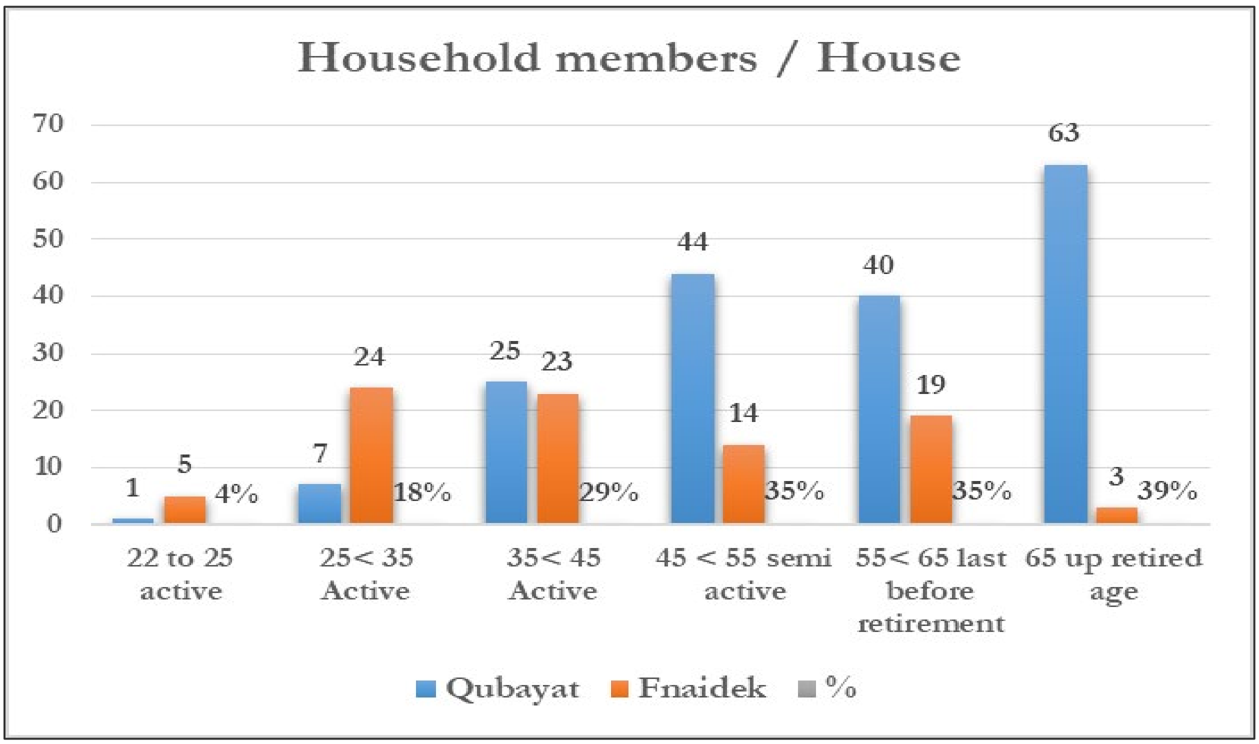
Many of the Fnaidek residents have government jobs and earn 800USD to 1,500USD per month (23 out of 88 surveyed households in Fnaidek, or 26%), an income that can allow a decent livelihood in their village. Conversely, the registered residents of Quobaiyat are mostly residing outside the village in either Tripoli or Beirut and are mainly employed in the private sector or self-employed. They are seasonal residents; this is reflected in the 1,750 actual residents covered in the survey.

The survey covered residents who are currently living in the villages. Fnaidek registered a count of up to ten household members and Quobaiyat counted up to nine members per household. The average number of household members was four in Quobaiyat and five in Fnaidek.

Income Levels and the Number of Household Members

Income level and the number of household members play a major socioeconomic factor in the burden of living expenses, which reflects on the cost of electricity and how it consumes a significant percentage of their income, as shown in **Figure 16-4**.

Figure 16-4 Number of Household Members



The survey reveals that a family earning between 800USD and 1,200USD per month spends around 200USD on electricity, which is considered a high expense as it represents a 25% at the lower end and 17% at the higher end of income level. Among the surveyed populations, the age distribution indicates a minimum age of 22 and a maximum age of 88 with a mode of 60-year-old residents who are either retired or permanent residents in the villages. The average age of the residents is 54 years, as shown in **Table 16-3**.

Table 16-3 Age Demographics

Age Demographics	Households	SME
Minimum	22	24
Average	54	45
Mode	60	35
Maximum	88	90

The survey revealed the following regarding youth and children, as shown in **Table 5-45**:

- 37 families have one female child under 16; 26 families have 2 females under 16.
- 33 families have one male child under 16, 29 families have 2 males under 16.

Table 16-4 Families with Children Under Age 16

Families with Male Children Under 16 Males	1 child	2 children	3 children	4 children	5 children	Grand Total
Quobaiyat	13	13	3	1	2	32
Fnaidek	20	16	7	3	1	47
Total Families	**33**	**29**	**10**	**4**	**3**	**79**
Families with Female Children Under 16 Females	**1 child**	**2 children**	**3 children**	**4 children**	**5 children**	**Grand Total**
Quobaiyat	15	12	2	1	1	31
Fnaidek	22	14	9	1	1	47
Total Families	**37**	**26**	**11**	**2**	**2**	**78**

Age distribution for working people varies significantly indicating the difference between household age and active working individuals in businesses in the villages. Here, the minimum active age is 22 years old and the maximum is 90 years old. The most frequent age reported is 45 years old. The age distribution of the active working individuals is shown in **Figure 16-5**.

The majority of the population of the sample villages is active and engaged in income generating activities. Moreover, the data shows an early working age of 22 in 4% of the sample size. Supporting a family business, in either farming or shops, is a way to cut down on expenses and it also represents a way of life in rural areas where work is a necessity as much as it is a habit in rural areas such as Quobaiyat and Fnaidek. The active working ages between 35 to 55 constituted about 136 individuals which is about 51% of the total sample size.

The distribution of professions and jobs is shown in **Figure 16-6**. The figure reflects the significant reliance on significantly on government employment, especially the Lebanese Army which provides a salary range of 800USD to 1,500USD per month. This wage is in stark contrast to the minimum wage in Lebanon, 600USD per month.

Figure 16-5 Age Distribution

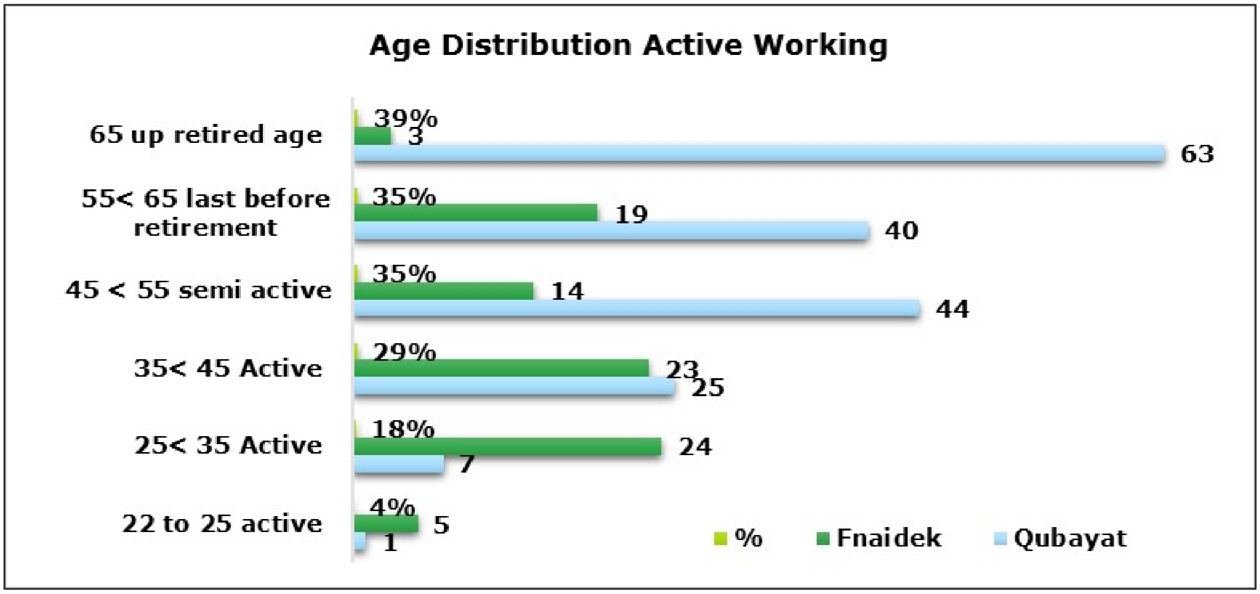
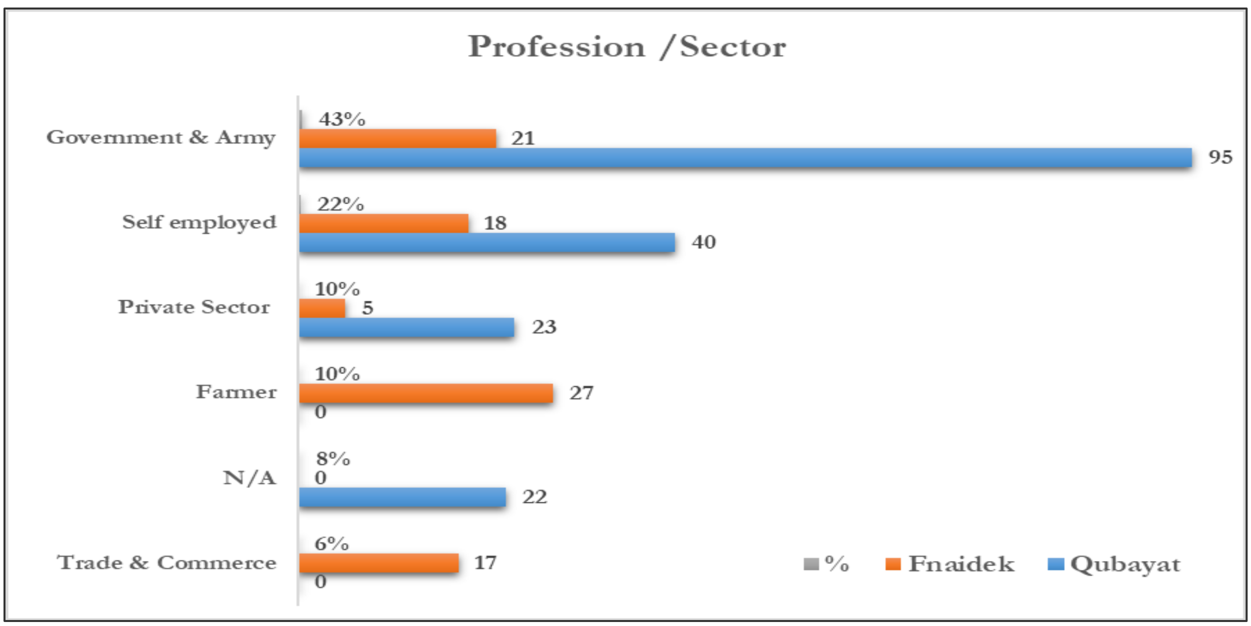


Figure 16-6 Professions Per Sector Per Village



The following provides a summary of the salary ranges in the region: Army and government salary range varies among the ranks and post of Lebanese Army members:

- The Lebanese Army and government make up 43% of the professional sector, totaling 116 individuals with salary range of 800 to 1,500USD per month.
- Self-employed individuals make up 22% of the professional sector, totaling 58% with a salary range of 800 to 2,000USD per month.
- Employees in the private sector and farmers each represent 10% of the professional sector; however, Quobaiyat measured a lower private sector engagement with a total of 23% vs. Fnaidek with 27% working entirely in farming (an active sector in the village).
- Trade and commerce represented 6% of the professional sector, with 17 traders in Fnaidek.

Out of 268 households interviewed, only 54 residents stay in their villages seasonally (i.e., from the end of June, July, August and to the beginning of September) whereas the rest did not express any feedback, as shown in **Table 16-5**.

Table 16-5 Seasonal Residency Profile

Seasonal Residency Profile	Quobaiyat	Fnaidek	Grand Total	%
Seasonal Stay	22	32	54	20%
N/A	158	56	214	80%
Total	**180**	**88**	**268**	**100%**

It can be assumed that because most residents own their houses in the two targeted villages, the 214 households with no feedback have permanent residences. Owning a house is a very important livelihood factor since it provides security and eliminates an extra financial burden, which is renting. **Figure 16-7** depicts the residency profile.

Figure 16-7 Residency Profile

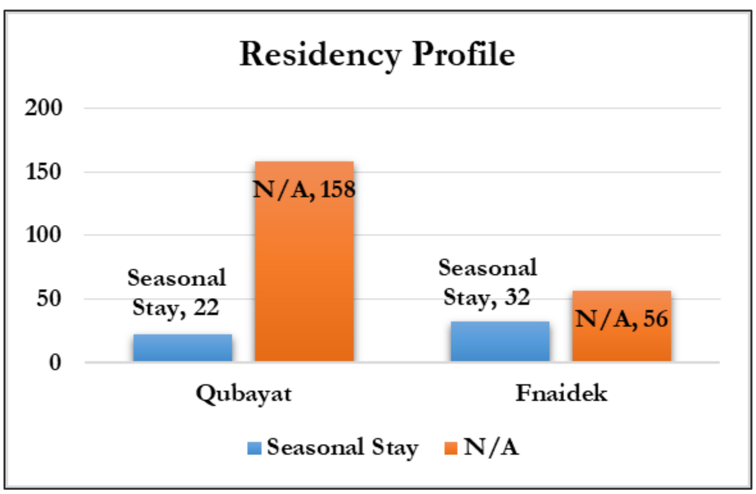


Table 16-6 shows the house ownership profile. Evidently, house ownership is very high as a house is part of basic life securities in villages. As such, 98.5% of the surveyed sample own a house and only 1.5% live in rental accommodations.

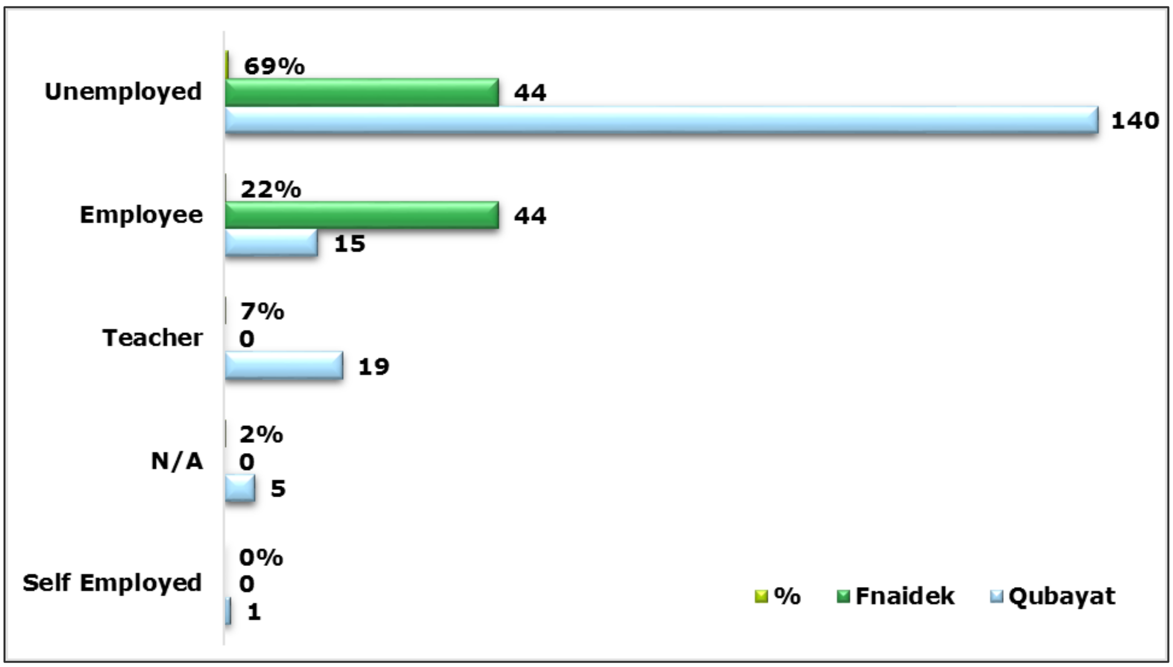
Table 16-6 House Ownership

House Ownership	Quobaiyat	Fnaidek	Grand Total	%
Rent	4		4	1.5%
Own	176	88	264	98.5%
Total	**180**	**88**	**268**	**100%**

Of the female sample surveyed, 27% work and provide secondary income to the family. This provides an extra financial support for the family and contributes to the household income by approximately 30%. Men as indicated before are either in the army or in the private sector in most of the respondents' cases.

Figure 16-8 depicts the women employment profile in the surveyed population. Despite the support some households get from working females, mainly married, the main income responsibility towards the household remains on the male as it is expressed in this baseline survey. This reflects the culture of the region and the lack of opportunities for women to be actively engaged in employment. The survey showed a low participation rate of 5.2% in the female labor force in Akkar, compared to a national average of 14.8%.

Figure 16-8 Female Employment Surveyed Population



In Fnaidek, 100 % of women surveyed rely on their husbands as the main provider of income even if they work, as shown in **Table 16-7**. In Quobaiyat, 160 out of the 180 surveyed, expressed that a male person is the only provider of income with 11 women working to support the household.

Table 16-7 Main Source of Income of Male Head of Household

Main Source of Income-Husband	Quobaiyat	Fnaidek	Grand Total
Yes	160	88	248
No	11	0	11
N/A	9	0	9
Total	**180**	**88**	**268**

As shown in **Table 16-8**, the retirement age in the targeted villages varies according to each person's desire to retire. In Lebanon, the official retirement age from employment or the Army is 65 years of age. The baseline survey shows that out of 268 individuals surveyed, 80 individuals (29.85%.) were retirees and homeowners living at home.

Table 16-8 Retirement Age

Retirement Age	Count
40 - 50	11
50 - 60	16
60 - 70	16
70 and above	29

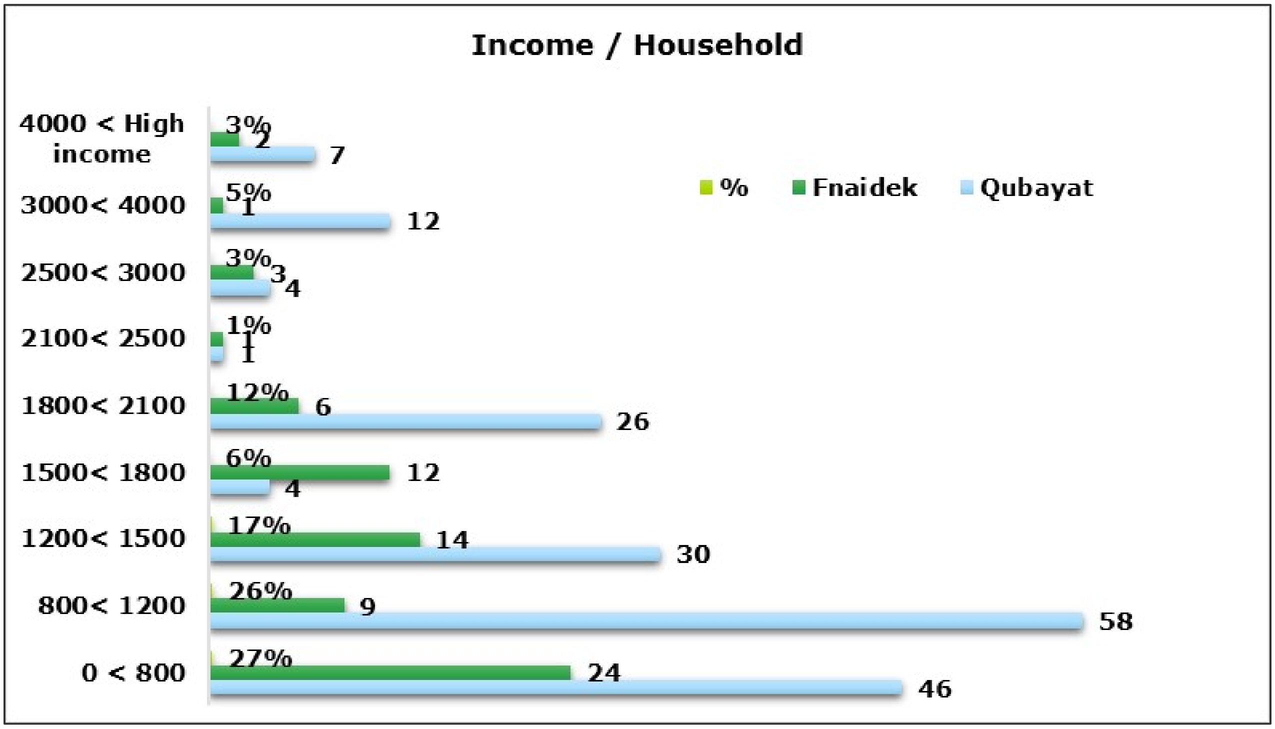
As mentioned previously, over one third of the Akkar population is engaged in agricultural activities, either as a primary or secondary job, to support their livelihoods. However, in both Quobaiyat and Fnaidek, the survey revealed that only 130 individuals (49% out of the 276 interviewed) own agricultural land. 21% of the 130 individuals have invested in their land to provide them with secondary income, but do not work as farmers. The remaining percentages represent the allocation of professions, other than farming or land. In addition, 17% of the surveyed population were engaged in trading activities and 16% in the private sector.

Electricity Cost as a Percentage of Income

Securing enough income to pay for the cost of electricity is a struggle for many households in the Akkar region. The survey shows that income varies greatly between each of the two villages. Fnaidek is more residential year-round, whereas Quobaiyat's residents move to the city giving it a profile as a seasonal village (summer, weekends and holidays). This has an impact on the income sources and range since most of Quobaiyat inhabitants enjoy better employment opportunities and income working in the cities of Tripoli or Beirut.

For example, of the households surveyed, 25 have an income above the 2,100USD threshold in Quobaiyat which is considered a good income as compared to Fnaidek where only 7 households are at this income level, as shown in **Figure 16-9**.

Figure 16-9 Income Per Household / Village



The burden of electricity shortage is felt across all Lebanon with remote cities and provinces facing long power outage hours. Akkar is no exception and faces many hours of power cuts each day, which creates a stressful economic and social condition on livelihoods. The high cost of having an alternative power supply through subscribing to generators is creating an overall financial challenge especially since 88% of those surveyed have a monthly income below the 2,100USD income level and reaching at times as low as 800USD per month.

Power cuts are relatively common in the Akkar region. **Table 16-9** shows the power cuts in hours in Quobaiyat and Fnaidek where at times up to 24 hours of power outage is encountered. Such long power outage hours indicate that the cost of subscription to alternative energy supply sources is impacting the livelihood of individuals and the economy of the region especially since the average cost of such alternative sources is 750 Lebanese Pounds /kilowatt.

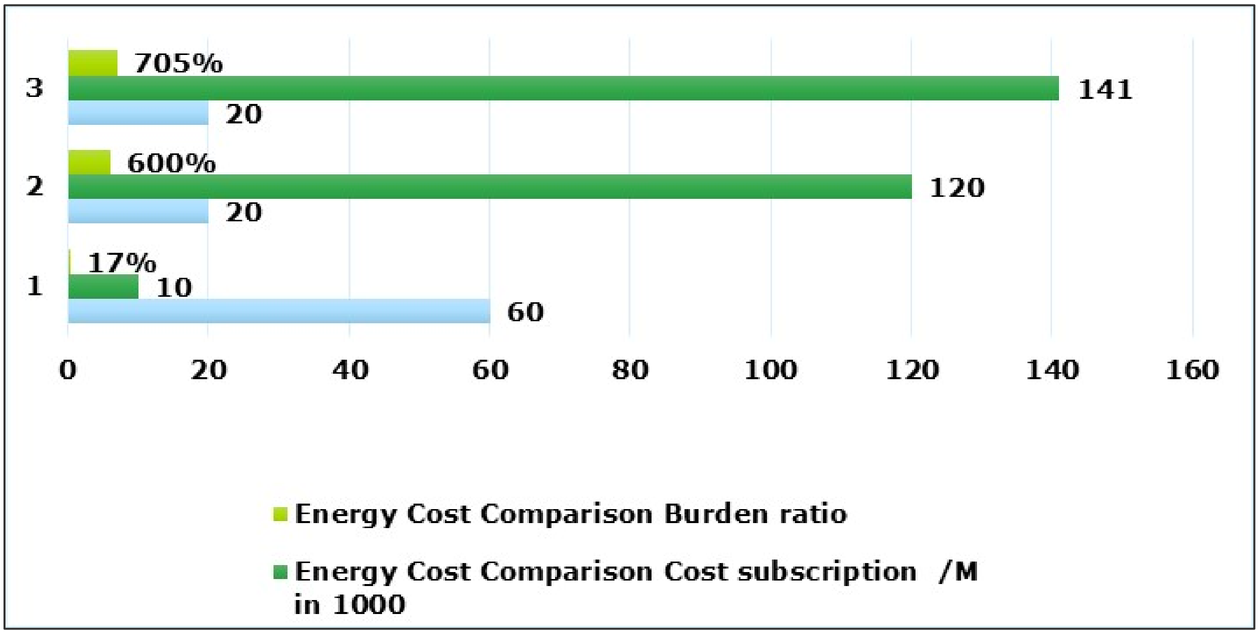
Table 16-9 Power Cuts / Hours in the Sample Villages

Power Cuts / Hours (H)	Quobaiyat	Fnaidek	Grand Total
2 H	1		1
6 H	3		3
8 H	4		4
12 H	10		10
14 H	3	88	91
15 H	2		2
16 H	6		6

Power Cuts / Hours (H)	Quobaiyat	Fnaidek	Grand Total
17 H	6		6
18 H	136		136
19 H	1		1
20 H	5		5
24 H	3		3
Total	**172**	**88**	**260**

Also, the margins of cost variation depend on the level of consumption. A comparison of energy consumption costs from the government (EDL) and privately-owned generators shows that the latter is much higher due to the long hours of power cuts and the high cost per unit of electricity supplied, as shown in **Figure 16-10**.

Figure 16-10 Energy Cost Comparison



Consumption Level Per Household Per Kilowatt

The cost of energy provided to households by private generators is 0.5USD (or 750 LBP)/Kilowatt plus a basic subscription cost of 25,000LBP; this rate applies to all regions in rural Lebanon, including Akkar. The only difference is the level of consumption by household and the capacity and dependency on energy. The level of consumption per kilowatt varies according to village, as shown in **Figure 16-11**.

Dependency on Electricity in Households

Energy dependency is a key factor to socioeconomic development regardless of its source. **Table 16-10** shows the perception of the surveyed population with respect to the quality of energy supply to their villages.

Figure 16-11 Capacity Household/kW/Month

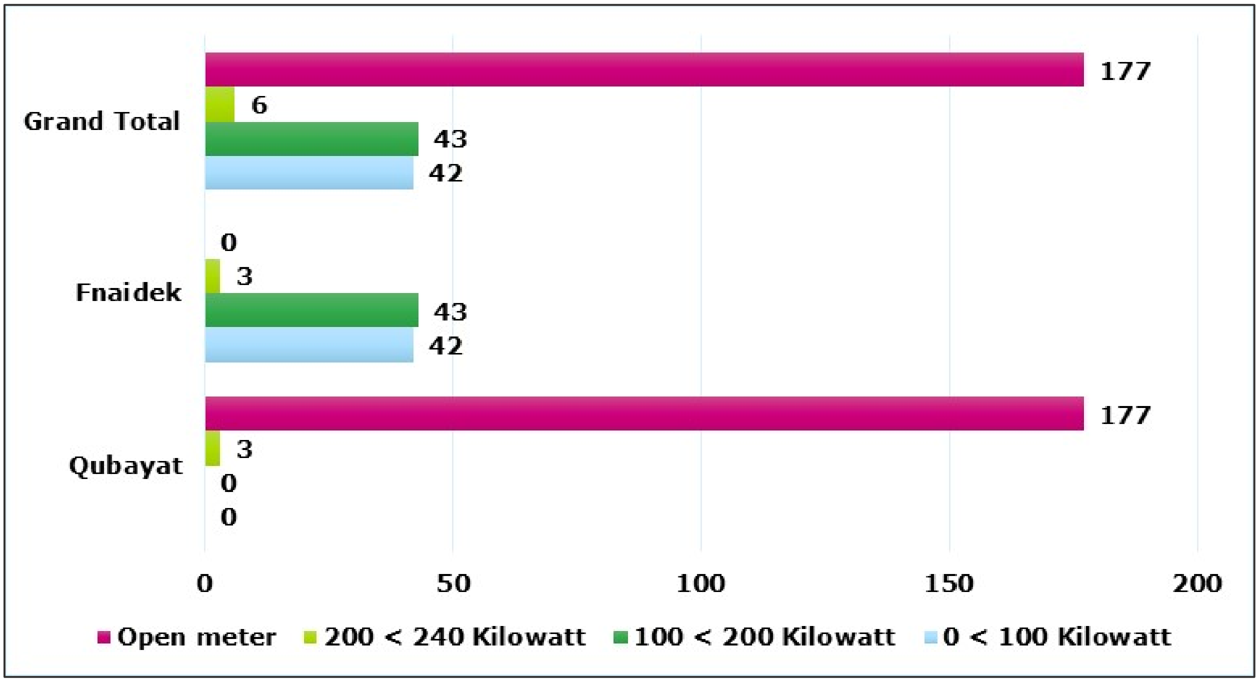


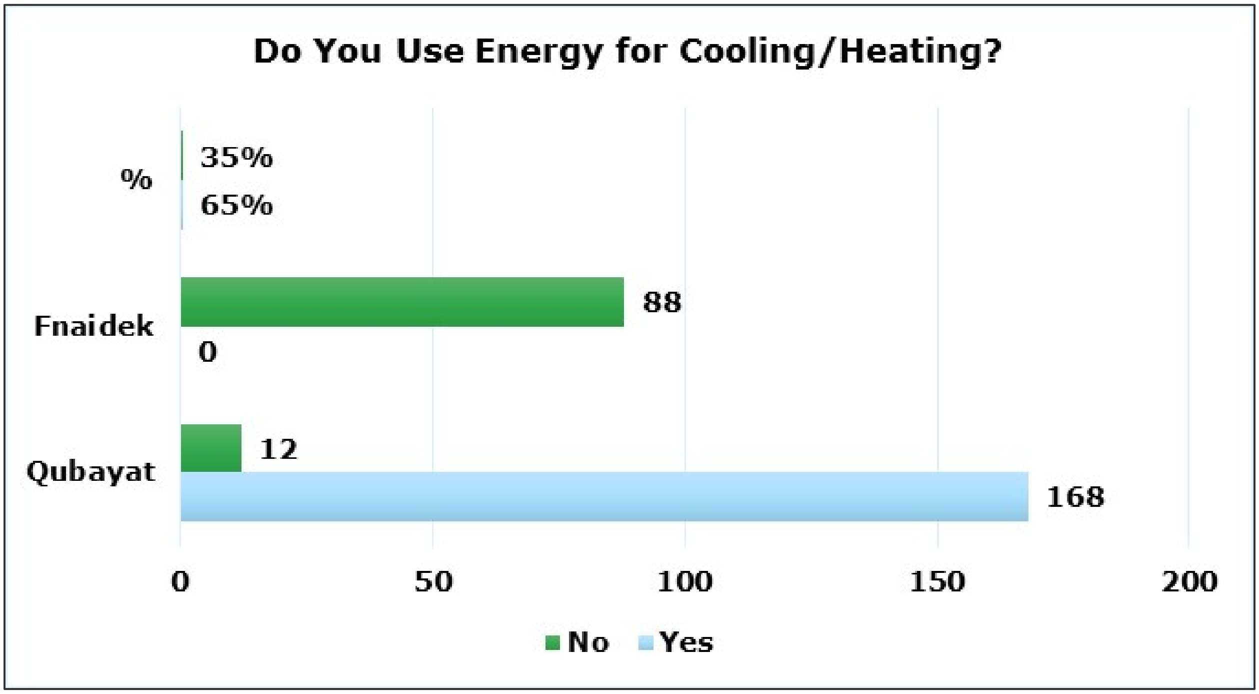
Table 16-10 Sufficiency in Energy Supply

Do You Have Enough Energy?	Quobaiyat	Fnaidek	Total	%
Yes	115	6	121	45%
No	61	82	143	53%
N/A	4	0	4	1%
Total	**180**	**88**	**268**	**100%**

In Quobaiyat, 64% of persons surveyed are satisfied with the energy supply, compared to only 7% in Fnaidek. 34% of Quobaiyat residents and 93% of Fnaidek residents think that they do not have enough energy supplied but they are unable to consume more due to the cost burden. An average of 53% of residents state that they have insufficient power supply. Energy has several uses in any economy and it impacts people's livelihoods. The common use of energy as we know is lighting and powering appliances. In industries, power production supports the activities of trade, services and tourism.

Another use of energy in households is for heating and cooling across all four seasons, as shown in **Figure 16-12**. 65% of the surveyed population confirmed the use of energy for their household cooling and heating. As global warming continues, and temperatures keep on rising creating climate change, cooling could be needed more than heating, which means more energy consumption and green energy can fill the gap.

Figure 16-12 Energy Use for Cooling and Heating



16.2.4 SMEs Survey

Age and Gender Distribution

The baseline survey interviewed 140 business owners covering various sectors operating and impacting the local economy of the surveyed villages. The age and category of business owners in both villages reflects the dynamics of both local economies. First, the age difference indicates that the youngest business owner is 24 years old, while the average age of the surveyed population is 45 years old, and the most frequent age registered was 35 years old, as shown in **Figure 16-13**.

Figure 16-13 Age Distribution Statistics for SME Owners

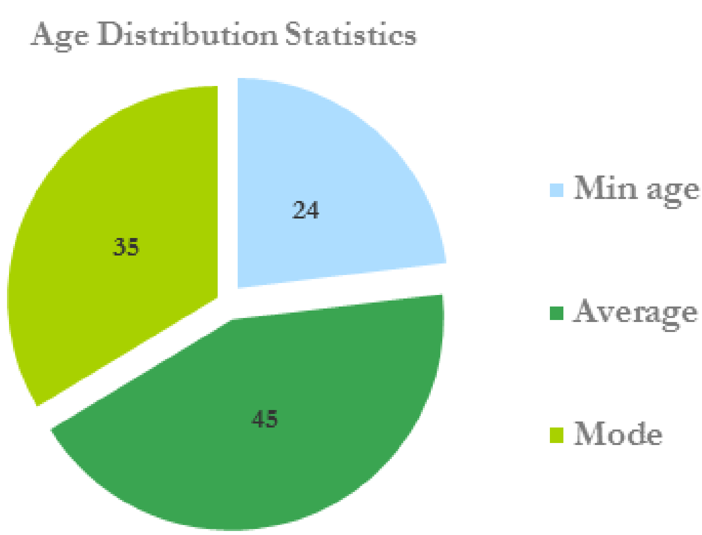
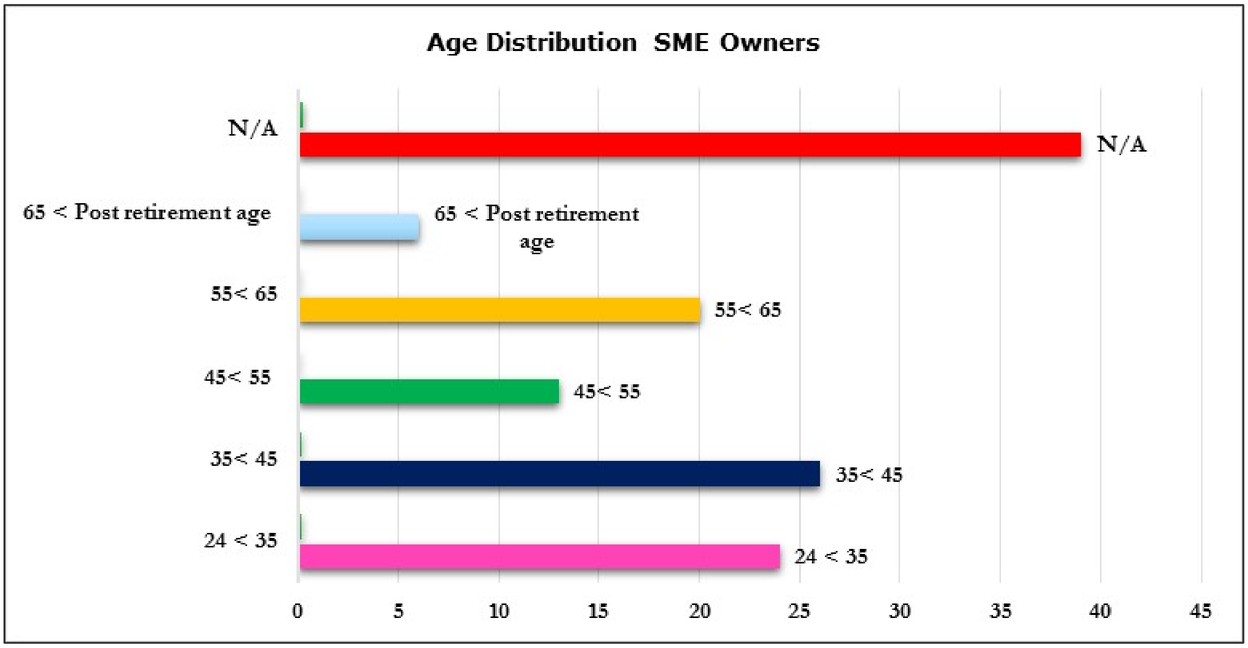


Figure 16-14 shows the age distribution of SME owners indicates that rural residents enjoy good health conditions and continue to work even post retirement age as represented by 14% SME owners of (55 to 65) age category and 4% post retirement age of 65 years. At the same time, 45% of business owners fall within the range of 24 to 55 years of age.

Figure 16-14 Age Distribution of SME Owners



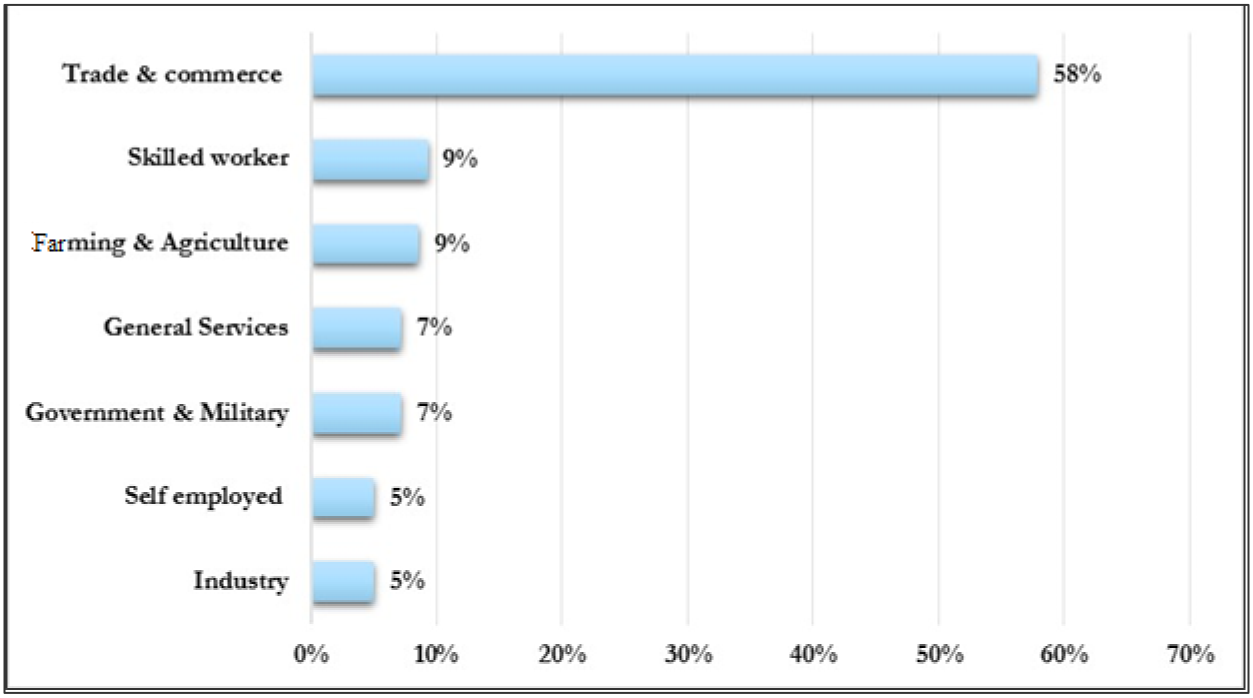
Young people aged 24 to 35 who do not have full-time work in the city with the private or non-private sector tend to work in their villages in either agriculture, services or as skilled workers. Their work contributes to the household income.

Economic Sectors

As for the sectors and fields of businesses operating in the villages, trade and commerce rank the highest with 58% of the sample size. Skilled workers account for 9%, a percentage similar to that of people working in the farming and agriculture sector. These three sectors represent the economic sector of most rural areas in Lebanon, as shown in **Figure 16-15**.

However, both farming and agriculture are considered seasonal work and their demand for energy is also seasonal, unlike general services which rely heavily on energy to power their operation and production. On the other hand, government and military employment constitute year-round employment under a consistent regular work schedule which dictates their associated energy consumption.

Figure 16-15 SME Economic Sectors



In terms of gender, **Table 16-11** shows that female business ownership is extremely low since in rural areas women are mostly housewives. Nonetheless, out of the 140 SMEs and business owners, in Quobaiyat, 4% are female business owners. Males are the main providers of household income and 96% of interviewed business owners were male. The social structure of households in rural areas allows women to be active and working; however, the nature of such involvement is limited to certain professions such as teachers or supporting the husband at his business whether it is farming or sales.

Table 16-11 SME Gender Distribution of Business Ownership

SME Gender Distribution of Business ownership				
Business Owners	**Quobaiyat**	**Fnaidek**	**Grand Total**	**%**
Female Business Owners	5	0	5	4%
Male Business Owners	47	88	135	96%
Grand Total	52	88	140	100%

While most businesses run continuously to support the local economy, some businesses are considered seasonal. The aspect of the business determines the cost burden of energy especially when electricity outages prevent at times business owners from operating and working more.

SME Business Cycle, Energy Consumption and Burden

The proportion of businesses operating yearly (i.e. continuously) in both Quobaiyat and Fnaidek is 69% whereas that of businesses operating seasonally is 30%, as shown in **Table 16-12**.

Table 16-12 SME Business Cycle

Business Cycle	Quobaiyat	Fnaidek	Grand Total	%
Monthly	1	0	1	1%
Yearly	20	77	97	69%
Seasonal	31	11	42	30%
Total	**52**	**88**	**140**	**100%**

Seasonal work can be related to summer season or agriculture season while year-round businesses are businesses that focus on serving the village residents on a year-round basis.

In Fnaidek, 88% of its businesses operate yearly and 13% seasonally. In Quobaiyat, SMEs enjoy a 38% yearly business operation while 60% are seasonal. With such levels of operation, electricity becomes a necessity and a financial burden on businesses especially when power cuts as long as 18 to 20 hours were assessed by the surveys. Fnaidek is also suffering a consistent 14 hours of power outage per day leaving businesses completely dependent on subscriptions to generators with the high cost expressed at 750 LBP /kilowatt equal to (0.5USD/Kilowatt).

Table 16-13 shows the frequency of power cuts which impact the economic cycle and development in the country. The Akkar region is seriously affected and is suffering the consequences of the high cost of energy using alternative supplies.

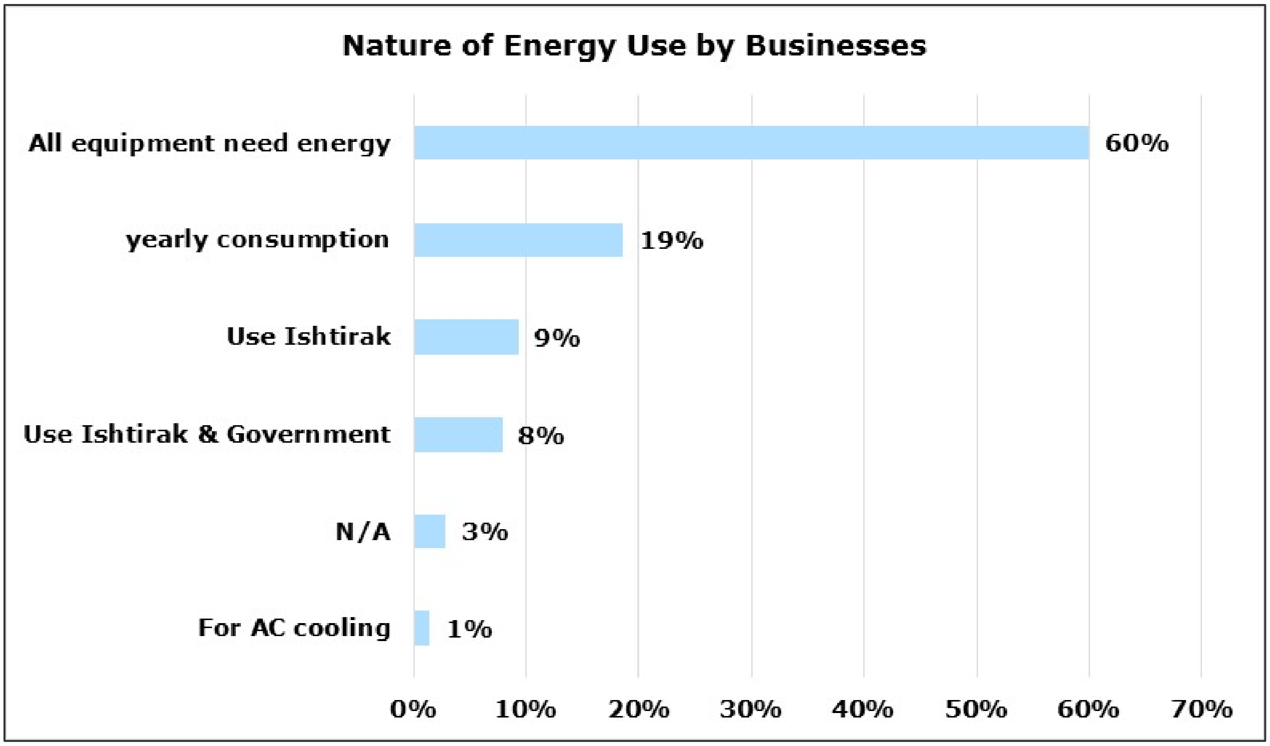
Table 16-13 Percent of SMEs Reporting Numbers of Hours of Power Cuts / Day

Hours of Power Outage / Day	Percent
Quobaiyat	
8 Hours	7.7
10 Hours	7.7
12 Hours	15.4
18 Hours	30.7
19 Hours	7.7
20 Hours	23.1
21 Hours	7.7
Fnaidek	
14 Hours per day	100

With economic development also depending on electricity, businesses are obliged to have subscriptions to private generators or resort to other alternative solutions if they can afford it in order to remain productive and sustain their operations.

Figure 16-16 shows the nature of energy use by businesses. Businesses operating machinery and equipment require the largest amount of energy regardless of the cost incurred (the word '*Ishtirak'* refers to subscription to private generators). In Fnaidek, 85% of businesses need subscriptions to generators to power their equipment while in Quobaiyat only 17% need the latter. Also, the use of heating and cooling in businesses is limited to 4% of the businesses in Quobaiyat.

Figure 16-16 SME Nature of Consumption of Energy



Nonetheless, an overall proportion of 19% of businesses have yearly consumption alternating between government and subscription to generators. In Fnaidek, 15% of businesses rely completely on subscription to a generator; 'Ishtirak' is their only viable source of energy (Note: Ishtirak means subscription to private generator).

The burden of needing another source of energy to power a business has its financial weight on business profitability since it consumes much of its earnings, especially when the business is associated with a high energy consumption level.

A cross comparison between electricity fees of government vs subscription rates, as shown in **Table 16-14**, indicates that businesses paid private generators 167 to 705% more than what they paid for the government supplied energy.

This energy cost comparison which compared the reported cost of consumption between government cost and that of subscription to private generators, as shown in **Table 16-15**, shows that due to the long hours of power cuts, businesses are ending up paying high costs that could be cheaper if more energy was supplied by the government.

Table 16-14 SME Energy Cost Comparison

Energy Cost Comparison		
Cost Gove /Month	**Cost Ishtirak /Month**	**Burden Ratio**
20,000	141,000	705%
90,000	150,000	167%
20,000	120,000	600%

Table 16-15 Dependency on Subscription to Generators

Do You Have Subscription to Generator?	Quobaiyat	Fnaidek	Total	Burden Ratio
Ishtirak	13	88	101	72%
No	0	0	0	0%
N/A	39	0	39	28%
Total	52	88	140	100%

72% of the people interviewed have subscriptions to generators, a fact that shows the importance of alternative energy in the absence of a better and more affordable source. The owners of the generators, in many cases, are benefitting from their monopoly as the sole suppliers of alternative energy in certain specified regions. In reality, every business owner is also a household owner which makes the burden of having energy cost more because of two subscriptions at the same time. The cost of energy that most active businesses in both villages pay is similar by cost i.e. 750LBP/kilowatt with a single variation: the consumption level which varies depending on the nature of their business operation and sector, for example industry vs services.

Consumption and Costs

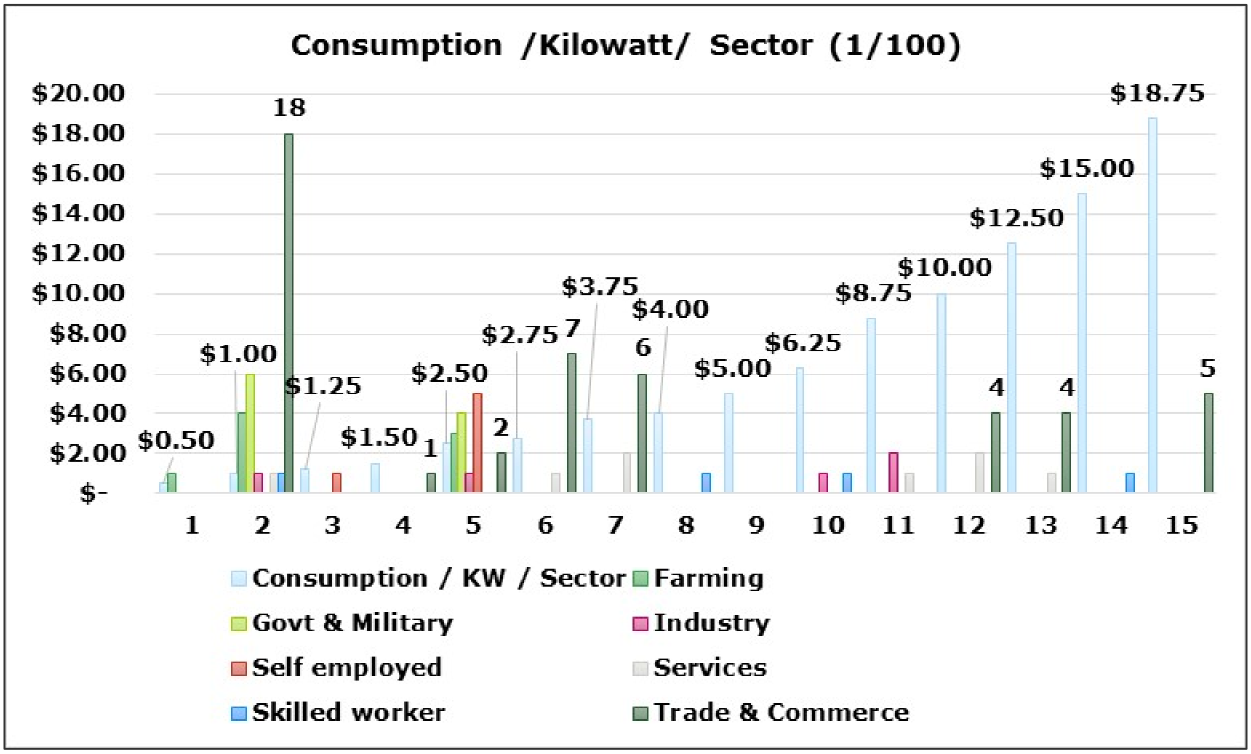
The additional expenses paid to acquire electricity could be allocated to improving livelihoods and business growth. **Table 16-16** shows cost paid from subscription by sector in USD. The income distribution remains the same across all sectors in both villages. For example, the respective cost of energy from generator subscriptions for business owners is up to 875USD per month for the industrial sector, 250USD for the farming sector, 1,250USD per month for the service sector, and up to 500USD per month for skilled worker’s workshops.

Table 16-16 Highest Cost Paid from Subscription by Sector in USD

Sector	Highest Cost of energy from subscriptions by sector in USD
Industry	875
Agriculture	250
Services	1250
Skilled worker	500

The direct correlation between income level and livelihood condition has been proven by the total cost of consumption of energy since energy takes a big portion of household and SME income in order to sustain a business and a household. **Figure 16-17** below shows the variations in energy expenses per sector. Costs of energy consumption in businesses range between 100USD to 150 USD per month for those with six operating hours, and a high of 800 to 1,500USD per month for those with ten operating hours.

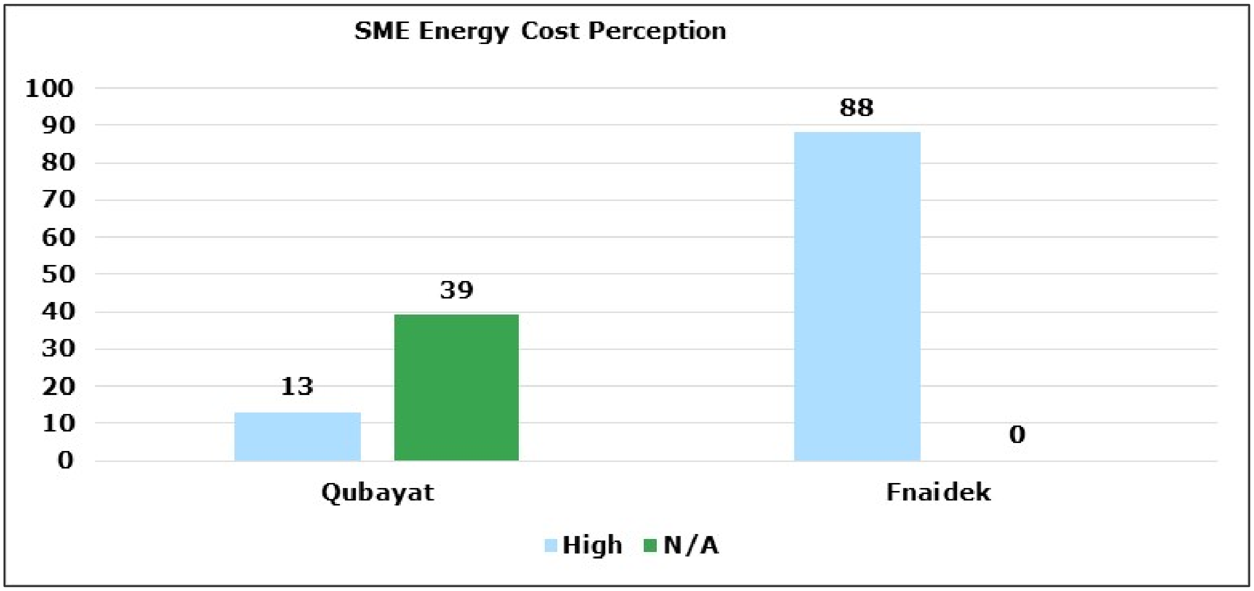
Figure 16-17 SME Consumption / KW / Sector



The survey feedback from SMEs indicates how much each sector bears as a minimum and as a maximum cost of energy which is expressed by 100% of the sample size as the high cost of energy. 74% of the SMEs state that the energy cost is high; this indicates the need for suitable alternative energy such as that proposed by the Project. **Figure 16-18** reflects qualitatively the burden of paying a high cost of energy from subscription to private generators with 100% of Fnaidek showing the high burden compared to 25% SMEs in Quobaiyat.

As expressed earlier, despite the income level and nature of the targeted entities, i.e. households or businesses, the cost of electricity remains high with only two alternatives available: government conventional energy or subscription to private generators.

Figure 16-18 SME Energy Cost Perception



Consumption Level per SME per Kilowatt

Similar to households, businesses are currently consuming power from generator energy at a rate of 0.50USD/kilowatt plus a basic subscription of 25,000 LBP. The same subscription package is used in almost all regions of rural Lebanon including the Akkar region. The only difference is the level of consumption by the businesses and the capacity and dependency on energy, which is high as **Table 16-17** shows.

Table 16-17 SME Capacity Consumption Per KW/M

Capacity SME /KW/Month	Quobaiyat	Fnaidek	Grand Total	%
0 -100	26	40	66	47%
100 - 200	12	33	45	32%
200 - 240	9	8	17	12%
Open Meter	5	7	12	9%
Total	52	88	140	100%

Unlike households, businesses cannot significantly control their consumption of energy. Out of the 140 sample sizes, only 12 businesses have an open meter, permitted as their businesses depends highly on running energy. On the other hand, 79% fall within the normal consumption moderate level indicating that business owners are sacrificing extra working hours in order to save on the cost of energy. Therefore, it is clear that the high cost of energy is limiting productivity.

With respect to the amount of energy consumed by each business within a specific sector in order to maintain its business running, the baseline survey captured the maximum consumption value for each sector and its monthly consumption per kilowatt. For example, in Quobaiyat, the trade and commerce sector pays up to 5,238USD for a Medium to Large Enterprise with a total of 307 KW/Month, whereas the farming sector, which, is seasonal pays 2,567USD with a 1,019 KW/Month. The services' sector, on the other hand, consumes around 180 KW/Month with a maximum of 200USD as a monthly expense.

Consumption Level per Sector per KW

The livelihood of families in rural areas is vulnerable especially when expenses are high and there are unregulated costs of basic needs, such as the cost of energy. **Table 16-18** provides a breakdown of energy consumption for each SME by professional sector and converts this to average monthly expenditure for Quobaiyat and Fnaidek. 99% of the surveyed SMEs across all sectors confirming that the extra cost of energy imposes a financial burden on them, as shown in **Figure 16-19**. Such a burden can only be addressed by improving the supply of government electricity through the use of alternative renewable energy sources which are readily available in the area, such as wind energy. The baseline assessment also showed the direct correlation between energy and productivity which in turn impacts the local economy directly.

Table 16-18 SME Consumption Level per Sector and KW

Quobaiyat	Consumption / Sector / Month	# of Businesses	Average Monthly Consumption	Consumption /KW/Month
Services	USD 200	2	USD 100	180
Industry	USD 233	2	USD 117	213
Skilled Worker	USD 647	8	USD 81	157
Self Employed	USD 1,500	1	USD 1,500	2960
Farming	USD 2,567	5	USD 513	1019
Trade and Commerce	USD 5,238	34	USD 154	307
Total	USD 10,385	52	USD 2,465	
Fnaidek	**Consumption / Sector / Month**	**# of Businesses**	**Average Monthly Consumption**	**Consumption /KW/Month**
Farming	USD 293	7	USD 42	78
Self Employed	USD 367	6	USD 61	116
Government Military	USD 427	10	USD 43	81
Industry	USD 727	5	USD 145	283
Skilled Worker	USD 727	5	USD 145	283
Services	USD 1,400	8	USD 175	345
Trade and Commerce	USD 6,640	47	USD 141	282
Total	USD 10,580	88.00	USD 753	

Figure 16-19 SME Subscription Cost Burden

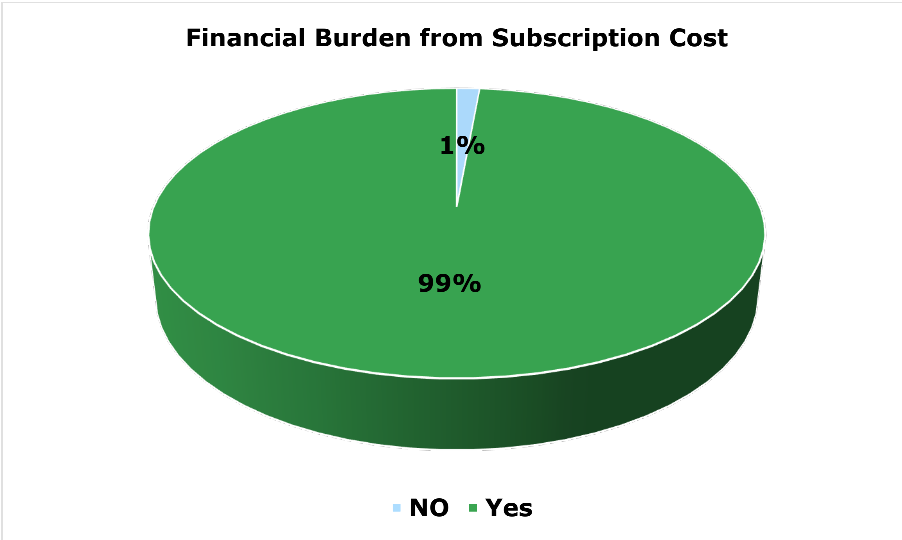


Table 16-19 shows a negative effect of energy shortage on SMEs. 96% consider their businesses directly affected by the lack of sufficient energy or its high cost or both together.

Table 16-19 Negative Effect of Energy Shortage on SMEs

Does Your Business get affected by energy supply level?	Quobaiyat	Fnaidek	Grand Total	Burden ratio
No	5	0	5	4%
Yes	47	88	135	96%
Total	52	88	140	100%

16.2.5 Rweimeh Village [1]

Because only high level socioeconomic data was provided for Rweimeh Village, it is summarized collectively in **Table 16-20**.

[1] Socioeconomic baseline data was provided by Mr. Abdo Jaafar, the focal point of El Rweimeh Village.

Table 16-20 Rweimeh Village Socioeconomic Data

Rweimeh Profile				
Livelihood		**Area**	**Shiite**	**Sunni**
The average monthly income is: 1,500 USD/Month.		300,000m^2	98%	2%
Total Households	**Summer Occupation**	**Winter Occupation**	**Private Generators**	**EDL**
120	120	12 (10%)	No neighborhood Private generator, but some households have their own generators, and they use the Lux or candles as an alternative.	EDL between 8 to 12 hours per day but non-continuous (e.g. 6 hours on and 6 hours off)
Total Inhabitants	**0-18 Years of Age**	**18 -40 Years of Age**	**40 and Above**	
480	240 (50%)	144 (30%)	96 (20%)	
Clinics	**Schools**	**Stores**	**Gas Stations**	
1 Clinic, now closed, that was open from 1960 to 2000.	1 School that closed 15 years ago.	No stores.	1 small Gas Station with a small grocery store.	
Lebanese Government	**Doctors**	**Engineers**	**Shop Owners**	**Truckers**
15	2	2	Some villagers own several commercial stores in Hermel.	Some villagers transport goods between Lebanon and Syria.

16.2.6 Socioeconomic Data Collected by Hawa Akkar

Hawa Akkar collected socio-economic data from 14 villages and towns within a range of a minimum of 20km (Quobaiyat) to a maximum of 45km distance from the city of Halba (including Wadi Khaled). The data collected from these villages is provided herein to represent the villages in the middle study zone around the three wind farms, as presented in **Table 16-21** through **Table 16-24**.

Table 16-21 Geographical Location of the Villages

Geographical Location	Distance from Halba (Km)	Distance from Tripoli (Km)	Distance from Beirut (Km)
Quobaiyat	20	50	140
Mqaible	32	72	141
Khat El-Petrol	35	73	145
Sahle	35	70	146
Chadra	26	90	146
Machta Hammoud	27	55	148
Andaket	30	60	150
Machta Hassan	32	65	150
Wadi Khaled	45	75	160

16.2.7 Land Lease and Acquisition

As presented in **Section 2 Project Description**, land issues are one of the most important considerations during Project development and implementation. Land parcels needed for the Project are owned by the Municipality of Fnaidek to the west and the Jaafar Family to the north and east (i.e. Karm Chbat and Rweimeh Village). Engagement with the Jaafar Family leadership began in 2017 to support the planned development of the Project. Following cadastral survey in 2018, land agreements have been executed as follows:

- Land tenure has been secured for a period of 28 years at an agreed price of US$34,000 / year during Phase 1 Technical Studies and Installation, US$7,000 /MW / year during Phase 2 Operations and Maintenance, and US$583.33 / MW / month during Phase 3 Decommissioning.
- Paperwork was filed by the Developer with the Ministry of Finance General Directorate of Land Registry and Cadastre to lease land parcels in Fnaidek Municipality and Karm Chbat.
- The plots subject of the abovementioned lease agreements are free from any occupant, liabilities, rights, liens, or encumbrances. The Project land take will not result in resettlement/economic displacement (loss of livelihoods).

Nonetheless, 155,611m^2 will be leased for the Project for 28 years, and 3,500m2 will be acquired permanently. This represents a loss of access to land by the Municipality of Fnaidek, Rweimeh Village and Karm Chbat.

Table 16-22 Population of Villages

Population	Wadi Khaled	Machta Hassan	Quobaiyat	Mqaible	Aandqet	Sahle	Khat El-Petrol	Chadra	Machta Hammoud
Registered Population	20,000	4,600	15,000	5,800	6,500	3,250	1,000	8,000	7,000
Residents during Summer	20,000	4,000	8,000	4,800	4,000	3,200	1,500	4,500	500
Residents during Winter	20,000	4,000	6,000	4,800	2,000	650	1,500	300	6,500
Constituents	7,000	2,600	10,000	2,600	4,000	1,400	300	3,648	3,272
Syrian Refugees	12,000	700	600	3,000	500	320	460	30	900
Male	50%	50%	47%	48%	48%	45%	48%	43%	40%
Female	50%	50%	53%	52%	52%	55%	52%	57%	60%
Less than 18 Years	50%	40%	33%	30%	35%	30%	33%	20%	41%
Between 18 and 39	27%	25%	30%	35%	25%	35%	30%	30%	40$
Between 40 and 64	13%	25%	30%	30%	25%	29%	30%	35%	15%
65 Years and Above	10%	10%	7%	5%	15%	6%	7%	15%	4%
Urban Area	20%	40%	33%	7%	10%	15%	10%	37%	40%
Agricultural Land	45%	30%	33%	5%	20%	35%	90%	8%	50%
Forests	5%	10%	34%	15%	60%	25%		29%	5%
Grazing Areas	30%	20%		68%	10%	25%		26%	5%
Other				5%					
Minimum Hours of Daily Electricity Cuts	16	16	12	17	12	14	16	10	12
Maximum Hours of Daily Electricity Cuts	16	16	18	17	18	18	16	16	15
Number of Educational Institutions	8	2	8	3	2	0	1	1	4
Total Number of Students	3,000	600	2,500	1,300	750	0	500	280	2,000
Private Hospitals	0	0	1	0	0	0	0	0	0
Dispensaries and Health Centers	0	1	3	0	2	0	1	1	2
Pharmacies	0	2	5	1	3	0	0	0	1
Agriculture	82%	80%	42%	48%	7%	50%	61%	13%	5%
Trade and Services	9%	8%	28%	43%	45%	6%	37%	39%	28%
Public Administration and Defense	3%	10%	25%	6%	40%	44%	1%	40%	24%
Other	7%	2%	5%	4%	8%		1%	8%	43%

Table 16-23 Average Household Size

Average Household Size	Average Household Members
Quobayat	4
Machta Hassan	5
Aandqet	5
Sahle	5
Chadra	5
Machta Hammoud	5
Mqaible	7
Wadi Khaled	8
Khat El-Petrol	8

Table 16-24 Educational Institutions According to Sector and Level of Education

Village	Sector		Educational Level				
	Public	Private	Pre-School	Elementary	Intermediate	Secondary	VET
Wadi Khaled	X		X	X	X		
Wadi Khaled	X		X	X	X		
Wadi Khaled	X		X	X	X		
Wadi Khaled	X		X	X	X		
Wadi Khaled	X		X	X	X		
Wadi Khaled	X		X	X	X		
Wadi Khaled	X					X	
Wadi Khaled	X					X	
Quobaiyat	X						X
Quobaiyat	X					X	
Quobaiyat	X					X	
Quobaiyat	X			X	X		
Quobaiyat		X		X	X		
Quobaiyat		X		X	X		
Quobaiyat		X					X
Quobaiyat	X						
Mqaible	X		X	X	X		
Mqaible	X		X	X	X		
Mqaible	X					X	
Machta Hammoud	X				X		
Machta Hammoud		X			X		
Machta Hammoud	X						X
Andaket		X	X	X	X	X	
Andaket		X					X
Machta Hassan	X		X	X	X		
Machta Hassan	X					X	
Khat El-Petrol	X		X	X	X		
Chadra	X						X

16.3 Land Access for Shepherds and Hunters

16.3.1 Shepherds Using the Project Area for Grazing

Information regarding shepherds grazing animals in areas near the Project was acquired from the Department of Grazing at the Ministry of Agriculture (Ms. Zeina Tamim). Mr. George Roustom (Head of Department of Aandqet Forests visited the Project site on 22 February 2019, and Mr. Mohammad Mostapha (Head of Department of the Qammouaa Forest) visited on 25 February 2019, who stated that they maintain grazing information covering the Project area. The shepherds grazing in the area and their villages of residence are shown in **Table 16-25**.

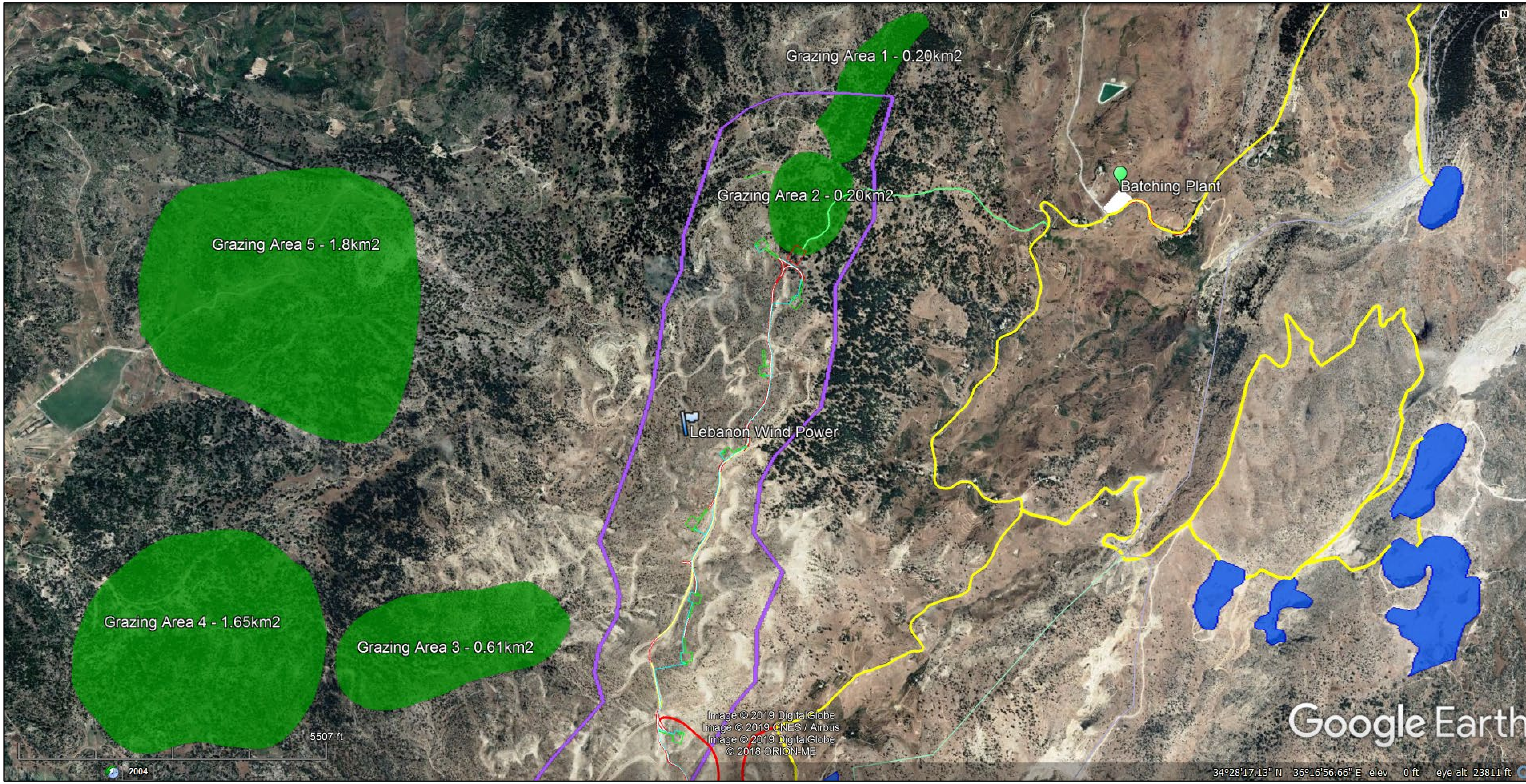
Table 16-25 Shepherds in the Area

Name	Village of Residence
Mahmoud Khaled El Kek	Fnaidek
Ali El Shaikh Hassan Zakaria	Fnaidek
Abdu El Shaikh Hassan Zakaria	Fnaidek
Mohammad Elshaykh Hassan Zakaria	Fnaidek
Ali Hammoud Zahraman	Fnaidek
Omar Ahmad Al Karir	Fnaidek
Ali Mohammad Kabalan	Fnaidek
Dib Ali Mostafa	Fnaidek
Jamil Darwish	Fnaidek
Khaled Abdul-Karim Darwish	Fnaidek
Hassan Saleh Kabalan	Fnaidek
Abed El Karim Bakkar	Fnaidek
Mohammad Hassan Dib Ali	Fnaidek
Ahmad Abu Aamsha Moundil	Fnaidek
Khodor Abu Aamsha	Fnaidek
Ahmad Abu Aamsha EL Aarnous	Fnaidek
Ali Hussein	Akkar El Atiqa’a
Ahmad Mostafa El Adraa	Jabal-Akroum Kfartoun
Mohammad Mostafa el Adraa	Jabal-Akroum Kfartoun
Ahmad Yassin el Adraa	Jabal-Akroum Kfartoun
Mohammad Shawki El Adraa	Jabal-Akroum Kfartoun
Yassin Mohammad Hassan Melhem	Jabal-Akroum Kfartoun
Ahmad Hassan Ali Melhem	Jabal-Akroum Kfartoun
El Adraa Khaled El Adraa	Jabal-Akroum Kfartoun
Ayyub Naaman	Jabal-Akroum Kfartoun
Mohammad Hussein Naaman	Jabal-Akroum Kfartoun

Based on the information obtained, 26 shepherds from Fnaidek, the closes village to the Project, and represent 61% of the shepherds. The grazing areas near the Project are shown in green in **Figure 16-20**. Two (2) of the smaller grazing areas are located within the immediate study zone, and as such, grazing at this location will be prohibited during the construction phase, i.e. 90 days. However, the Fnaidek shepherds will be able to use the other grazing areas without restriction.

Both Grazing Area 1 and Grazing Area 2 are 0.20km^2, resulting in a temporary prohibition of grazing of 0.40km^2. The grazing areas that will remain accessible are Grazing Areas 4, 5 and 5, and represent 4.06km^2, and are nearer to Fnaidek. Therefore, there is temporary loss of access of land for grazing of 8.6% of the total available.

Figure 16-20 Grazing Areas Used by Fnaidek Shepherds Within or Near the Project



16.3.2 Hunters Using Tracks Within or Near the Project

As discussed in **Section 6 Stakeholder Engagement and Consultation**, Key Informant Meetings were held with bird hunters using tracks within and near the Project, as shown in **Figure 16-21**. During these meetings, the hunters (who requested anonymity) were advised that access to tracks within the Project area would be temporarily prohibited during the construction phase for a period of 90 days. The hunters indicated the following:

- Birds seems to avoid the installed masts and are not flying around them.
- No one in the area makes a living from hunting, it is a hobby only.
- The hunters confirmed that they can find another place to hunt.
- Hunting as a hobby usually comprises hunting at a diversity of sites.
- There were different opinions about the Project; while some of the hunters believe that the Project is beneficial for the area and therefore it is ok if they change the place of their hobby; others think that the Project is not beneficial for them as their hobby will be affected.
- Some hunters were concerned about nature more than their hunting. They mentioned that the migratory birds are part of the equilibrium of the ecosystem and should neither be hunted nor be harmed by turbine blades as they are responsible of reducing the number of snakes, rats and dead animal corpses.
- The hunters mentioned that the shops selling hunting equipment / bullets may be affected by the Project.
- A lot of local businesses benefit from hunting season especially bungalows, cafés and restaurants. Their income may be affected if hunting activities are decreased.

16.3.3 Businesses Near the Project

While the hunters mentioned that the income of local businesses including accommodation and restaurants may be affected by the Project, the Project is expected to contribute positively as construction workers may need accommodation, dine at restaurants, and make purchases in the area.

The availability of accommodation sufficient for the 150 construction workers, if necessary, is currently being investigated. Depending on the OEM/EPC Contractor selected, a worker camp may be constructed; alternatively, workers may drive or be transported by bus to and from nearby villages, depending upon where workers reside.

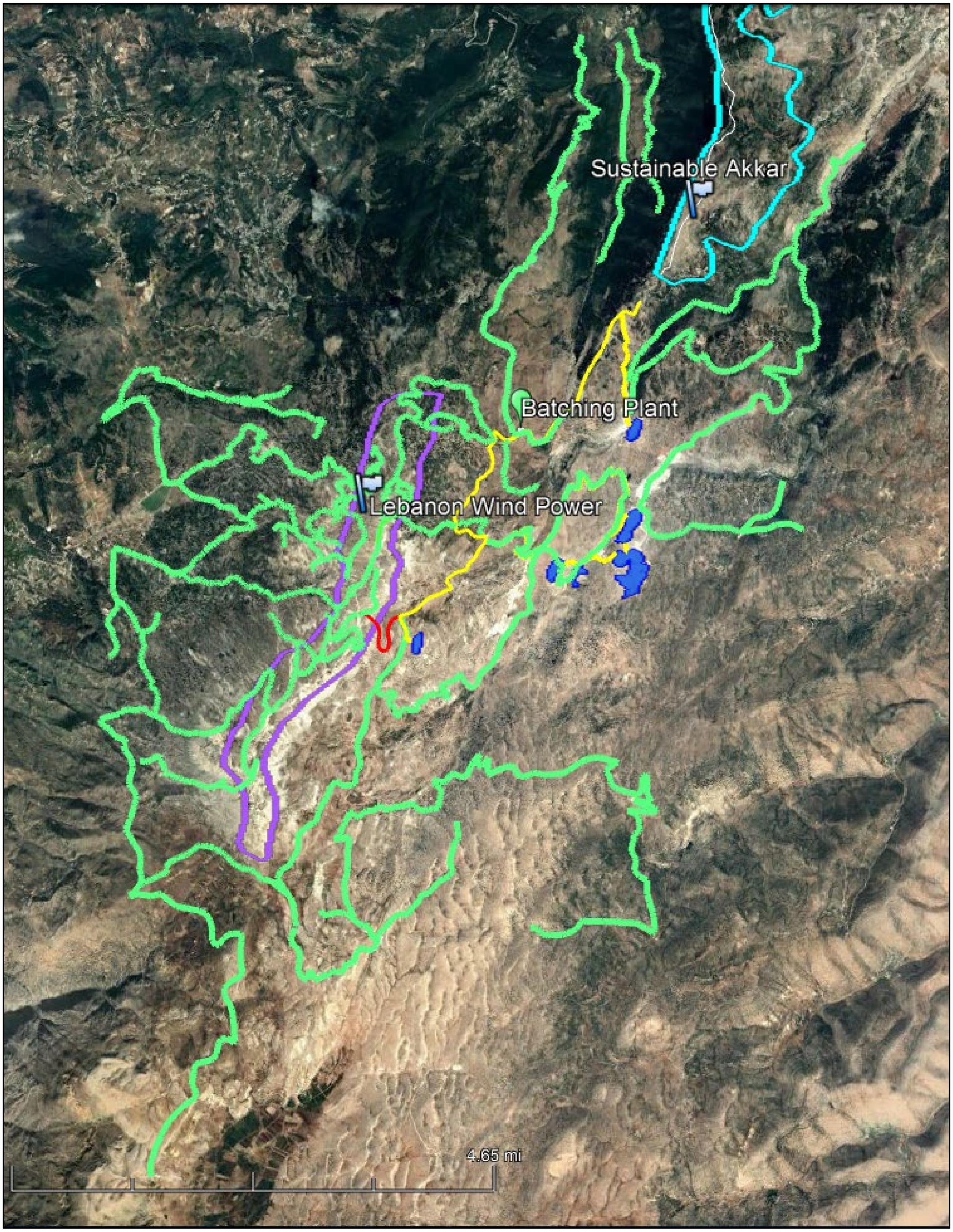
The findings will be incorporated into the mitigation.

16.3.4 Vulnerable Groups

Vulnerable groups considered during the development of the ESIA include the following:

- Women: due to cultural norms in Lebanon (and specifically within the context and setting of the Project area), the participation of women in the decision-making process is limited which could result in overlooking any specific concerns they might have.
- Elderly: due to civil status and potential decline, this could limit their participation in the decision-making process which could result in overlooking any specific concerns they might have.

Figure 16-21 Hunting Tracks Near and Within the Project Area



- Informal settlements and Syrian and Palestinian refugees in Lebanon in general, and in Akkar in particular. This includes people that have fled from their home to seek safety in Lebanon, many of whom are excluded from key facets of social, political and economic life. As they face restrictions on legal status and human rights, this could limit their participation in the decision-making process which could result in overlooking any specific concerns they might have.

The gender and age breakdowns in villages in the DAOI and IAOI were previously presented in **Section 16.2**.

The location of informal settlements are presented in **Figure 16-22**.

In addition to informal settlements, UNHCR has developed a map of vulnerable population groups throughout Lebanon, as shown in **Figure 16-23**.

16.3.5 Potential for Influx

The potential for influx by workers during the construction phase is possible, though the commitment to employ workers in the immediate area, from the northern region, from Lebanon, and lastly internationally, limit the potential impact. The potential for influx is currently being explored. Findings will be incorporated into mitigation.

16.4 Impact Assessment

16.4.1 During Construction

During the construction phase, the impact of the Project on socioeconomic conditions is expected to be primarily positive given:

- The potential for the consistent provision of electricity to meet demand.
- The expected sourcing of construction materials (concrete, steel, aggregates, etc.) from the Akkar region.
- The sourcing of Project personnel (construction workers) from the northeastern part of Akkar.
- The potential income that may be generated by nearby businesses including hotels and restaurants.

The negative impacts experienced by villages and informal settlements along the transport route are temporary and expected to result in a Moderate impact. The negative impacts experienced by Rweimeh Village during the transport of construction materials are temporary and expected to result in a Minor impact. Refer to **Section 17 Community Health, Safety and Security** for the assessment of transport and traffic impacts to communities.

Land Lease/Acquisition

While there is a land lease/acquisition process in place, and the landowners have agreed that the compensation provided is appropriate and fair, the Project represents a loss of access to 137,004m^2 will be leased for the Project for 28 years, and 3,500m^2 will be acquired permanently. The impact severity is anticipated to be Low.

Figure 16-22 Informal Settlements in Lebanon

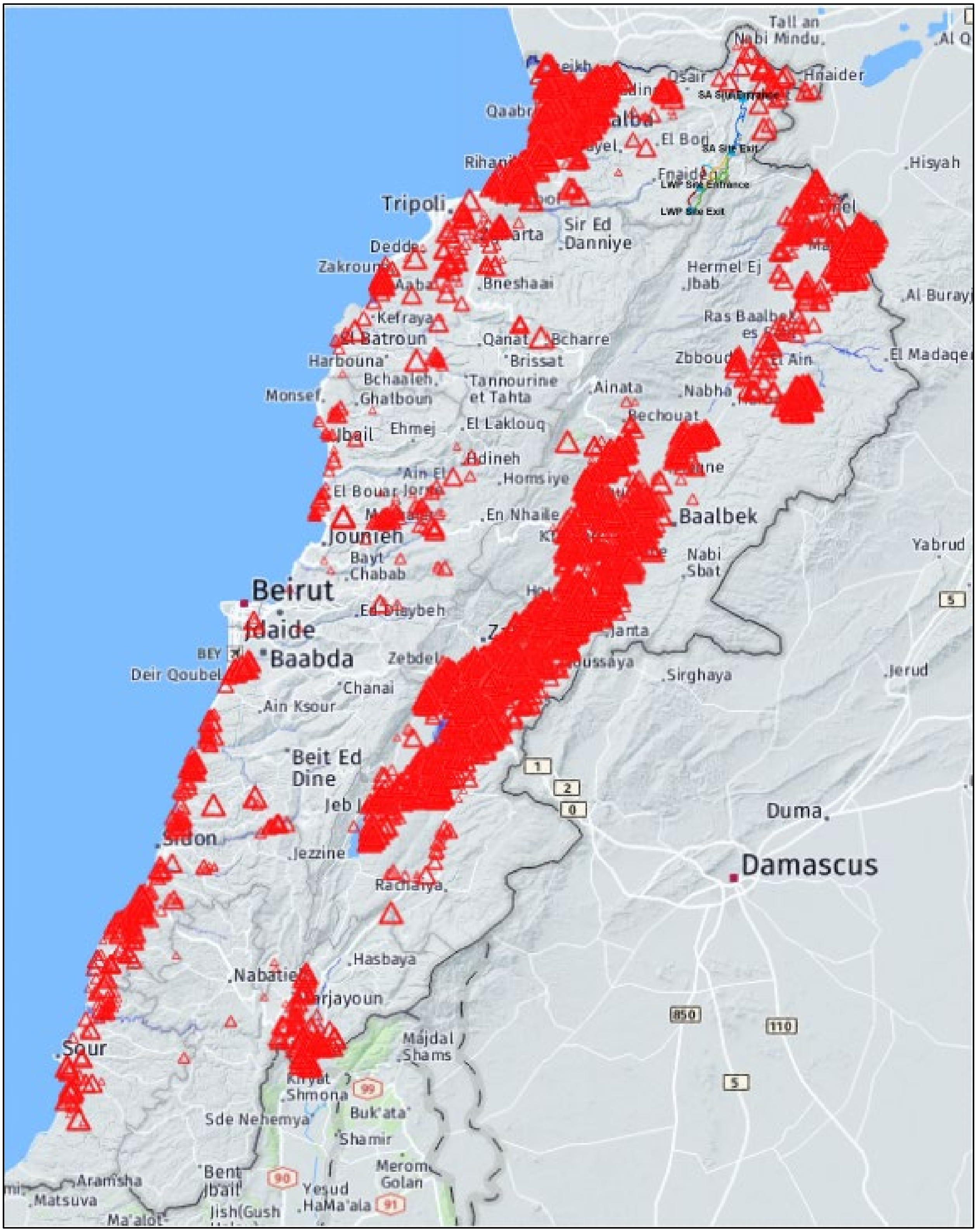
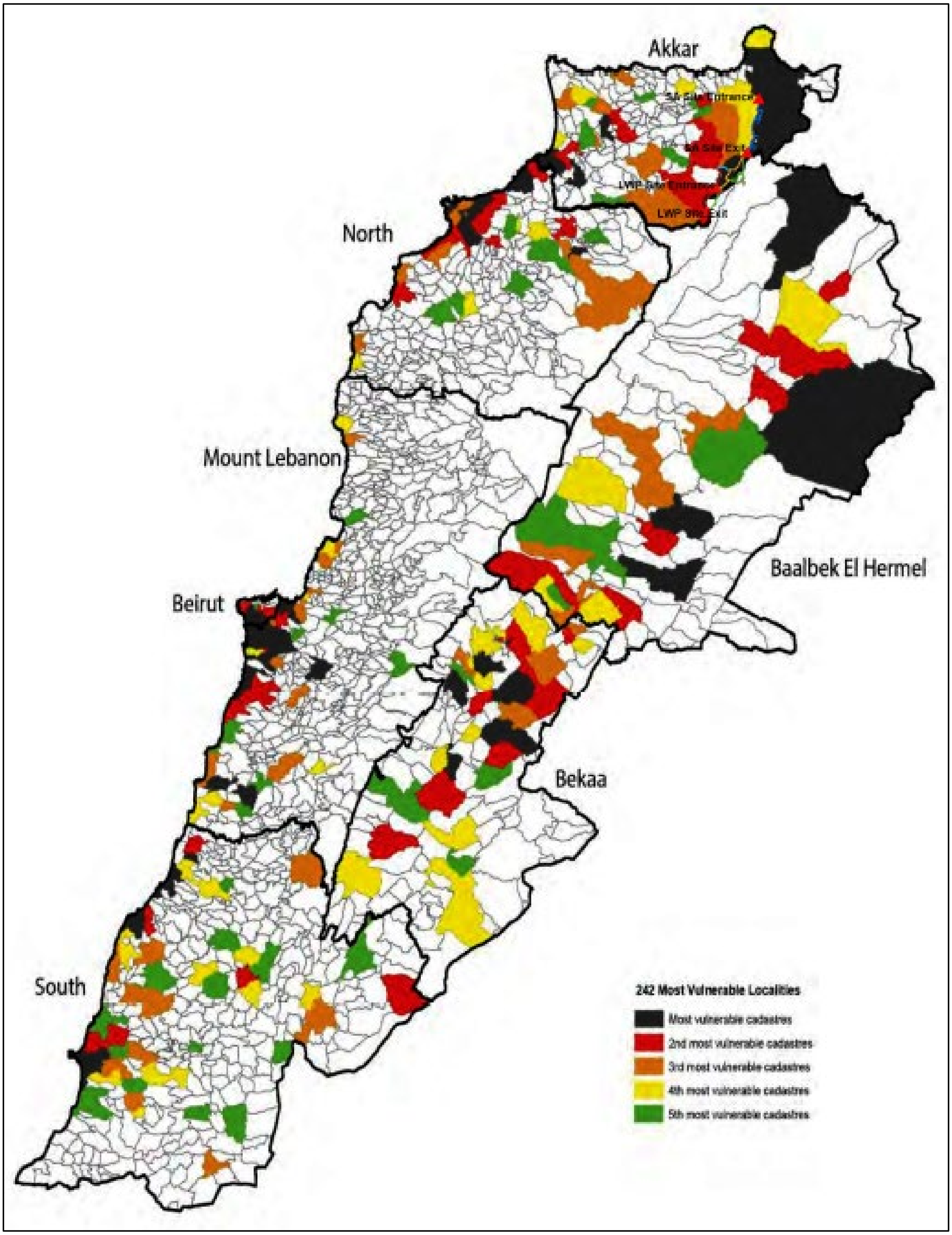


Figure 16-23 UNHCR Map of Vulnerable Population Groups in Lebanon



Access to Grazing Areas by Shepherds

Access to Grazing Area 1 and Grazing Area 2 (totaling 0.40km^2) will be temporarily prohibited of during construction. The grazing areas that will remain accessible are Grazing Areas 4, 5 and 5, and represent 4.06km^2, and are nearer to Fnaidek. Therefore, only 8.6% of the total area available for grazing will be temporarily unavailable. This impact severity is anticipated to be Slight.

Access to Tracks by Hunters

Access to tracks within the Project area would be temporarily prohibited during the construction phase for a period of 90 days. There are other tracks available for hunters, who only hunt recreationally. The impact severity is anticipated to be Slight.

Businesses Near the Project

The Project is expected to contribute positively as construction workers may need accommodation, dine at restaurants, and make purchases in the area. Therefore, the impact severity is anticipated to be Positive.

Vulnerable Groups

Impacts to vulnerable groups, including women, the elderly and informal settlements, are not expected to be disproportionately different than other community members. However, it is noted that additional measures to communicate the Project information, including provision of schedules, health, safety and security measures are necessary. The impact severity is anticipated to be Low.

Potential for Influx by Workers

The influx of workers has the potential to overwhelm businesses in the Project area; however, as indicated previously, workers are expected to drive or be transported to and from nearby villages, depending on their village of residence. Therefore, the impact severity is anticipated to be Low.

Mitigation

Mitigation measures for socioeconomic impacts are as follows:

- Agreed land lease/acquisition process.
- Advance notification of transport schedule and health, safety and security measures (refer to Section 17 Community Health, Safety and Security).
- Additional communication protocols to address vulnerable groups including women, the elderly and informal settlements.
- Establishment of the CRO Office in Jabal-Akroum Kfartoun.
- Community development projects as agreed between Municipalities and the Developer.

As such, the overall impact severity is expected to be Low, with a sensitivity of Medium-High, resulting in a Minor impact, as shown in **Table 16-26**.

Table 16-26 Assessment of Access to Grazing Areas During Construction

		Sensitivity of Receptor				
		Low	Low-Medium	Medium	Medium-High √	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	**Minor √**	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

16.4.2 During Operation

The major socioeconomic impact of the operational phase of the Project is expected to be positive, with the provision of affordable electricity to the local community and to the broader Lebanese electrical consumers.

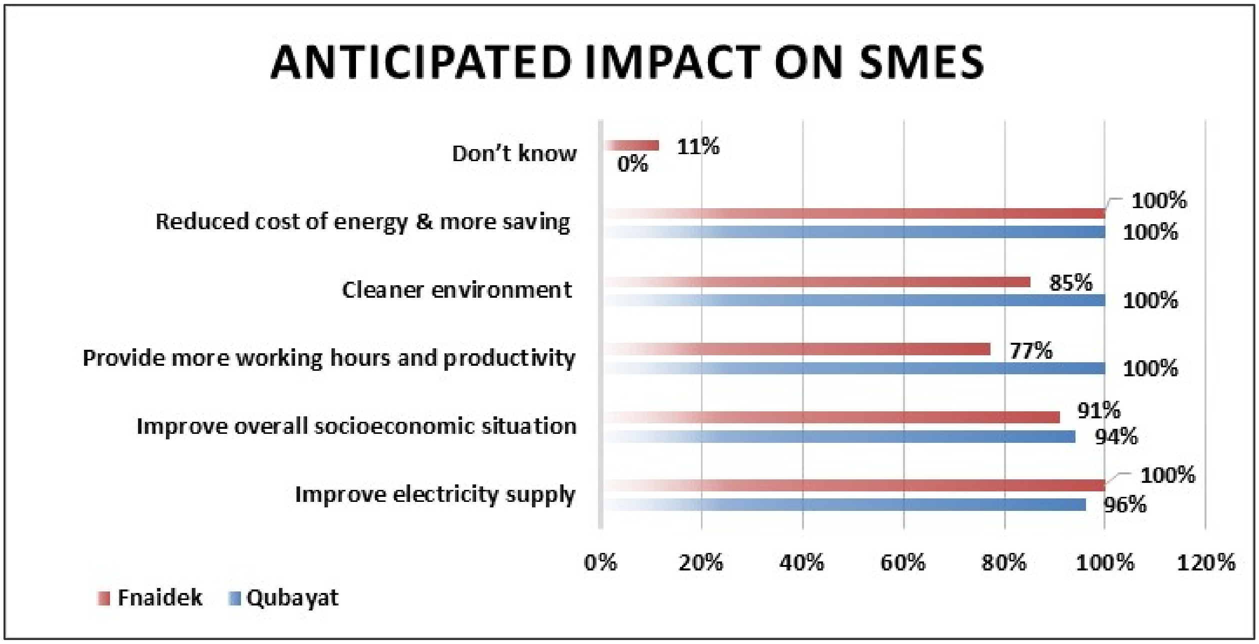
The Project is expected to provide 22KV of supply bulk power to be distributed to the residents of neighboring Quobaiyat and Fnaidek. Electrification is expected to boost the local economy by stimulating productivity and enterprise efficiency, while enhancing complementary infrastructure such as roads and transportation (Plan Blue, 2010). Additionally, energy, at the industry level is directly linked to development, and is a catalyst for production and economic growth.

In terms of economic growth and livelihoods' development, electricity positively impacts quality of life both directly and indirectly. Better energy supply means more hours of lower cost/efficient energy, longer operating business hours generating more income from work, and economic savings in comparison to the high cost of generator use. This is especially relevant given that power cuts as long as 18-20 hours were noted in the socio-economic surveys of both Quobaiyat and Fnaidek. Fnaidek also generally experiences consistent 14 hours of power outages daily, leaving businesses completely dependent on subscription to generators with expected costs around 750 LBP/kilowatt. In fact, 72% of people interviewed for this project indicated that they have generator subscriptions.

With cheaper electricity provided by the Project, economic growth is expected in all sectors that benefit from sufficient energy supply, from basic lighting needs for backyard laying hens, to the powering of large-scale industrial activities. The current additional expenses paid to acquire electricity would then be allocated to improving livelihoods and business growth. Other local socio-economic factors expected to significantly improve with the provision of low-cost energy are health and education.

In general, 79% of surveyed individuals in Quobaiyat and Fnaidek support the Project and anticipate that it will reduce their energy costs, reducing their financial burdens and increasing their production and savings. Also, all individuals surveyed anticipated that the new network would improve power distribution and reach more houses and businesses across their villages. Perceived positive impacts of the project are summarized in **Figure 16-24**.

Figure 16-24 Public Socio-Economic Expectations of the Project



An additional perceived benefit of the Project is the provision of green energy and its impact on health and the environment. 75% of surveyed businesses were completely aware of the environmental benefits of the project and indicated that they are looking forward to the project's completion and the increased energy supply to their villages.

16.4.3 During Decommissioning

Decommissioning impacts on socio-economics is expected to be similar to those noted for project construction, particularly with regards to sourcing of local labor and equipment. These impacts are expected to be moderate and positive.

17. COMMUNITY HEALTH, SAFETY AND SECURITY

This section presents the baseline and impact assessment for community health, safety and security including noise, shadow flicker, visual and traffic.

17.1. Noise

17.1.1. Baseline Methodology

There are no existing wind turbines in the area at present. However, there are two other wind energy projects (Sustainable Akkar and Hawa Akkar) planned north of the site which will be considered in the cumulative calculation.

Two background measurement campaign were conducted in the area. The first one was conducted at the Sustainable Akkar Wind Farm site in September 2018. At this measurement ten locations on the site were considered and the noise measurements were taken for time period of 15 minutes. The second measurement was performed in February 2019. At this measurement the receptor (IP 73) with the anticipated highest noise level generated by the LWP project was considered as measurement loTcation. This measurement was conducted for 48h with a concurrent wind measurement

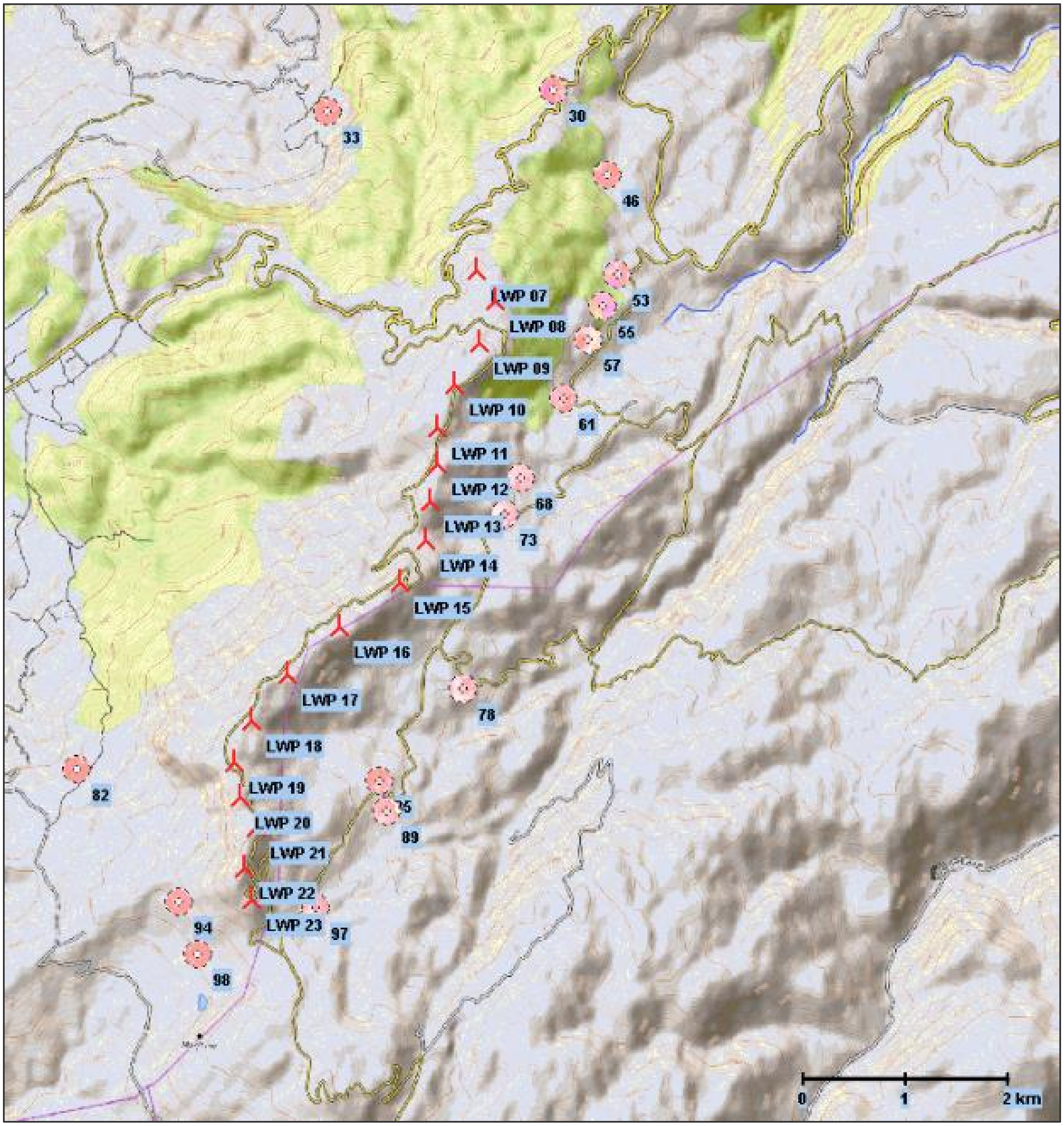
A site visit in which the relevant receptors where identified and documented was conducted on 12th September 2018 by SES. In advance of the site visit potential noise receptors were identified in a desktop study using topographical maps and aerial photographs. The EHS Guidelines for Wind Energy (2015) recommends focusing on receptors within 2,000m of any of the turbines. As a worst-case approach the closest occupied dwellings in the surrounding of the wind farm were considered as receptors. Due to the fact that the noise levels of the turbines will decrease with an increased distance to the wind farm potential receptors which are located in a greater distance will also have lower noise emissions. Therefore, this study focuses on the closest receptors to the Project site. However, the noise isolines will also provide information about the calculated noise levels in areas with a greater distance to the site. The noise receptors are shown in **Figure 17-1.**

17.1.2. Baseline Findings

17.1.2.1. Background Noise Measurement at the Sustainable Akkar Wind Farm

Background noise measurements at the nearby Sustainable Akkar wind farm (on the next mountain ridge 6-7 km north of Lebanon Wind Power site) were undertaken by the noise consultant Dr. Charbel Afif between 23th September and 1st October 2018. In compliance with the latest IEC standards and American National Standards Institute (ANSI), all noise measurements were made using a Class 1 Sound Level Meter, calibrated before and after each measurement according to the manufacturer's guidelines. As per WHO guidelines, measurements of environmental noise are best made close to the point of reception, therefore the 10 locations chosen are near a mosque, a restaurant, residential units and clinic. Each measurement period was 15 minutes at each location.

Figure 17-1 Project Noise Receptor Locations



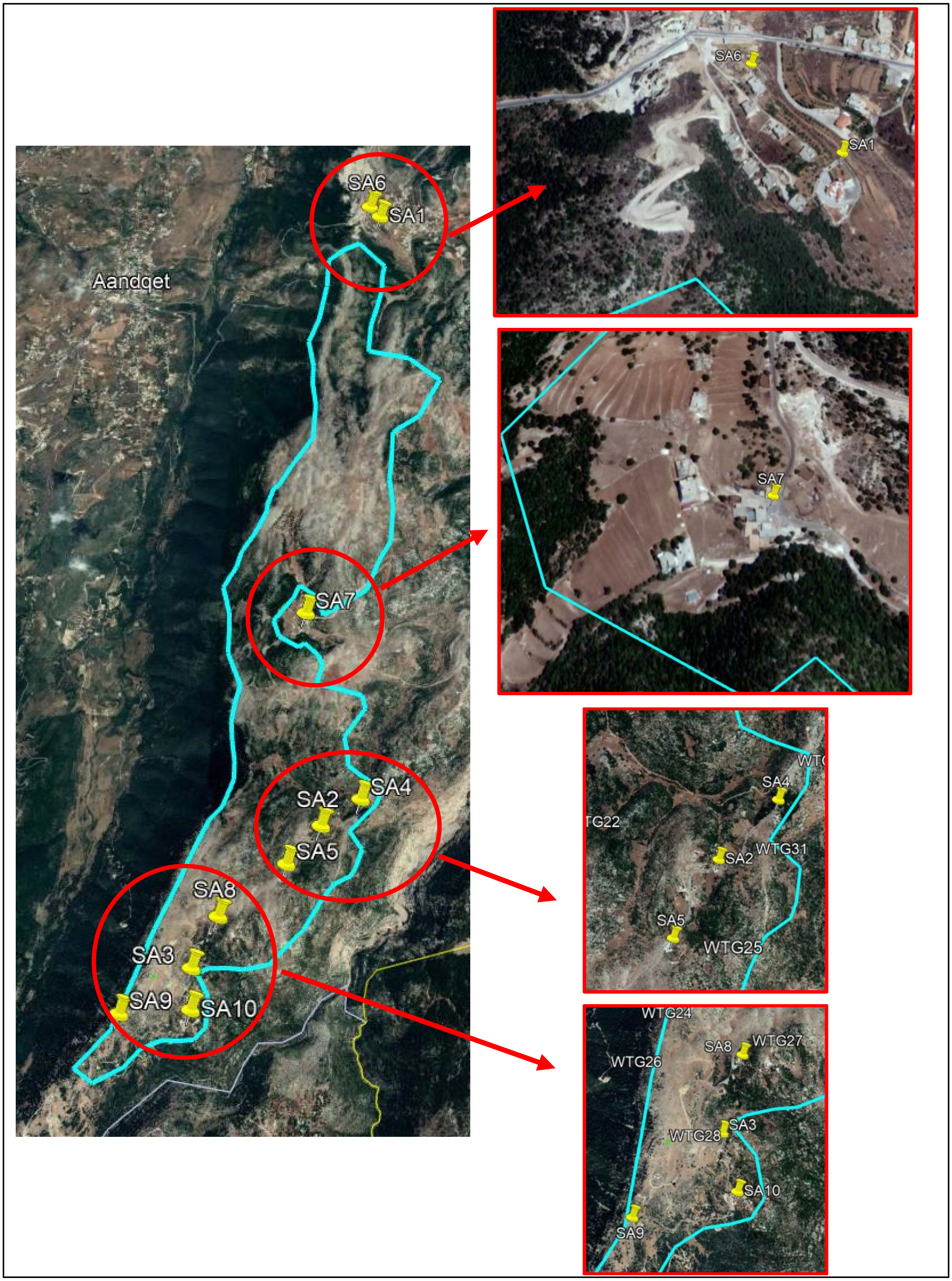
The IFC Guideline for wind energy recommends 10-minute measurement intervals rather then 15-minute periods. Therefore, a second measurement at Receptor 73 was conducted for 10-minute intervals for 48 hours as recommended in IFC Guideline 1.7 Noise. Nevertheless, the 15-minute measurement provides a good overview about the background noise situation in the area as measurements were taken at 10 different locations.

Noise level measurements were carried out over 3 days at each of the overall ten locations (SAN1 to SAN10). Each measurement lasted for 15 minutes. Sound levels were recorded during the day and again during the night in order to provide a representative baseline noise level for each period. Each measurement period lasted 15 minutes (i.e. 3 days x 2 measurements (day + night) x 15 minutes/each). Noise measurements were conducted during the day and night. The locations chosen are presented in **Table 17-1** and shown in **Figure 17-2**.

Table 17-1 Description of Sustainable Akkar Noise Monitoring Locations

Monitoring Location	Coordinates	Description
SAN1	N 34.592912° E 736.332869°	Near a few residential units and a clinic.
SAN2	N 34.534884° E 36.329091°	Near a residential unit and road leading to the WFPP.
SAN3	N 34.522998° E 36.316504°	Residential unit located around 5m from a road.
SAN4	N 34.537162° E 36.333136°	Near a road leading to the WFPP/picnic area.
SAN5	N 34.531622° E 36.325671°	Near a warehouse/storage area selling gravel.
SAN6	34.593886°N, 36.331583°E	Near few residential units and Army checkpoint.
SAN7	N 34.553742° E 36.326421°	Near few residential units and small farm.
SAN8	N 34.527236° E 36.318940°	Near residential units with an internal road leading to them.
SAN9	N 34.519296° E 36.309467°	Near a restaurant and a residential unit. Internal road leading to the restaurant.
SAN10	N 34.519597° E 36.316714°	Near a mosque and few residential units. 20 m away from the road.

Figure 17-2 Sustainable Akkar Noise Monitoring Locations



The noise metric LA90 was used to characterize the baseline noise as it is thought to be more representative of existing conditions than the equivalent sound level or LAeq because of the nature of the noise (WHO, 1999).[1] The LA90 is the measured sound pressure level (in A-weighted decibels or dB(A)) that is exceeded 90 percent of the time during a monitoring event. High noise events (such as a large transport truck passing nearby) tend to be excluded in the L90 metric. The noise metric L90 is generally considered representative of the ambient level of a noise environment (WHO, 1999).

The baseline noise levels measured at the Sustainable Akkar site are provided in **Table 17-2**. Higher noise levels were noted only once during day time at SAN9 at a residential unit near to a restaurant which was busy on 23 September 2018. The available noise data at the Sustainable Akkar site shows that the noise levels during the night time range between 25-37 dB(A). This low background noise level is typical for such a remote and mountainous area. The measurements during the day indicates a noise level of 29-40 dB(A), while one 15-minute interval was measured at 48 dB(A) where the noise meter was located close to a busy restaurant. There is no relevant technical noise preload that need to be considered in the calculation in addition to the planned wind turbines.

17.1.2.2. Background Noise Measurement at the Project

The baseline noise measurements for Lebanon Wind Power were conducted by the noise consultant Dr. Charbel Afif between 12 and 25 February 2019. Two (2) locations were chosen for the measurement campaign: one at the Sustainable Akkar wind farm (Receptor 34) and the other at the Lebanon Wind Power site (Receptor 73). The coordinates, photos and details of the monitoring locations/campaign are summarized in **Table 17-3** and shown in **Figure 17-4**. Noise was measured for an interrupted period of 48 hours at each location as per the IFC guidelines.

The noise measurements were made by a Class 1 Sound Level Meter. The sound level meter used complies with the latest IEC standards and American National Standards Institute (ANSI). It was factory-calibrated in 2018. It was also calibrated before and after each measurement according to the manufacturer's guidelines.

Meteorological data was acquired from the nearest meteorological station operated by SA. Wind speed was measured at 40.4m height. The following formula was used to calculate the wind speed to 10m height (Institute of Acoustics, 2014) with 0.05 being the standard ground roughness length.

$$WS_{10m} = WS_{40.4m} \times \frac{\ln(10/0.05)}{\ln(40.4/0.05)}$$

Baseline noise levels are presented in **Table 17-5.**

The noise background data at the Project (Receptor 73) site indicates that the noise levels (L_{A90}) during the night time range between 30-39 dB(A) while there is an increase of the noise levels at higher wind speeds. This quite background noise level is typical for such a remote and mountainous area. The measurements during the day indicates a noise level (L_{A90}) of 31-47 dB(A). While noise levels over 40 dB(A) were only observed at wind speeds over 5 m/s.

[1] WHO (1999) Guidelines for Community Noise, page 23 World Health Organization, Geneva (1999).

Table 17-2 Noise Measurements at Sustainable Akkar

Day 1	**Day time: Sunday 23/9/2018**		**Night time: Sunday 23/9/2018**	
Location	*Time*	*Noise Levels in dB(A)*	*Time*	*Noise Levels in dB(A)*
		L_{90}		*L_{90}*
SAN1	11:40 am	35.2	1:55 am	28.8
SAN6	12:10 pm	34.6	1:36 am	26.4
SAN7	1:17 pm	29.1	12:39 am	24.9
SAN4	2:10 pm	38.2	11:57 pm	29.8
SAN2	2:45 pm	31.0	11:38 pm	27.6
SAN5	3:12 pm	31.8	11:20 pm	26.7
SAN8	3:46 pm	37.7	10:59 pm	26.5
SAN3	4:06 pm	34.4	10:37 pm	24.6
SAN9	4:48 pm	47.6	10:18 pm	26.3
SAN10	5:17 pm	34.5	10:00 pm	28.8
Day 2	**Day time: Friday 28/9/2018**		**Night time: Wednesday 26/9/2018**	
Location	*Time/Period*	*Noise Levels in dB(A)*	*Time/Period*	*Noise Levels in dB(A)*
		L_{90}		*L_{90}*
SAN1	1:40 pm	38.7	2:00 am	25.8
SAN6	2:00 pm	39.8	2:22 am	28.4
SAN7	2:47 pm	32.2	3:12 am	25.9
SAN4	3:22 pm	34.9	4:12 am	35.8
SAN2	3:45 pm	32.6	4:36 am	27.8
SAN5	4:04 pm	36.1	4:57 am	25.8
SAN8	4:26 pm	35.0	5:21 am	26.9
SAN3	4:51 pm	30.3	5:43 am	25.6
SAN9	5:10 pm	33.0	6:02 am	24.3
SAN10	5:27 pm	38.0	6:24 am	31.8
Day 3	**Day time: Monday 1/10/2018**		**Night time: Monday 1/10/2018**	
Location	*Time/Period*	*Noise Levels in dB(A)*	*Time/Period*	*Noise Levels in dB(A)*
		L_{90}		*L_{90}*
SAN1	10:40 am	33.2	2:00 am	26.9
SAN6	10:22 am	35.6	2:26 am	27.2
SAN7	9:47 am	31.5	3:13 am	25.6
SAN4	9:03 am	35.8	4:17 am	36.9
SAN2	8:38 am	31.6	4:39 am	26.8
SAN5	8:17 am	31.8	5:02 am	26.8
SAN8	7:55 am	34.6	5:22 am	33.9
SAN3	7:36 am	31.2	5:46 am	25.6
SAN9	7:18 am	30.6	6:03 am	24.2
SAN10	7:00 am	31.5	6:24 am	33.8

Table 17-3 Noise Monitoring Locations

Monitoring Location	Coordinates	Details of The Monitoring Campaign	Photographs
NM SA - IP34	Zone 37S/ 34.527319°N, 36.321035°E	Start date: 2/12/2019 8h40 End date: 2/14/2019 8h50 Period 48.16 hours Height: 1.5 m above ground	
NM LWP - IP73	Zone 37S/ 34.473917°N, 36.268675°E	Start date: 2/23/2019 16h50 End date: 2/25/2019 17h50 Period 49 hours Height: 1.5 m above ground	

Figure 17-4 Project Noise Monitoring Locations

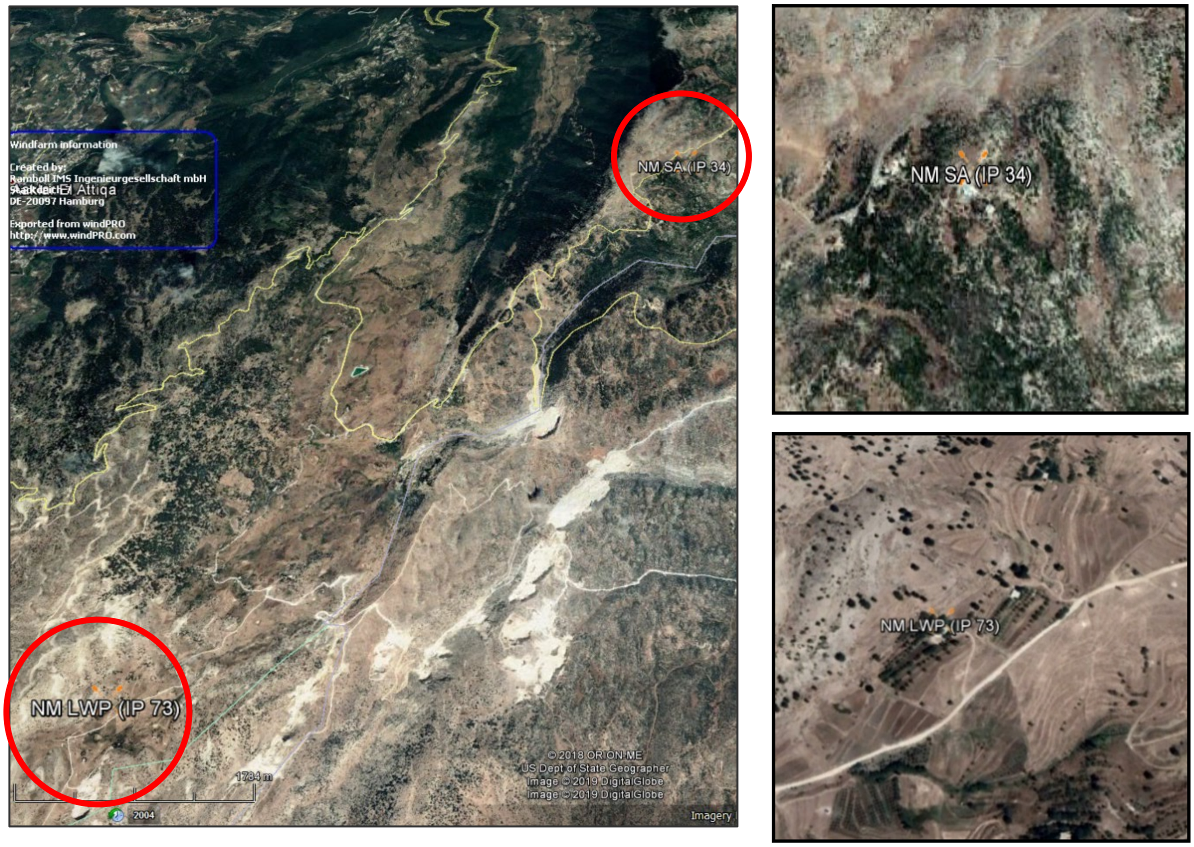


Table 17-5 Project Noise Measurements

IP 34 (SA) – Wind Speed Corrected to 10m									
	0<WS<1	**1<WS<2**	**2<WS<3**	**3<WS<4**	**4<WS<5**	**5<WS<6**	**6<WS<7**	**7<WS<8**	**8<WS<9**
Count	6	34	56	77	43	34	27	10	2
Wind speed (m/s)	0.85	1.58	2.49	3.46	4.45	5.49	6.42	7.19	8.43
Temperature (°C)	5.41	5.51	5.72	5.96	6.78	7.64	7.50	8.18	7.88
Wind direction (°)	150.80	122.20	107.04	132.27	130.58	133.17	147.00	151.40	140.25
Humidity (%)	59.32	64.78	68.62	79.18	73.27	63.79	60.25	52.39	56.32
Air pressure (mbar)	628.64	629.62	631.34	634.84	633.29	634.30	631.80	632.23	631.83
Leq - 10 min daytime	36.78	36.67	35.83	36.94	36.97	39.02	43.22	47.07	-
LA90 - 10 min daytime	34.68	34.03	33.28	34.31	34.12	36.32	39.85	43.52	-
Leq - 10 min nighttime	31.46	30.97	31.72	32.61	35.37	43.81	46.75	47.94	48.94
LA90 - 10 min nighttime	29.22	29.05	29.70	30.16	32.92	40.57	42.88	43.83	45.21
IP73 (LWP) – Wind Speed Corrected to 10m									
	0<WS<1	**1<WS<2**	**2<WS<3**	**3<WS<4**	**4<WS<5**	**5<WS<6**	**6<WS<7**	**7<WS<8**	**8<WS<9**
Count	77	98	42	17	10	12	21	12	5
Wind speed (m/s)	0.63	1.47	2.39	3.33	4.47	5.63	6.47	7.31	8.26
Temperature (°C)	5.24	4.52	5.01	4.81	4.09	4.17	3.86	3.03	2.16
Wind direction (°)	314.93	310.88	270.45	193.35	158.10	162.29	152.91	144.61	144.13
Humidity (%)	59.29	75.03	69.86	63.04	76.46	73.42	87.36	96.03	99.99
Air pressure (mbar)	848.40	848.09	848.71	848.69	849.06	848.81	848.97	848.88	848.59
Leq - 10 min daytime	33.07	33.21	33.22	37	32.62	45.33	40.71	44.6	49.75
LA90 - 10 min daytime	31.23	31.01	31.16	34.22	30.95	42.27	37.65	42.25	46.68
Leq - 10 min nighttime	31.16	33.23	32.99	34.45	34.4	35.7	39.64	41.8	40
LA90 - 10 min nighttime	29.55	31.33	31.26	32.59	32.15	32.90	36.59	38.96	37.8

These measurements underline the quiet and rural background of the area. The background noise monitoring also confirms that there is no significant technical preload by other commercial or industrial activities which need to be considered in the calculation in addition to the planned wind turbines. While noise levels increase with higher wind speeds, the effect of masking the wind turbine noise by the wind itself is not considered in this assessment.

17.1.3. Noise Impact Assessment

17.1.3.1. Noise Impacts During Construction

A full construction noise assessment was not undertaken as the exact construction methodology is not known so far. The EPC Contractor has not been selected and the machinery composition and working methods/areas are yet to be defined. Therefore, a construction noise assessment was conducted that comprised a qualitative assessment with a supporting example based on quantitative calculations. The prediction of construction noise levels was undertaken using the calculation methodology presented in ISO 9613-2:1996. Noise generated by the transport of the WTG components was not considered in the assessment as a total of 22 trucks roundtrip will be added to the existing traffic per week. Further, the existing road segments already carry a significant amount of traffic. The Noise Assessment Report is provided in **Appendix N** (was **Appendix R**).

During the construction phase potential noise emissions are expected from the activities associated with the installation of turbines, transmission lines and substation as well as the development of access roads and road widening activities. The main sources of noise are associated with transportation activities and the delivery of raw materials and turbines and furthermore with the operation of excavation, leveling and construction equipment. The following major activities will be conducted during the construction phase:

- Construction noise (breaker, excavator, dump truck etc.).
- Construction of access roads.
- Construction of electrical substation and associated structures.
- Erection of turbines.

Each of the construction activities includes working with heavy "balance-of-plant" machines with noise levels (LWA) up to 120 dB(A), as shown in **Table 17-6.**

The construction work is usually carried out one after the other at each turbine location, up to a maximum of two turbines per week. However, for the noise assessment, it was assumed that the work will occur concurrently at two turbine locations (i.e. at WTG 12 and WTG 13). This scenario represents a worst case which might not be expected, or even if so, might occur for only a period of a few weeks. Turbines 12 and 13 were selected since the nearby noise receptor IP 73 is considered to be the receptor with the highest noise impact.

Table 17-6 Balance-of-Plant Machines

Activity	Balance-of-Plant Machines
Laying of access tracks	1 x excavator (107 dB(A)), 1 x roller (107 dB(A)), 1 x bulldozer (109 dB(A)), 2 x dump truck (115 dB(A))
Excavation of foundations	1 x breaker (mounted on wheeled backhoe – 120 dB(A)), 1 x excavator (107 dB(A)), 2 x dump truck (115 dB(A))
Concreting of foundations	2 x concrete mixer (108 dB(A)), pumping (106 dB(A), or idling (99 dB(A))
Erection or dismantling of turbines	2 x mobile crane (106 dB(A)), 3 x flatbed truck (108 dB(A))

The construction noise was calculated for 16 locations around the wind farm, at the same noise sensitive areas that were used for the operational noise prediction. The equivalent continuous noise levels LAeq were calculated, as presented in **Table 17-7**.

Even if the construction works were to occur simultaneously at two turbine locations, the noise levels will remain below the long-term noise limit according to the EHS Guideline Noise 1.7 (2007) during day time of 55 dB(A). The noise levels will be also below the local noise limit of 60 dB(A) derived from the governmental Decision No. 52/1 of July 1996.

In summary, the potential construction noise impacts on nearby residents are limited to a short time of the construction phase. The impacts will be of a negative nature and high likelihood but due to the large distance to the closest dwellings of low magnitude. The dwellings affected by the construction noise are houses located in a rural environment and are considered of medium sensitivity. Given all of the above, the impact is considered to be of minor significance.

Mitigation

In order to organize the construction works with as little nuisance as possible, it is recommended to limit the working hours from Monday to Friday 7 a.m. to 7 p.m., if possible. Some flexibility in working hours may be required during the delivery and erection of turbines and depending on weather conditions.

The final time schedule of the transport movements should be clarified with the authorities and communities. Only well-maintained equipment should be operated on-site. Following the implementation of this mitigation measure, the significance of the residual impact can be reduced to low, and therefore is not significant.

17.1.3.2. Noise Impacts During Operation

Wind turbines produce noise caused by several different mechanisms which can be roughly grouped into mechanical and aerodynamic sources. The major mechanical components include gearbox, generator and yaw motors in addition to fans and hydraulic motors. Mechanical noise is radiated by the surface of the turbine and by openings in the nacelle housing. The interaction of air flow and the turbine blades produces aerodynamic noise caused by a variety of processes as air passes over and past the blades (IFC, 2015).

Table 17-7 Noise Assessment - Construction Phase

IP	IP Name	Laying of Access Roads [dB(A) L_{Aeq}]	Excavation of foundations [dB(A) L_{Aeq}]	Concreting of Foundations [dB(A) L_{Aeq}]	Erection of Turbine [dB(A) L_{Aeq}]	EHS Noise Level/Daytime [dB(A) L_{Aeq}]	Local Noise Level/Daytime [dB(A) L_{Aeq}]
30	House Under Construction	30	33	23	25	55	60
33	House	30	34	24	26	55	60
46	Occupied House in Summer	32	35	25	27	55	60
53	House	35	39	29	31	55	60
55	Villa	37	40	30	32	55	60
57	House	39	42	32	34	55	60
61	House	43	46	36	38	55	60
68	House	48	52	42	44	55	60
73	House	49	53	43	45	55	60
78	House	39	42	33	35	55	60
82	House	28	31	21	23	55	60
85	House	34	38	28	30	55	60
89	House	33	36	26	28	55	60
94	House	27	30	20	22	55	60
97	House	28	32	22	24	55	60
98	House	25	28	19	20	55	60

The noise generated by the wind turbines at nearby residences was calculated using WindPRO 3.2 (DECIBEL module), produced by Energi-og Miljødata (DK). WindPRO is a commercial software program that enables noise modeling of wind farms using sound propagation factors as adopted by ISO 9613-2. The modeling process included the following steps: (1) characterizing the noise sources, (2) creating a digital terrain model (DTM) of the site and vicinity to enable the model to evaluate effects of distance and topography on noise attenuation, and (3) assigning the equipment sound levels to appropriate locations on the site. WindPRO then calculates sound levels in the vicinity of the project site. For the modeling, numerous modeling receptor locations representing the residences nearest the proposed wind turbine locations were used.

National Noise Limits

The noise limits in Lebanon depend on the land use and the period of the day and are derived from the governmental Decision No. 52/1 of July 1996. The limits are listed in **Table 17-8**.

Table 17-8 Limits for Noise Levels per Decision No. 52/1 of July 1996 [dB(A)]

Region Type	Limit for Noise Level		
	Day time 7 am-6 pm	Evening time 6 pm-10 pm	Night Time 10 pm–7 am
Residential areas having some construction sites or commercial activities/are located near a road	50-60	45-55	40-50
Urban residential areas	45-55	40-50	35-45
Industrial areas	60-70	55-65	50-60
Rural residential areas	35-45	30-40	25-35

The Project is located in a remote mountainous area in which some agricultural activities take place. There are no residential areas in the immediate surrounding of the planned wind farm. The closest villages of Akkar el Aatiqa and Es Sayeh are located at a distance of more than 2km of the proposed turbine locations and are therefore due to the large distance not relevant for the noise assessment. However, in the vicinity of the wind farm individual dwellings exists along roads. These houses were incorporated into the assessment as noise sensitive areas (receptors) and considered with a noise limit of 50 dB(A) during the night time since they will have some commercial activity (the planned wind farm) in vicinity.

International Noise Limits

The EHS Guidelines for Wind Energy (2015) sets the following screening criteria for wind farms:

> *"Preliminary modeling should be carried out to determine whether more detailed investigation is warranted. The preliminary modeling can be as simple as assuming hemispherical propagation (i.e., the radiation of sound, in all directions, from a source point). Preliminary modeling should focus on sensitive receptors within 2,000 meters (m) of any of the turbines in a wind energy facility."*

> *"If the preliminary model suggests that turbine noise at all sensitive receptors is likely to be below an LA90 of 35 decibels (dB) (A) at a wind speed of 10 meters/second (m/s) at 10 m height during day and night times, then this preliminary modeling is*

likely to be sufficient to assess noise impact; otherwise it is recommended that more detailed modeling be carried out, which may include background ambient noise measurements."

A preliminary modelling exercise has indicated that turbine noise at some sensitive receptors is likely to be above an LA90 of 35 dB at a wind speed of 10m/s at a 10m height during the day and night times. Since the screening noise limit of 35 dB is exceeded, more detailed modelling was conducted and included:

- A background ambient noise measurement to establish that there is no significant technical noise preload.
- A concurrent measurement of the prevailing wind speeds using the meteorological mast located on the mountain ridge close to the future turbine locations.
- Consideration of the cumulative noise effects of the three planned wind farms, Lebanon Wind Power, Sustainable Akkar and Hawa Akkar.
- Conducting a noise modelling based on worst case assumptions (see propagation model and assumptions), including calculation of the noise impact using the maximum sound power level of the turbines rather than the LA90 value.

The EHS Guidelines for Wind Energy (2015) do not provide a noise limit other than the screening limit. Therefore, the IFC / World Bank Environmental, Health, and Safety General Guideline 1.7 Noise (2007) was consulted, as shown in **Table 17-9**.

Table 17-9 Noise Level Guidelines per IFC General EHS guidelines (2007)

Receptor	Daytime (07:00-22:00) [dB(A) L_{Aeq}]	Nightime (22:00-07:00) [dB(A) L_{Aeq}]
Residential, institutional, educational	55	45
Industrial, commercial	70	70

For the evaluation of the noise level at the receptors the lower noise limit for the night time of 45 dB(A) will be applied in this analysis. The guidelines value of 45 dB(A) applies for a noise level measured out of doors.

Propagation Model and Assumptions

The calculation model of the International Standard ISO 9613-2 '*Acoustics – Attenuation of sound during propagation outdoors – Part 2 General method of calculation*' is used to predict the levels of noise generated by the wind farm. This model predicts the sound pressure level by taking the source sound power level for each WTG and subtracting a number of attenuation factors:

Predicted Noise Level = Law + D – Ageo – Aatm – Agr – Abar – Amisc, with:

Law = sound power level of each turbine.
D = directivity correction factor (not used for worst case downwind propagation).
Ageo = losses due to geometrical divergence.
Aatm = losses due to atmospheric absorption.
Agr = losses due to the ground effect.
Abar = barrier losses where the turbine hub is unsighted.
Amisc = miscellaneous effects (vegetation, buildings).

When calculating predicted noise levels with ISO 9613-2, it is assumed that the noise sensitive area (receptor) is located downwind of the noise source (turbine). For upwind situations, lower noise levels can be expected. When noise propagation for multiple sources in different directions is calculated, the results are always worst-case assumptions. In addition, it should be noted that one receptor cannot be downwind of all noise sources at the same time. The meteorological coefficient C0 was set to 0 dB. The applied method does not use Abar and/or the Amisc attenuation factors, therefore deliver more conservative results. There is sufficient buffer to the noise limits since the modelling was carried out under the following worst-case assumptions:

- Downwind noise propagation conditions for each turbine location and for each receptor.
- 70 % humidity and 10 °C air temperature.
- The maximum sound power level [in dB(A)] of the turbine was used (to be expected only under high wind conditions).
- Masking of the turbine noise by the noise of the wind itself was not considered.
- Meteorological coefficient C0 was set to 0dB.
- Abar and the Amisc attenuation factors were not considered in the calculation.
- A security surcharge of 1 dB(A) is applied on the maximum sound power level of the turbines.

Therefore, the detailed modelling provides a sufficient degree of conservatism in the modelling assumptions to make any under-prediction unlikely. The model predictions are based on a widely validated prediction algorithm and manufacturer's technical data.

Noise Sources

The primary noise sources associated with the Project would be a maximum of 16 wind turbines. However, the noise impact was undertaken assuming full operation of 17 wind turbines as a worst-case scenario, with all wind turbines operating simultaneously and continuously.

Generally, the operational noise of a wind turbine has two sources: 1) the aerodynamic noise produced by the rotating blades; and 2) the mechanical noise produced by the turbine's gearbox and generator. The intensity of the WTG noise depends on the wind speed. At very low wind speeds, no relevant noise emission is produced. WTGs become louder with increasing wind speed and power production.

The final wind turbine model has not yet been selected. Therefore, in this noise assessment three different turbine models listed in **Table 17-10** are considered.

The Project will be equipped with one turbine type from the following OEM/EPC Contractor: Vestas, GE or Siemens-Gamesa (it is noted that Nordex is no longer under consideration as a potential OEM/EPC Contractor; however, the Nordex noise assessment results have been included herein as they were the closest turbine type to the Siemens-Gamesa turbine type). The sound power level of proposed Siemens-Gamesa turbine is in the range of the three considered scenarios, therefore no additional calculation was conducted for the Siemens-Gamesa turbine type.

The background noise monitoring has shown that the noise levels (L_{A90}) are 30-39 dB(A) during the nighttime, and therefore typical for such remote and mountainous area. While background noise levels increase with higher wind speeds, the effect of masking the wind turbine noise by the wind itself was not considered in this assessment. The background noise monitoring also confirms that there is no significant technical preload by any other commercial or industrial activities which needs to be added to the noise levels at the receptors.

Table 17-10 Technical WTG Data for Three Scenarios

	Planned WTG Scenario A	Planned WTG Scenario B	Planned WTG Scenario C
Name(s) on Print Out	7-23	7-23	7-23
Number	17	17	17
Manufacturer	Nordex	Vestas	GE
WTG-Type	N149	V150	5.3-158
Rotor Diameter [m]	149	150	158
Hub Height [m]	105	105	121
Rated Power [MW]	4.5	4.2	5.3
Operating Mode, Nighttime	Mode 0	P01	Normal Operation
Serrations	No	Yes	Yes
Source of Sound Power Level	F008_271_A12_DE	0067-7067 V08	-NO_5.3-158-50Hz_IEC_EN_r03
L_{WA} [dB(A)], Nighttime	108.1	104.9	106.0
L_{WA} [dB(A)], Daytime	108.1	104.9	106.0
Surcharge*) [dB(A)]	1.0	1.0	1.0
L_{WA} Total [dB(A)], Nighttime	**109.1**	**105.9**	**107.0**

The sound power level information refers to the maximum sound power level of the wind turbine types. The individual sound sources of all wind turbines overlap to a resulting sound pressure level, which is to be evaluated for the relevant receptor.

The sound power levels of the turbines for the standard mode were taken from the manufacturer specifications. In addition, a security surcharge of 1 dB(A) was applied.

Noise Modelling Results

The additional and cumulative load of the planned wind turbines at the surveyed receptors were calculated according to the ISO 9613-2:1996. Noise levels were calculated for the following at a maximum of 17 locations:

- Vestas 4.2MW turbine.
- Nordex 4.5MW turbine.
- GE 5.3MW turbine.

The noise level for the Siemens 4.5MW turbine was not calculated, as the Nordex 4.5MW turbine is comparatively louder and therefore represents the worst-case scenario for a 4.5MW turbine. The modeled results for the Vestas V150, Nordex N-149 and GE 5.3-158 are summarized in **Table 17-11** to **Table 17-13.** The modeled results are shown in **Figure 17-5** to **Figure 17-7**.

Table 17-11 Calculated Noise Levels for Scenario A: Nordex N149

Noise Sensitive area	Noise Levels LWP Wind Farm [dB(A) L_{Aeq}]	Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A) L_{Aeq}]	IFC Noise Level Guideline Daytime/Nighttime [dB(A) L_{Aeq}]
30 House	32.2	32.7	55/45
33 House	30.4	30.6	55/45
46 House	33.7	34.2	55/45
53 House	37.2	37.3	55/45
55 Villa	38.7	38.8	55/45
57 House	40.4	40.5	55/45
61 House	41.2	41.2	55/45
68 House	43.5	43.5	55/45
73 House	44.5	44.5	55/45
78 House	39.1	39.1	55/45
82 House	37.5	37.5	55/45
85 House	41.5	41.5	55/45
89 House	40.6	40.6	55/45
94 House	43.3	43.3	55/45
97 House	44.4	44.4	55/45
98 House	41.5	41.5	55/45

Figure 17-5 Calculated Noise Levels for Scenario A: Nordex N149

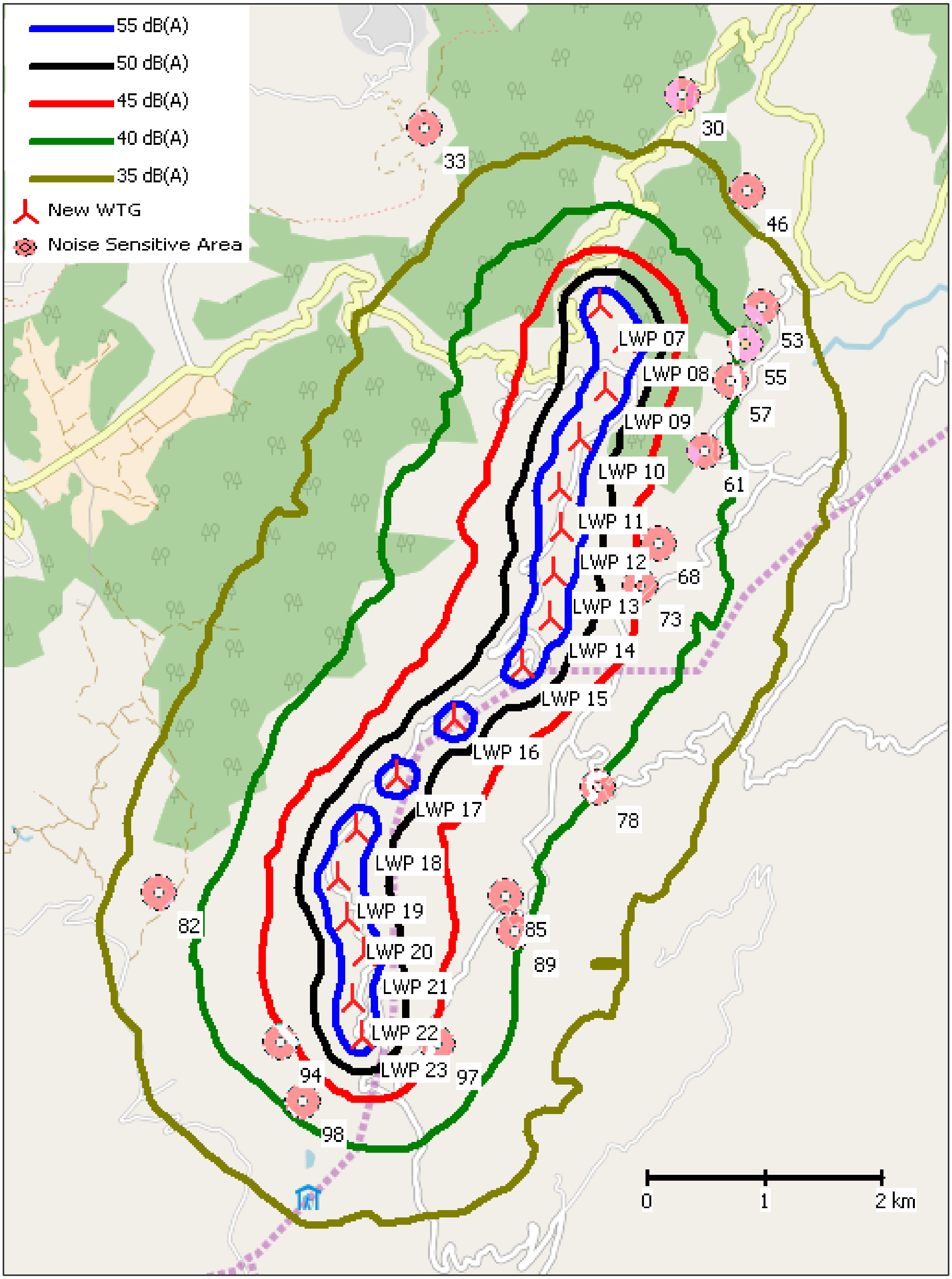


Table 17-12 Calculated Noise Levels for Scenario B: Vestas V150

Noise Sensitive Area	Noise Levels LWP Wind Farm [dB(A) L_{Aeq}]	Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A) L_{Aeq}]	IFC Noise Level Guideline Daytime/Nighttime [dB(A) L_{Aeq}]
30 House	29.0	30.0	55/45
33 House	27.2	27.6	55/45
46 House	30.5	31.4	55/45
53 House	34.0	34.3	55/45
55 Villa	35.5	35.7	55/45
57 House	37.2	37.3	55/45
61 House	38.0	38.0	55/45
68 House	40.3	40.3	55/45
73 House	41.3	41.3	55/45
78 House	35.9	35.9	55/45
82 House	34.3	34.3	55/45
85 House	38.3	38.3	55/45
89 House	37.4	37.4	55/45
94 House	40.1	40.1	55/45
97 House	41.2	41.2	55/45
98 House	38.3	38.3	55/45

Figure 17-6 Calculated Noise Levels for Scenario B: Vestas V150

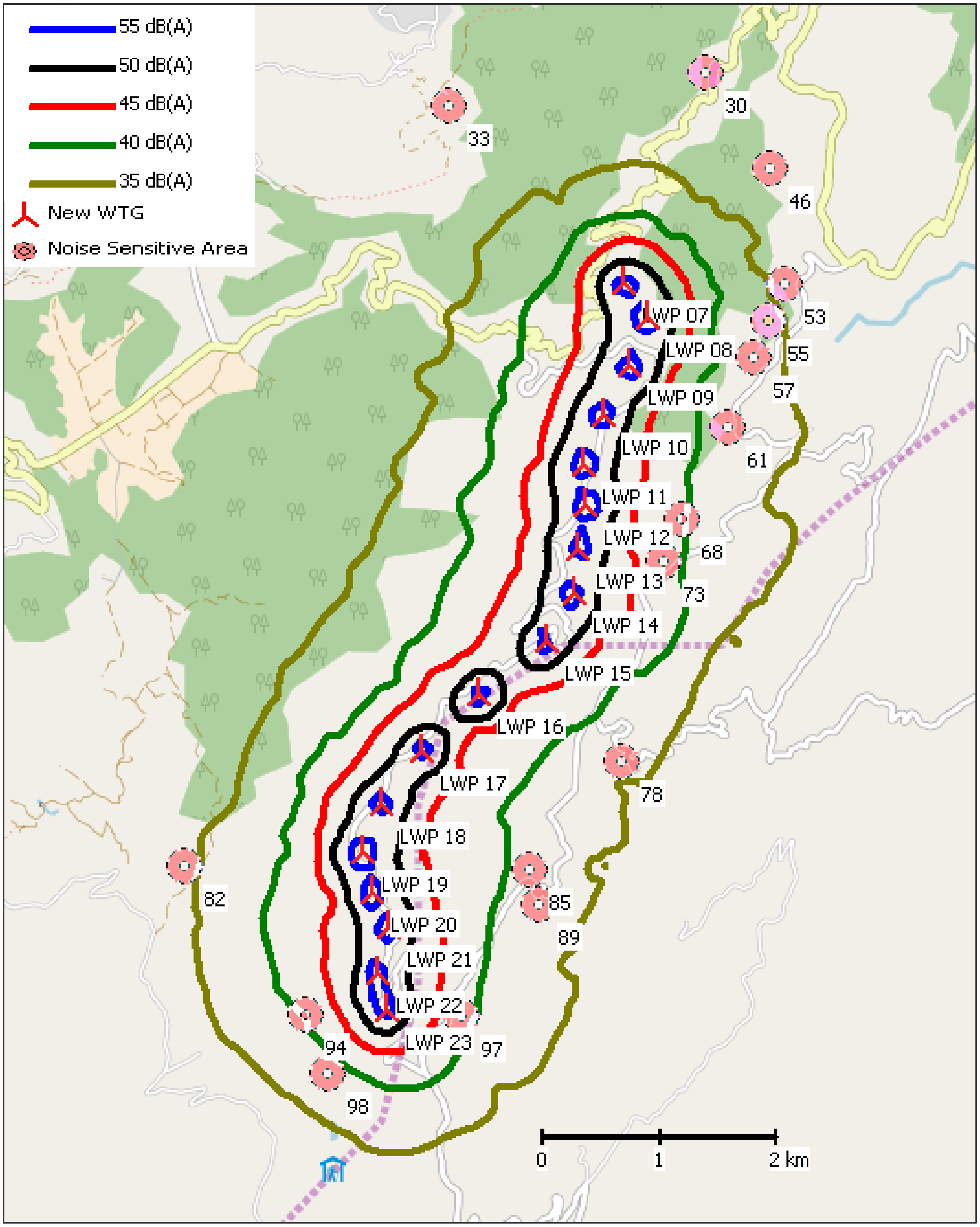
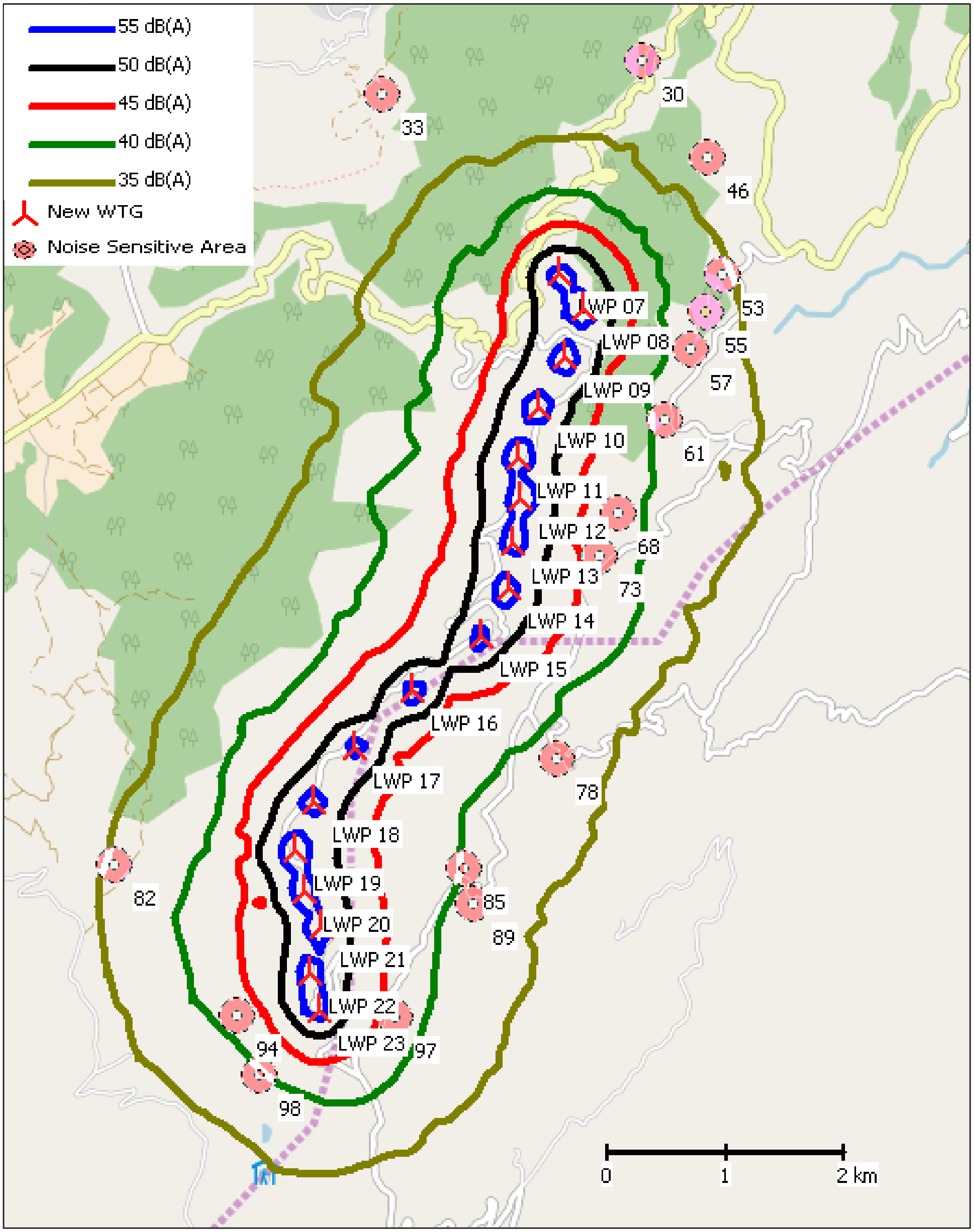


Table 17-13 Calculated Noise Levels for Scenario C: GE 5.3-158

Noise Sensitive Area	Noise Levels LWP Wind Farm [dB(A) L_{Aeq}]	Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A) L_{Aeq}]	IFC Noise Level Guideline Daytime/Nighttime [dB(A) L_{Aeq}]
30 House	30.2	30.9	55/45
33 House	28.3	28.6	55/45
46 House	31.9	32.6	55/45
53 House	35.4	35.6	55/45
55 Villa	36.7	36.8	55/45
57 House	38.6	38.6	55/45
61 House	39.2	39.3	55/45
68 House	41.5	41.5	55/45
73 House	42.6	42.6	55/45
78 House	37.5	37.5	55/45
82 House	35.5	35.5	55/45
85 House	39.6	39.6	55/45
89 House	38.7	38.7	55/45
94 House	41.6	41.6	55/45
97 House	42.6	42.6	55/45
98 House	39.6	39.6	55/45

Figure 17-7 Calculated Noise Levels for Scenario C: GE 5.3-158



Mitigation

The turbine locations were optimized to minimize the impact of noise by keeping a sufficient distance to the surrounding properties. This has been one of the key factors during the design process. The distance of the WTGs to nearby receptors was increased by eliminating the originally planned WTGs 01-06; consequently, operating the turbines in a noise reduced mode is not required. The WTGs will be maintained regularly to ensure that the turbines do not become louder over time. If it would become necessary for any unknown reason to reduce the noise output of the wind farm, all turbine types under consideration offer the possibility to be operated in a noise-optimized mode. While the power output would be reduced, this measure would allow the reduction of the sound power levels once the wind farm is in operation.

For all three scenarios, the modeled sound levels are less than IFC's nighttime noise limit guideline of 45 dB(A). The potential noise impacts on nearby residents affect a few dwellings in vicinity of the Project site. The potential noise impacts are considered to be negative in nature and high likelihood since the turbines will be operating constantly apart from times with low wind speeds. Since the noise limits are met the magnitude of the impact is assessed to be low for the 13 receptors which will have higher noise levels of 35dB(A) (i.e. the worst-case N149 scenario). For the three receptors that will experience a noise level below 35dB(A) the magnitude of the impact is assessed to be Slight. The dwellings affected by noise impacts are houses located in a rural environment and are considered of Medium-High sensitivity. Given the distance of the Sustainable Akkar wind farm, and the even greater distance to the Hawa Akkar wind farm, there are negligible cumulative noise impacts. Given all of the above, the noise impact during the operation is considered to be of minor significance, as shown in **Table 17-14**.

Table 17-14 Noise Assessment for Operation Phase (Worst-Case Scenario)

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High√**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	**Minor√**	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

17.1.3.3. Noise During Decommissioning

During decommissioning, the main sources of noise are associated with the dismantling and removal of the wind turbines and associated infrastructure. Given the temporary nature of these activities and the remote location of the project site, these impacts were considered to be of minor significance, like during the construction phase.

17.2. Shadow Flicker

17.2.1. Baseline Methodology

The project area is mountainous and rocky, with sparse vegetation. The 17 WTGs are located on a ridge, oriented north to south. The elevation of the project area varies from 1,800 m to 2,200 m.

The shadow flicker impact of a wind energy project is limited to the moving blade of the turbines. Since there are no existing wind turbines in the planning area, a detailed study about the shadow flicker baseline is not necessary. However, there are two other wind farm projects (Sustainable Akkar and Hawa Akkar) planned in the area which need to be considered in the assessment.

Shadow flicker occurs when the sun passes behind the wind turbine and the turbine casts a shadow. At times when the blades are turning areas of moving shadow occur and a flickering affect is caused when these shadows fall on the ground, structures or other objects. Shadow flicker may become a problem if potentially sensitive receptors (e.g. residential properties, health care facilities, schools, etc.) are located nearby and have a specific orientation to the wind energy facility (IFC, 2015). The objectives of the shadow flicker assessment, as presented in **Appendix O,** are as follows:

- To identify the areas that are affected by the shadow flicker of the WTGs.
- To assess impacts of the Project on residential and/or other sensitive receptors like hospitals or schools.

The methodology of the shadow flicker assessment is based on the Environmental, Health, and Safety Guidelines Wind Energy (IFC, 2015). The probability of shadow flicker occurrence and the extent of its effects on the residents depend on a number of factors such as the direction of windows relative to the turbine, the distance from the turbine, the turbine hub height and the rotor diameter, the width of the blades, the time of year and the time of day. Exposure to shadow flicker decreases with increasing distance from the wind farm.

The final wind turbine model has not yet been selected. Therefore, three different turbine models that may be selected for Lebanon Wind Power wind farm were assessed, i.e. the Vestas, Nordex, and GE Wind turbines as shown in **Table 17-15**).

With a mean blade width of 2.8m, the Vestas V150 has the broadest blade, and therefore casts the largest shadow area (1,905 m). Consequently, the Vestas V150 model was considered as worst-case scenario for identifying the potential receptors. While the Vestas V150 has the largest area in which shadow flicker can occur, the shadow flicker times generated by the GE 5.3-158 for individual receptors within its shadow area can be higher due to the larger rotor. The shadow flicker area of a proposed Siemens turbine is in the range of the three considered scenarios, therefore no additional calculation was conducted for the Siemens-Gamesa turbine type.

Table 17-15 WTG Input Data

	Planned WTG Scenario A	Planned WTG Scenario B	Planned WTG Scenario C
Number in reports	7-23	7-23	7-23
Count	17	17	17
Manufacturer	Nordex	Vestas	GE Wind
WTG type	N149	V150	5.3-158
Rotor diameter \m	149	150	158
Hub height \m	105	105	121
Rated power \MW	4.5	4.2	5.3
Mean blade width \m	2.7	2.8	2.7
Shadow length \m	1,809	1,905	1,819

To assess the compliance with the recommended limits, shadow flicker was modeled and predicted based on an astronomical worst-case scenario, which is defined in the EHS Guideline for Wind Energy (2015) as follows:

- There is continual sunshine and permanently cloudless sky from sunrise to sunset.
- There is sufficient wind for continually rotating turbine blades.
- Rotor is perpendicular to the incident direction of the sunlight.
- Sun angles less than 3 degrees above the horizon level are disregarded.
- Distances between the rotor plane and the tower axis are negligible.
- Light refraction in the atmosphere is not considered.

The affected houses will not suffer from shadow flicker if:

- The weather is overcast.
- The rotor plane of the turbine is parallel with the imaginary line between the location of the sun and the respective IP.
- There is an obstacle between the respective building and the sun in the direction of the wind turbine.
- The wind turbines are not under operation.
- There is poor visibility due to fog.

The calculations were conducted using WindPRO 3.2 software (SHADOW Module), produced by Energi-og Miljødata (DK). The model considers the movement of the sun relative to the time of day and time of year predicting the time and duration of expected shadow flicker at the window of an affected receptor. The input parameters used in the model are as follows:

- The turbine locations.
- The turbine dimensions.
- The locations of the receptors (IPs) to be assessed.

To support the calculation, a digital terrain model (DTM) was developed using SRTM (Shuttle Radar Topography Mission) data with a resolution of 30m.

According to the IFC guideline (2015) the threshold for the predicted shadow flicker duration is:

- Accumulated exposure on residential properties should not exceed a total of 30 hours per year.
- Exposure on residential properties should not be longer than 30 minutes per day.

If one of these thresholds is exceeded, mitigation methods such as turning off turbines during critical times must be considered, e.g. the turbines which cause the exceedance should be equipped with a shadow flicker shut down module.

17.2.1.1. Receptors

A site visit in which the relevant receptors where identified and documented was conducted on 12th September 2018 by SES. In advance of the site visit potential shadow flicker receptors were identified in a desktop study using topographical maps and aerial photographs. Since residential houses were identified as shadow flicker receptors their sensitivity is assessed to be medium-high.

The area of potential shadow flicker receptors was selected based on the "20% criteria". If less than 20% of the sun is being covered by the passing rotor blade, the resulting shadow intensity at a neighboring property will not be strong enough to account for a nuisance. For the Vestas V150, which has the largest shadow area of the considered turbines, this corresponds to a theoretical maximum distance of 1,905m from the wind turbine.

This study focuses on the closest receptors to the wind farm site. However, the shadow flicker maps will also provide an indication about the shadow flicker times of the potential effected area around the wind farm site. The shadow flicker receptors are displayed in **Figure 17-8**. The astronomically maximum shadowing (hours/year) based on the Vestas turbine is shown in **Figure 17-9.**

17.2.2. Shadow Flicker Impact Assessment

17.2.2.1. Shadow Flicker Impacts During Construction

The shadow flicker impact of a wind energy project is limited to the moving blade of the turbines therefore, there will be no impacts in terms of shadow flicker during the construction phase.

17.2.2.2. Shadow Flicker Impacts During Operation

The calculations were conducted according to the recommendations of the IFC Environmental, Health, and Safety Guidelines for Wind Energy (2015). The technical data for the calculations was provided by the turbine manufacturer. Shadow flicker exposure naturally decreases with an increase in distance from the wind farm. Predicted exposure of a receptor to the shadow flicker effect is measured in minutes per day and cumulative yearly hours.

In order to account for cumulative impacts, the potential for overlapping shadow areas resulting from the nearby wind energy projects was assessed. The shadow flicker area depends on the dimensions of the turbine and the "20% criteria".

The potential shadow flicker impacts on nearby residents is limited to individual dwellings in the vicinity of the Project site. There are no villages or bigger settlements located in the shadow area of the turbines.

Figure 17-8 Shadow Flicker Receptors

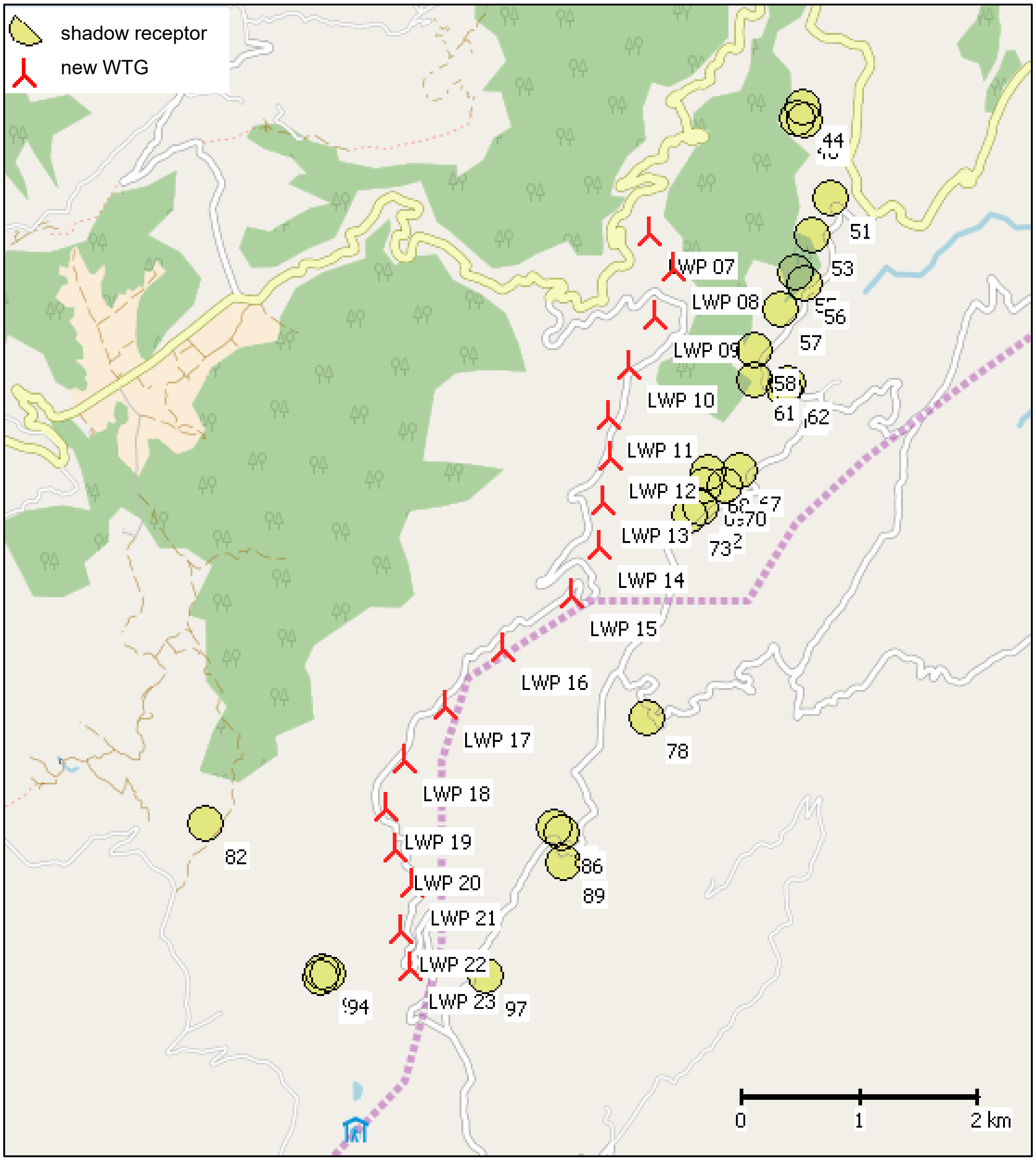
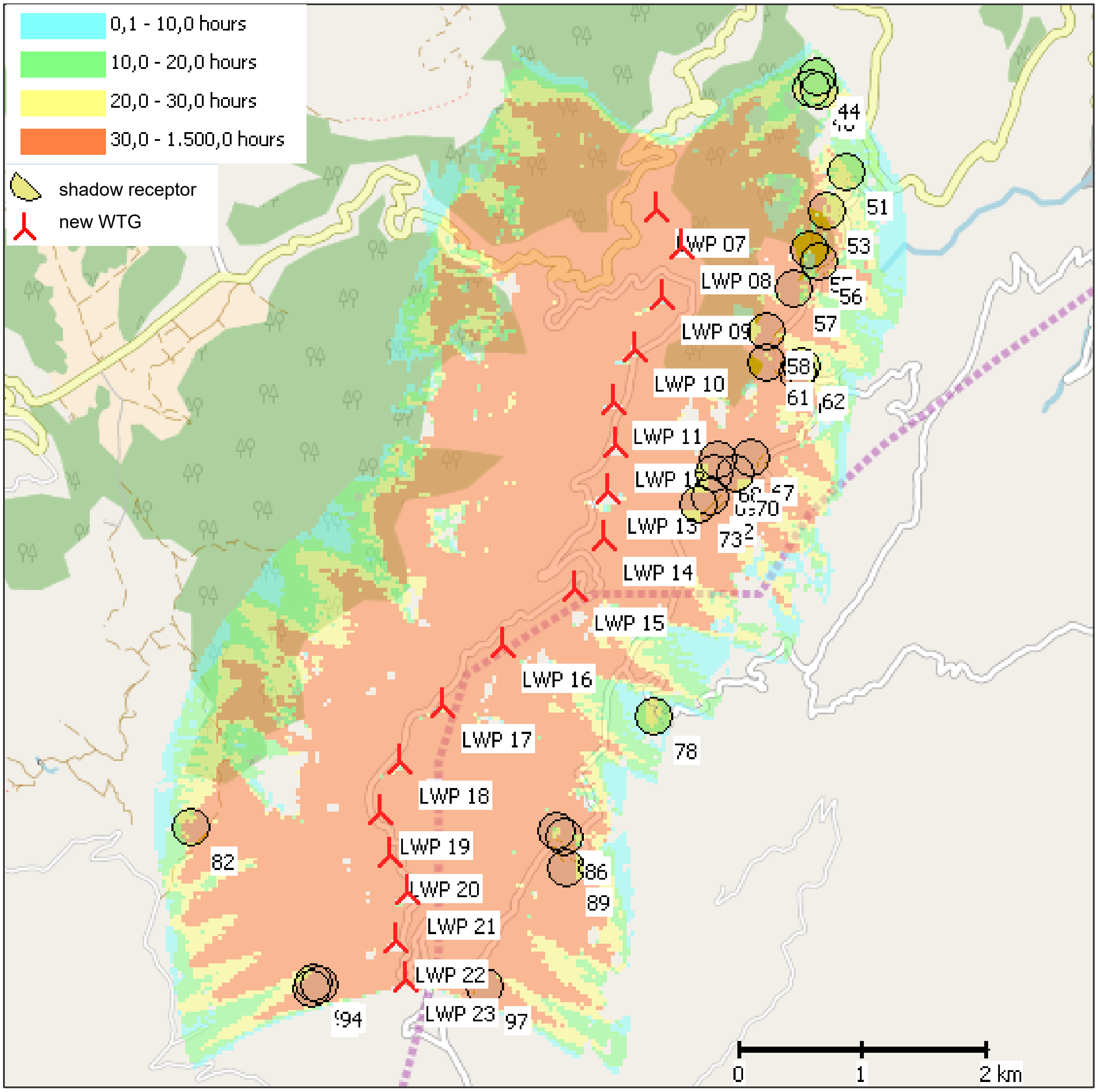


Figure 17-9 Astronomically Maximum Shadowing (h/year), Vestas V150 Scenario



The results show the hours of shadow flicker which accumulate at locations near the wind farm during a year, as presented in **Table 17-16** through **Table 17-18.** Again, it is noted that Nordex is no longer under consideration as a potential OEM/EPC Contractor; however, the Nordex noise assessment results have been included herein as they were the closest turbine type to the Siemens-Gamesa turbine type.

The shadow flicker impacts will be of a negative nature and high likelihood. The calculated shadow flicker times show that the maximum astronomical possible shadow flicker times will be above the recommended limits of 30 hours per year and 30 minutes per day. This can cause annoyance for residents; however, the maximum astronomical possible shadow flicker times will remain below 1 hour per day. Therefore, if shadow flicker shut down modules are not installed, the magnitude of the impact is assessed to be medium. The dwellings affected by shadow flicker are houses located in a rural environment and are considered of high sensitivity, resulting in a major impact significance if not mitigated.

Cumulative Shadow Flicker Impacts

Due to the large distance of more than 5,000 m to the closest nearby planned wind farm (Sustainable Akkar) there will be no overlapping shadow areas from the turbines of the project and the Sustainable Akkar wind farm, and therefore none from the turbines of the Hawa Akkar wind farm as well, which is even located in a greater distance. Consequently, cumulative impacts can be ruled out for shadow flicker. Thus, the shadow flicker assessment focused solely on the turbines of the Lebanon Wind Power wind farm.

Mitigation

The installation of shadow flicker shutdown modules in the turbines is a very common and an often-applied mitigation measure. Shutdown modules will eliminate the possibility for exceedances of annual and day limits. An automatic shadow-flicker shutdown system shuts down the WTG when the sun is shining (direct sunshine on a horizontal area > 120 W/m²). These systems shut down a turbine when one of two conditions are reached:

- More than 30 minutes of shadow-flicker occur on one day at a receptor.
- The maximum annual quota of shadow-flicker at a receptor is exceeded.

When shutdown systems feature a radiation sensor, the turbines only shut down when the sun is shining. If the shadow-flicker shutdown system does not include a radiation detector, the WTG will shut down at all times when the shadow-flicker assessment indicates shadow-flicker at a receptor (i.e. also in cases of overcast sky or fog when there is actually no shadow flicker).

The use of shadow flicker shutdown modules will have a (small) negative effect on the energy yield of the wind farm.

Following the implementation of this mitigation measure, the significance of the residual impact can be reduced to minor, as shown in **Table 17-19.**

Table 17-16 Duration of Shadow Flicker at Emission Points, Scenario A Nordex N149

Receptor	Accumulated Astronomical Maximum Possible Shadow Flicker [Hours per Year]	Astronomical Maximum Possible Shadow Flicker* [Minutes per Day]
44 house	10:26	0:20
46 house	15:19	0:21
47 house	18:55	0:21
51 house	15:15	0:22
53 house	28:58	0:26
55 villa	**57:30**	0:30
56 villa	**57:58**	0:29
57 house	**32:06**	0:29
58 house	**35:16**	0:28
61 house	**54:50**	0:29
62 house	26:26	0:24
63 house	28:41	0:25
67 house	**43:16**	0:29
68 house	**110:49**	**0:40**
69 house	**92:57**	**0:36**
70 house	**80:39**	**0:33**
72 house	**65:25**	**0:37**
73 house	**100:35**	**0:41**
78 house	0:00	0:00
82 house	15:31	0:21
85 house	29:33	0:25
86 house	**50:21**	0:23
89 house	**61:54**	0:24
92 house	**37:00**	**0:42**
94 house	**47:12**	**0:45**
95 house	**43:25**	**0:42**
97 house	**69:52**	**0:47**

* Highest value which can occur astronomically within one year.

Table 17-17 Duration of Shadow Flicker at Emission Points, Scenario B Vestas V150

Receptor	Accumulated Astronomical Maximum Possible Shadow Flicker [Hours per Year]	Astronomical Maximum Possible Shadow Flicker* [Minutes per Day]
44 house	10:33	0:20
46 house	15:35	0:22
47 house	19:11	0:21
51 house	22:29	0:22
53 house	29:18	0:26
55 villa	**58:17**	**0:31**
56 villa	**58:51**	0:29
57 house	**32:33**	0:29
58 house	**38:35**	0:28
61 house	**55:36**	0:30
62 house	26:49	0:24
63 house	**36:37**	0:25
67 house	**54:48**	0:29
68 house	**112:10**	**0:40**
69 house	**94:18**	**0:36**
70 house	**81:25**	**0:34**
72 house	**66:21**	**0:37**
73 house	**101:35**	0:42
78 house	0:00	0:00
82 house	**33:56**	0:21
85 house	29:58	0:25
86 house	**51:01**	0:24
89 house	**62:27**	0:24
92 house	**37:39**	**0:42**
94 house	**47:55**	**0:45**
95 house	**43:59**	**0:42**
97 house	**70:43**	**0:47**

* Highest value which can occur astronomically within one year.

Table 17-18 Duration of Shadow Flicker at Emission Points, Scenario C GE Wind 5.3-158

Receptor	Accumulated Astronomical Maximum Possible Shadow Flicker [Hours per Year]	Astronomical Maximum Possible Shadow Flicker* [Minutes per Day]
44 house	11:09	0:21
46 house	20:17	0:22
47 house	23:15	0:22
51 house	16:48	0:23
53 house	**32:21**	0:27
55 villa	**64:18**	**0:32**
56 villa	**62:59**	0:30
57 house	**35:29**	0:30
58 house	**38:32**	0:30
61 house	**60:20**	**0:31**
62 house	29:40	0:25
63 house	**32:13**	0:26
67 house	**48:15**	**0:31**
68 house	**125:24**	**0:43**
69 house	**95:08**	**0:37**
70 house	**85:55**	**0:35**
72 house	**72:52**	**0:39**
73 house	**108:38**	**0:43**
78 house	0:00	0:00
82 house	17:28	0:22
85 house	**32:55**	0:26
86 house	**57:07**	0:25
89 house	**67:28**	0:25
92 house	**42:05**	**0:44**
94 house	**54:50**	**0:47**
95 house	**51:00**	**0:44**
97 house	**78:12**	**0:49**

* Highest value which can occur astronomically within one year.

Table 17-19 Shadow Flicker Assessment for Operations Phase (Worst-Case Scenario)

		Sensitivity of Receptor				
		Low	Low-Medium	Medium	Medium-High	High√
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	Negligible	Minor	**Minor√**
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

17.3. Visual Amenity

The aim of the visual amenity assessment is to assess the potential effects of the Project on views available to people.

17.3.1. Visual Amenity Baseline Methodology

Information regarding the existing visual conditions in the Project was obtained through physical survey of the area. Photographs were taken to support the assessment by SES during site visits conducted between September to December 2018 from the perspective of identified receptors, as shown in **Figure 17-10**. To ensure that the site visit was conducted to Ramboll standards, SES was prepared for the site visit by training videos and comprehensive site visit instructions as well as telephone conferences.

The Project is located 3km southeast of the village Akkar el Aatiqa and approximately 6.5km west of the Syrian border. A maximum number of 17 wind turbines to be located on a ridge oriented north to south was used to represent the worst-case scenario. The elevation of the project area varies from 1,800m to 2,200m. The project site landscape can be characterized as mountainous and rocky with sparse vegetation in the highest parts of the Project area. The lower parts of the wind farm have more vegetation including brutia pine forests, evergreen oak woods, juniper woodland mixed forests and grassland.

The ridge on which the wind farm is located is divided in two: a wetter and greener western part with more vegetation; and a drier eastern part of the site which is located in the shadow of the mountain ridge. The area in the west and in the north of the planned wind farm is an important forest region (Karm Chbat Nature Reserve) and has, therefore, ecological and recreational importance. The area west of the wind farm is also characterized by more human activity including scattered settlements, roads, small fields and olive plants plantations. In the northern part of the site, there are telecommunication masts which are widely visible in the area. A high voltage power line runs overhead north of the Project site, passing the settlement of El Rweimeh Village.

17.3.1.1. Receptors

Viewpoints (visual receptors which include photomontages)

Viewpoints were selected from those places which are potentially most sensitive to the anticipated change arising from the development. Initially, six viewpoints were selected in the study area in cooperation with Ramboll landscape experts and Dr. Layale Abi-Esber, a local environmental expert. The viewpoints were checked against the ZTV in order to ensure that there is actually visibility of the turbines from the proposed locations. The viewpoints include important recreational sites as well as local settlements in the surrounding of the wind farm.

In a second step, the selected viewpoints were discussed with and confirmed by the Ministry of Environment to ensure that there is a representative coverage of the potential effects in the study area. Due to the very low population density and the reduced visibility caused by the topography there is no visual receptor in the south of the development. The characteristics of the visual receptors are presented in **Table 17-20** and **17-21.**

For the viewpoints, photomontages were made which predict the visual change taking place once the wind turbines are erected. By using the realistic positions in the landscape and the correct scale of the wind turbines, visualizations provide a good impression on how the landscape will look like after the wind farm construction.

Settlements

In addition, next to the considered viewpoints the settlements in vicinity of the wind farm were also assessed. The assessment of the views from settlements will be based on the viewpoints and also on the ZTVs of the study area. The following settlements were considered:

- Jouar el Hachich.
- El Rweimeh.
- Quobaiyat.
- Akkar El-Atiqa'a.
- Es Sayeh.
- Fnaidek.

The characteristics of the settlement visual receptors are presented in **Table 17-21**.

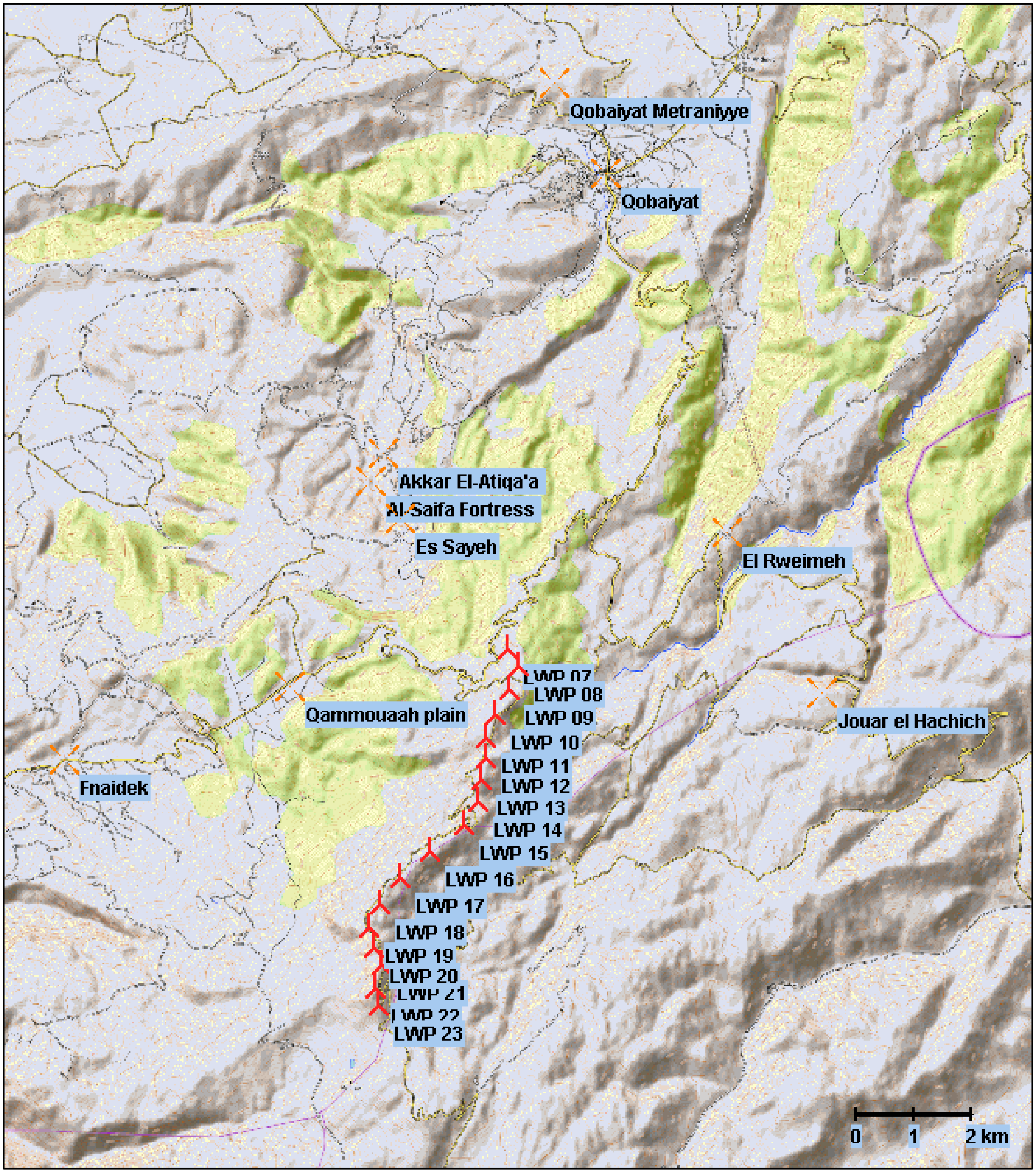
Table 17-20 Visual Receptor Sensitivity Assessment

Receptor	Key Characteristics	Sensitivity
Qobaiyat Metraniyye	Located approximately 9km north of the Project at an altitude of 680m. The visual receptor was selected because of its potential to have cumulative views of all three wind farm projects in the area due to its exposed location. Is also represents a worst-case view of the village Qobaiyat which is the largest village in the north of the site. The receptor is located on a hill in the north of the village Quobaiyat.	Low
Al-Saifa Fortress Akkar El-Atiqa'a	Located approximately 4km northwest of the Project at an altitude of 790m. The visual receptor was selected because it is one of the major historic sites in the area and as a recreational site. However, the ruin is not a frequently visited site by recreational users or holidaymakers as there is no supporting infrastructure such as designated parking lots, picnic tables or information boards. The fortress is in a state of ruin, with only a part of the northern tower remaining. The ruin of the fortress can be regarded as national important historic site. The site is mentioned on the website http://www.discoverlebanon.com.	High
Qammouaah Plain	Located approximately 3.5km west of the Project at an altitude of 1,440m. The visual receptor was selected because it is the most important recreational site in the area. The plain is the starting point for tourists visiting the ancient woodlands and the nature reserve in the area. Therefore, it is frequently used by holidaymakers. The Plain has touristic infrastructure such as restaurants, accommodations and inflatable castles for children.	High

Table 17-21 Visual Receptor Sensitivity Assessment – Settlements

Receptor	Key Characteristics	Sensitivity
Jouar el Hachich	Located approximately 5km east of the Project at an altitude of 1,390m. The visual receptor was selected because it represents an unblocked view from the very low densely populated area located east of the project site. The scattered small settlement east of the wind farm comprises a couple of detached houses. As existing large man-made structures, a quarry and telecommunication masts on the ridge of the wind farm site are visible. The area has a sparse population density and is usually not visited by recreational users or holidaymakers.	Medium
El Rweimeh	Located approximately 5.5km northeast of the Project at an altitude of 1,300m. The visual receptor was selected because of its exposed location on the next mountain ridge in the northeast of the site. The scattered small settlement northeast of the wind farm comprises a couple of detached houses. Most of the houses are only occupied a couple of months during the year. The area is already influenced by technical structures including two large overhead power lines and telecommunication masts. Views in the valley and towards the wind farm area are partly blocked by the existing trees. The area has a spare population density and is usually not visited by recreational users or holidaymakers.	Medium
Qobaiyat Village	Located approximately 8km north of the Project. The village is located in a Valley at an altitude of about 550 m. Some neighborhoods in the west and in the north of the village are located on a slope. The village has a higher population density than the surrounding area and has an increased summer population.	Medium - High
Akkar El-Atiqa'a village	Located approximately 4km northwest of the Project. The village is located on the eastern slopes of a valley. Most of the houses are facing towards the valley (west). The village is located at an altitude of about 800 m.	Medium - High
Es Sayeh village	Located approximately 2.9km northwest of the Project. The village is located on the eastern slopes of a valley, most of the houses are facing towards the valley (west). The village is located at an altitude of about 950m.	Medium - High
Fnaidek	Located approximately 6km west of the Project. The village is located on gentle slope increasing towards the wind farm site. The center of the village has a denser development compared to the smaller villages in the surrounding and include many four-storied buildings. The center of the village is located at an altitude of about 1,150m.	Medium - High

Figure 17-10 Lebanon Wind Power Visual Receptors



17.3.2. Visual Impact Assessment

17.3.2.1. Visual Impacts During Construction

During construction, the main visual impacts come from land clearing and excavation, stockpiling of equipment and materials, the use of large construction equipment such as cranes, and the construction of the turbines and transmission towers themselves. While the construction phase is anticipated to last about one year, the use of large construction equipment like cranes, which has the largest visual impact is limited to several weeks.

At the individual turbine locations, the cranes will be placed only for a couple of days. Due to the temporary nature of the construction process and the remote location of the project the visual construction impacts will be low in significance. Therefore, this section will focus on the operational phase of the project.

17.3.2.2. Visual Impacts During Operation

During operation, the predominant visual impact will be the wind turbines, adding man-made elements of considerable scale. The assessment of visual effects will consider the effects of change on the views available to people outside of the immediate site boundary of the project.

To judge the visual consequences on people, zones of theoretical visibility (ZTV) of the proposed development and visualizations were generated. While the ZTVs give an estimation of which areas are affected by the wind farm, the use of key viewpoints and visualizations give a realistic impression on how views in the area will look like after the wind farm construction.

Using this methodology visual impact assessment consists of predicting and evaluating the impact of the project settlement patterns and cultural heritage features. The above-mentioned tools and methodology are recommended in IFC Environmental, Health, and Safety Guidelines for Wind Energy (2015).

Zones of Theoretical Visibility (ZTVs)

Zones of theoretical visibility (ZTV) are used to describe the area over which a development can theoretically be seen and is based on a digital terrain model (DTM) created by using SRTM (Shuttle Radar Topography Mission) data with a resolution of 30 m.

Wind turbines can be clearly visible in a distance from 15 km at good weather conditions, however beyond that distance they are not likely to modify the landscape composition[2]. Therefore, the study area and the distances of the ZTV was defined as 15 km from the outer limit of the wind farm. The radius is based on the EIA guideline report for Lebanon[3] and a German guideline[4] for landscape assessment.

In the study area, the character of most of the forest is rather open with space and visibility between the individual trees. Therefore, forest cover was not included in the ZTV to reduce the visibility of the turbines. The same was observed for the settlements nearby the wind farm. Most of the houses are individual detached houses where visibility can be found between the dwellings. Therefore,

[2] Environmental Impact Assessment, CEDRO, Guideline Report, 2012.
[3] Environmental Impact Assessment, CEDRO, Guideline Report, 2012.
[4] Nohl; Beeinträchtigungen des Landschaftsbildes durch mastartige Eingriffe, Kirchheim bei München 1993/2001.

settlements were also not considered as land cover in the calculations. By taking out the forest and the settlements as land cover, which usually blocks the visibility of the turbines, a worst-case approach was applied for calculating the ZTV. The ZTVs are presented in **Appendix P**.

The ZTV calculation of the area around the wind farm shows how many turbines are visible for the entire study area (see Annex).

Visualizations (Photomontage)

To prepare visualizations, photographs of the landscape were taken, and 3D models of the proposed turbines were projected into the photographs. These renderings are produced with the software WindPRO by the Danish company EMD. For the visualizations the focal length of the photos, the coordinates of the photo location, a digital terrain model, the coordinates of the planned turbines and 3D models of the wind turbines are considered.

As a worst-case approach, the photographs for the visualizations were taken during clear weather conditions and the rotors are set to face towards the observer. Rather than providing the most realistic visualizations, the turbines were displayed dark when the background was bright and white when the background was rather dark in order to provide a worst-case photograph. The photomontages are also presented in **Appendix P**. The receptors and their sensitivity are described in the following section.

A viewing distance is provided under the visualizations based on the focal length of the photograph (in case of a panoramic picture, it is based on the opening angle). The visualizations give a realistic picture of the proposed development, when they are looked at with the provided viewing distance.

Assessing Visual Receptors

The assessment of the significance of effects is derived from a comparison of the nature of the effects (magnitude), as well as the nature of the receptors (sensitivity). The visual impact evaluation is based on the sensitivity degrees presented in **Table 17-22**.

The sensitivity of visual receptors is defined as very high, high, medium and low based on professional interpretation, combining judgements of their susceptibility to the type of change or development proposed and the value attached to the particular views. Visual receptors consist of the particular person or group of people likely to be affected at a specific viewpoint and are assessed in terms of both their susceptibility to change in views and visual amenity and also the value attached to particular views. The susceptibility of different visual receptors mainly depends on:

- The occupation or activity of people experiencing the view at particular locations.
- The extent to which their attention or interest may therefore be focused on the views and the visual amenity they experience at that particular location.

The magnitude of change can be described as very large, large, medium, small and very small, as shown in **Table 17-23.**

Table 17-22 Receptor Sensitivity Criteria

Sensitivity level	Characteristics
Very High	Receptor is highly sensitive to changes due to the following factors: • Receptor type is nationally valued, designated and or unique. • Receptor type is of cultural value with strong historical or topical cultural associations e.g. important with tourists. • Views are almost free from existing distracting manmade structures like power lines, roads, large buildings etc. • Receptor is frequently visited by recreational users or holidaymakers.
High	Receptor is highly sensitive to changes due to the following factors: • Receptor type is of cultural value with historical or topical cultural associations e.g. important with tourists. • Receptor has a nature-related recreational feature. • Low level of existing distracting manmade structures like power line, roads, large buildings, etc. • Receptor is visited by recreational users or holidaymakers.
Medium	Receptor is sensitive to changes due to the following factors: • Receptor type has some cultural value with historical or topical cultural associations. • Receptor has some extant nature-related recreational feature. • Receptor or views are locally valued but regionally or nationally common • Medium level of existing distracting manmade structures like power line, roads, large buildings etc. • Receptor is occasionally visited by recreational users or holidaymakers.
Low	Receptor is less sensitive to changes due to the following factors: • Receptor type has low or none cultural value with historical or topical cultural associations. • Receptor has no or very little nature-related recreational features. • Considerable existing distracting manmade structures like power line, roads, large buildings etc. • Receptor is hardly visited by recreational users or holidaymakers.

Table 17-23 Criteria for Magnitude of Visual Amenity Change

Magnitude	Characteristics
Very Large	Very large changes in landscape characteristics, wind turbines controlling the view.
Large	Range from notable changes in landscape characteristics, wind turbines can be easily and unmistakable seen.
Medium	Moderate changes in landscape characteristics in a local area, wind turbines clearly visible.
Small	Minor change in landscape characteristics, wind turbines are visible.
Very Small	Very minor change in landscape characteristics, wind turbines not clearly visible or not obvious visible.
No Change	Wind turbines are not visible.

The magnitude depends on the following:

- The distance of the receptor to the proposed development.
- The extent of existing landscape elements that will be lost.
- The extent of adding new landscape elements.
- The geographic area over which the intervention will be perceived.
- The alteration of the skyline/altering the vertical scale in relation to existing landscape features.
- The duration of the change.
- The reversibility of the change.

To assess the project's impact on visual receptors, the magnitude of change and visual sensitivity must be considered. By combining these two aspects the following matrix is obtained, as presented in **Table 17-24**).

Table 17-24: Significance Matrix

Receptor sensitivity / Impact magnitude	Low	Medium	High	Very High
Very Small	Negligible	Slight to negligible	Slight	Slight
Small	Slight to negligible	Slight to moderate	Slight to moderate	Moderate to substantial
Medium	Slight to moderate	Moderate	Moderate to substantial	Substantial
Large	Moderate	Moderate to substantial	Substantial	Substantial
Very Large	Moderate	Substantial	Substantial	Critical

Assessment of Effects on Visual Receptors

Roads and Craned Pads

New internal tracks connecting the proposed turbines to the existing road network will be required. The material used for the tracks and crane pads will be similar to the existing bedrock. Therefore, the new tracks and crane pads will not stand out visually from the surrounding. New road sections will be on the rocky ridge of the site, consequently the new roads made of gravel will not visual attract attention due to the similar visual appearance. Since the project area is mountainous, the visibility of the new tracks will be limited and partly blocked by the topography. The magnitude of change is considered to be low given that the tracks fit themselves into the surrounding and that most tracks are hidden in the landscape. The new tracks will not be adding a new element to this landscape. Therefore, the effect of new tracks on the landscape and visual resource is considered to be minor and not significant.

Cabling

Due to visual concerns it was decided that the power lines which collects the energy from the wind farm site will be executed by underground cables, routed along the line of new tracks. Therefore, there will be no additional overhead powerlines necessary for the Project. Consequently, this study will rather focus on the new wind turbines.

Wind Turbines

The Project turbines will add man-made elements of considerable scale, establishing a new landmark feature and a point of reference in views from the wider area. Large, multimegawatt turbines with rotor diameters of up to 158m are considered for the project. Using such large turbines reduces the number of turbines necessary per generation capacity and therefore the footprint of the project. In addition, turbines with large rotor diameters have reduced rotor speeds in comparison with smaller turbines, which also reduces the visual impact. At the time Ramboll was contracted to undertake the landscape and visual assessment, the final wind turbine model had not yet been selected. Therefore, four different turbine models that may be selected for Lebanon Wind Power wind farm were assessed, as listed in **Table 17-25** (it is noted that Scenario A representing Nordex has been removed).

Table 17-25 WTG Scenarios

	Planned WTG Scenario B	Planned WTG Scenario C	Planned WTG Scenario D
Number in Reports	7-23	7-23	7-23
Count	17	17	17
Manufacturer	Vestas	GE Wind	Siemens
WTG type	V150	5.3-158	SG145-4.5
Rotor Diameter \ m	150	158	145
Tip Height \ m	180	200	180
Hub Height \ m	105	121	107.5
Rated Power \ kW	4.2	5.3	4.5
Rotor Speed \ rpm	4.9 -12.0	5.2 - 9.7	up to 10.8

For the assessment including the ZTVs, as well as the visualizations, the turbine type GE Wind 5.3-158 with a tip height of 200 meters was considered as a worst-case approach due to its large rotor and its larger total height compared to the Vestas and Siemens-Games models.

The key visual receptors were assessed based on criteria provided in the methodology, as shown in **Table 17-26 and 17-27** and its sensitivity classified accordingly. In a second step the significance of the impact was established by considering the magnitude of impact as well the sensitivity of receptor.

Table 17-26 Assessment of the Significance on Key Receptors

Receptor	Sensitivity	Magnitude of change	Significance
Qobaiyat Metraniyye	low	- Small- Most of the turbines will be visible from the viewpoint. However, the WTGs will be very small features in the landscape and only be visible at good weather conditions due to the distance of more than 9 km to Lebanon Wind Power wind farm.	Slight to Negligible
Al-Saifa Fortress Akkar el-Atiqa'a	High	-None- The ZTV and the photomontage demonstrate that the viewpoint will have a very restricted view of the development due to the existing orography which blocks the view towards the wind farm. Only the tips of the blades of the very northern turbines will be visible.	Negligible
Qammouaah Plain	High	-Small to Medium- The ZTV demonstrates that in some areas of the plain the visibility of the Lebanon Wind Power wind farm is blocked by the topography. In the northern part of the plain four to five WTGs will be visible (see visualizations). The turbines will appear to be of a small scale, as the turbines are over 3 km away from the nearest point of the plain. Due to the topography and the distance, the few visible turbines will only be visible on a ridge in the background and therefore not be a dominate landscape feature visible from the plain.	Moderate

Table 17-27 Assessment of the Significance on Settlements

Receptor	Sensitivity	Magnitude of change	Significance
Jouar El Hachich	Medium	-Small to Medium- Most of the turbines will be clearly visible. However, the turbines will only be relatively small features in the landscape due to the distance of approx. 5 km to the planned wind farm.	Slight to Moderate
El Rweimeh	Medium	-Small to Medium- The turbines will be clearly visible. However, the turbines will only be relatively small features in the landscape due to the distance of approximately 5.5 km to the closest turbine. The WTGs of the southern part of the wind farm will appear even smaller due to the larger distance to the village.	Slight to Moderate
Qobaiyat Village	Medium - High	-Small- The ZTV indicates that the center of the village will only have a visibility of some turbines, the rest of the turbines will be blocked by the topography. In the center of the village the houses itself will also reduce the visibility of the turbines. Some areas in the western part of Qobaiyat will have no visibility of the turbines at all, due to the local topography. The northern slopes of Qobaiyat have an increased visibility due to its exposed location. Therefore, the Viewpoint "Qobaiyat Metraniyye" was selected to be in this area, considering an worst case view from the village and its surrounding. The magnitude of change is restricted due to the distance of over 8 km to the closest WTG, therefore the turbines will appear in a small scale. Due to the array of the wind farm spreading from north to south, the furthest WTG is located in a distance of more than 14 km. Due to the wind park array stretching from north to south the turbines will also only cover a small percentage of the field of view from a potential observer located in the north of the project which will considerably reduce the magnitude of change for the village Qobaiyat.	Slight to Moderate

Receptor	Sensitivity	Magnitude of change	Significance
Akkar El-Atiqa'a village	Medium - High	-Small- Due to a ridge, which is located between the village and the ridge on which the wind farm is located, the village will only have a limited view of the planned turbines. The ZTV shows that some parts of the village will not have any visibility of turbines, some areas of the village will have visibility of some of the most northern turbines of the project. Due to the local topography most of the houses are orientated towards the valley and therefore their views are rather towards the west and not towards the turbines which are in the south-east of the village.	Slight to Moderate
Es Sayeh village	Medium - High	-Small- Due to a ridge, which is located between the village and the ridge on which the wind farm is located, the village Es Sayeh will hardly have a visibility of the planned turbines. The ZTV shows that some parts of the village will not have any visibility of turbines, some areas of the village will have visibility of some of the most northern turbines of the project. Due to the local topography most of the houses are orientated towards the valley and therefore their views are rather towards the west and not towards the turbines which are in the south-east of the village.	Slight to Moderate
Fnaidek village	Medium - High	- Medium - The ZTV shows that the village will have a visibility of about the half of the planned turbines. The turbines will be equally distributed on the ridge of the wind farm and follow the topography of the mountain. Although the project will be clearly visible on the horizon from exposed places in the village and the WTGs would occur as new elements in the landscape, the magnitude of change is restricted, and the turbines will not be dominate features in the landscape. This is due to the distance of about 6 km, therefore the WTG will not rather appear in a large scale. In addition, the density of the buildings will result that large areas of the village will experience a reduced or blocked visibility of the project.	Moderate to Substantial

To summarize, due to the remote location of the Project, and the presence of few settlements, individual houses and cultural features visually effected by the planned wind turbines. From the most frequently visited tourist spot in the area, the Qammouaah Plain, only a few wind turbines are visible, and the turbines will not be a dominate landscape feature.

Cumulative Effects on Visual Amenity

The cumulative effects on visual amenity during operations were also assessed. Refer to **Section 22 Cumulative Impacts**.

17.3.2.3. Visual Impacts During Decommissioning

Decommissioning impacts are similar to construction impacts: the stockpiling of equipment and materials, the use of large construction equipment such as cranes, and the decommissioning process itself. Given the temporary nature of the decommissioning process, visual impacts are expected to be of negligible significance.

17.4. Transport and Traffic Impacts to Communities

17.4.1. Baseline Methodology

As presented in **Section 12 Transport and Traffice**, two route surveys and a Traffic Impact Study were undertaken to assess the conditions for the practical and safe transport of WTG components to the Project. The methodology was to assess potential routes, identify obstacles along those routes and to survey peak hour traffic volumes at key road links and junctions. Based on these studies, the preferred transport route for the Project was selected, as described in **Section 2**.

This section presents the impacts of transport and traffic to community health, safety and security, elaborating the difference between physical impacts and those to pedestrians, drivers and communities.

17.4.2. Baseline Findings

17.4.2.1. Obstacle Removal

The transport and traffic studies identified obstacles along the route that will need to be removed entirely or modified to provide the vertical and lateral clearance needed to transport the WTG components, as previously summarized in **Table 12-9**. The obstacle removal works are generally as follows:

- Temporary concrete bund, curb, electric pole and overhead removal.
- Removal of curbs, electric poles, trees, lamp posts, and fencing along ramps, roundabouts and curves, as well as prohibition of car parking during transport.
- Raising of the pedestrian bridges to provide a vertical clearance of 570cm.
- Ground leveling and compaction at significant curves to facilitate maneuverability.

17.4.2.2. Construction of New Road Segments

New sections of road will be constructed as follows:

- In order to avoid impacts to Chadra, Machta Hassan and Machta Hammoud, a new 0.65km section of asphalt road will be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 2-8**). The new road section will connect with the existing asphalt road outside of Machta Hammoud.
- A new 0.15km section of asphalt road will be constructed (shown as #2 in **Figure 2-8**) between two existing sections of asphalt road in order to avoid hairpin turns near homes.
- A new 3.0km section of gravel road will be constructed within the existing railroad right of way (ROW) managed by Machta Hammoud Village (shown as #3 in **Figure 2-8**), traveling east before connecting to an existing asphalt road to enter the Hawa Akkar Wind Farm.

17.4.2.3. Addition to Traffic Volume

Capacity analysis was undertaken for the 5 road segments to be used, Road Segments A, B, C, D, and E, under three scenarios:

1. The existing traffic conditions (year 2018); This scenario uses the existing traffic volumes collected through automatic and manual counts.
2. Future background traffic conditions (year 2020) without the Project; this projection applied a conservative traffic growth rate of 3%.
3. Future traffic conditions (year 2020) with the Project; the projection was derived after assigning the generated trips for the transport of the WTG components in combination with the projection generated under Item 2.

The resulting LOS was then calculated for the selected road segments under the three scenarios to illustrate the impact of the additional traffic. As an extra measure of conservatism, the LOS was calculated between 10pm and 11pm (a period of higher traffic volume), whilst the WTG component transport will be undertaken between 12am and 4am.

During the WTG transport, the LOS of Road Segment A will be reduced from A to B, Road Segment B will be reduced from A to C, Road Segment C will be reduced from A to B, and Road Segment D will be reduced from A to B. For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road. For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.

17.4.3. Transport and Traffic Impact Assessment

17.4.3.1. Transport and Traffic Impacts During Construction

Obstacle Removal

Obstacle removal activities will be undertaken by the Developer in close coordination with the concerned local authorities. Obstacles will be removed either temporarily (concrete blocks, selected poles) or permanently before being moved to another location (selected poles) or reinstated with an improved design (roundabout islands).

Removal of obstacles will cause a temporary impact to pedestrians, drivers, and communities along small sections of the roadway, creating delays or detours.

Mitigation

- The temporary removal of concrete bund, curb, electric pole and overhead cable, and demolition of the 45m of concrete wall be coordinated with the Port Authority.
- Raising of pedestrian bridges, prohibition of car parking, removal of curbs, electric poles, trees, lamp posts, and fencing at ramps and roundabouts and ground leveling and compaction of significant curves will be coordinated with the Ministry of Transport.
- Asphalt speed bumps will be replaced with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass.
- Any modification required for the Al Abdeh roundabout will be discussed with the municipality as it is under their authority.
- Such works will be coordinated and permitted by the Developer and the Ministry of Transport and scheduled for time periods when traffic levels and/or pedestrian use are lowest.

As such, the impact severity is considered Low and the receptor sensitivity considered Medium, resulting in a Minor Impact as shown in **Table 17-28**.

Table 17-28 Assessment of Impacts from Obstacle Removal

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	BHigh	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Construction of New Road Segments

New 0.65km Asphalt Road

Land purchase from private land owners is necessary for the construction of the new 0.65km section of asphalt road through a ~12.5ha parcel of land outside of Machta Hassan and Machta Hammoud, as shown in **Figure 17-11**. This segment of road is being constructed to avoid travel along existing roads that traverse Chadra, Machta Hassan and Machta Hammoud.

Figure 17-11 New 0.65km Asphalt Road Segment to Avoid Chadra, Machta Hassan and Machta Hammoud

The land is currently vacant, and there will be approximately 120m distance between the existing houses and the new segment of road. Compensation will be provided at a cost to be agreed with the landowner(s). As such, the impact to the landowner(s) is considered minor when compared to the alternative of traffic and transport impacts to the densely developed city centers.

<u>New 0.15km Asphalt Road</u>

Land purchase from private land owners is necessary for the construction of the new 0.15km section of asphalt road between two existing sections of asphalt road, as shown in **Figure 17-12**. The purpose of the road segment is two-fold: 1) to avoid hairpin turns near homes; and 2) to create greater buffer distances (i.e. 21m to 60m) between the transport route and the homes.

Compensation will be provided at a cost to be agreed with the landowner(s). As such, the impact to the landowner(s) is considered minor when compared to the alternative of traffic and transport impacts to the densely developed city centers.

<u>New 3.1km Gravel Road within Existing Railroad ROW</u>

Land purchase from the Municipality of Machta Hammoud is necessary for the construction of the new 3.1km section of gravel road within an existing railroad ROW, as shown in **Figure 17-13**. It is noted that a 0.11km segment of asphalt road will also be constructed to join the existing asphalt road to enter the Hawa Akkar wind farm site (shown in red on **Figure 17-13**).

Compensation will be provided for construction within the railroad ROW at a cost to be agreed with the Municipality of Machta Hammoud. It is noted that the existing railroad ROW is currently used as a road by vehicles, as shown in **Figure 17-14**. As such, the new segment of gravel road is considered a roadway improvement that will enhance driving conditions.

In addition, compensation will be provided at a cost to be agreed with the landowner to join the gravel road with the existing asphalt road. This land that will be acquired is currently mowed lawn that fronts the intersection of the railroad ROW and the existing asphalt road, as shown in **Figure 17-15**. Therefore, the acquisition does not represent a loss of agricultural land and/or source of subsistence.

<u>Mitigation</u>

The construction of asphalt and gravel roads will occur for a period of 6 months and will be coordinated and permitted by Ministry of Transport and scheduled for time periods when traffic levels are lowest. The construction would be performed under the supervision and conditions of the relevant municipality.

The improved road network will have a positive impact on the health and safety in the area by providing safer roads, minimizing impacts to city centers, providing greater buffer distances between houses and the road and eliminating dangerous curves/turns.

As such, the impact severity is considered Low and the receptor sensitivity considered Medium, resulting in a Minor Impact as shown in **Table 17-29**.

Figure 17-12 New 0.15km Segment of Asphalt Road

Figure 17-13 New 3.1km Gravel Road within Railroad ROW

Figure 17-14 Existing Railroad ROW Used by Vehicles

Figure 17-15 Land Acquisition for 0.11km Asphalt Road Segment

Table 17-29 Assessment of Impacts from New Road Segments

		Sensitivity of Receptor				
		Low	Low-Medium	Medium √	Medium-High	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	BHigh	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Construction of Internal Track

Land will be leased from the following villages for the construction of internal track (and other Project components):

- Project: Fnaidek, Rweimeh Village and Karm Chbat.
- Hawa Akkar Wind Farm: Chadra, Aandqet and Mqaible.
- Sustainable Akkar Wind Farm: Aandqet, Jabal-Akroum Kfartoun and Rweimeh Village.

Track work will also occur near the Lebanese Army Military base in Sahle.

However, it is considered that the construction of the internal tracks will have no impact on access to homes and businesses by residents of the surrounding villages and/or access to and operations at the Lebanese Army Military base. While access to certain areas will be prohibited during internal track construction (and the Construction phase in general), this measure is being taken to ensure the health, safety and security of community members. No negative impacts on health and safety are anticipated from internal track construction, particularly if the proper procedures and measures will be followed to ensure public wellbeing.

Mitigation

- Construction of internal track will occur for a period of 3 months and will be coordinated with the Ministry of Transport and the Lebanese Army.
- Occupational health and safety rules, codes and regulations will be followed during works.
- The OEM/EPC Contractor will be supervised by and accountable to the Developer.

Therefore, the impact severity is considered Slight and the receptor sensitivity considered Medium, resulting in a Negligible Impact as shown in **Table 17-30**.

Table 17-30 Assessment of Internal Track Development

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	**Negligible √**	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Transport of WTG Components

Villages Along the Transport Route

The transport of WTG components will add a roundtrip convoy of 11 oversized trucks twice per week (a total of 22 trucks roundtrip per week) to the existing road network for a period of 8 weeks. Based on the traffic counts carried out during baseline studies, communities along these roads currently experience the passage of nearly 57,000 heavy vehicles per week. During transport, the LOS will not decrease below LOS C, and the calculated decrease in LOS will only occur temporarily, two times per week over a total period of 8 weeks.

Informal Settlements

As shown in **Figure 17-16**, there are no informal settlements within or near the Project's immediate study area. Informal settlements located immediately adjacent to the WTG transport corridor are summarized in **Table 17-31**.

Twenty-two (22) informal settlements, comprised of 195 individual tents and 1,235 people, are currently located adjacent to existing Road Segments B, C, D, and E, and experience average daily traffic totals of 36,392, 20,580, 16,007 and 12,070, respectively. As above, transport of WTG components will add a roundtrip convoy of 11 oversized trucks twice per week (a total of 22 trucks roundtrip per week) to the existing traffic volume experienced by the informal settlements for a period of 8 weeks.

It is noted that informal settlements may not have access to traditional forms of notification, i.e. radio, television, newsletters or postings at village municipal buildings. Therefore, this has been incorporated into the planned mitigation planning.

Table 17-31 Summary of Informal Settlements Immediately Adjacent to the WTG Transport Corridor[5]

Settlement Code	Code Name	Number of Tents	Number of Individuals
37271-01-010	Minie 010	2	13
37271-01-063	Minie 063	3	14
37271-01-032	Minie 032	1	5
37271-01-065	Minie 065	3	18
37271-01-019	Minie 019	4	13
37271-01-058	Minie 058	2	20
37271-01-021	Minie 021	3	11
37291-01-009	Zoug Bhannine 009	83	392
37291-01-003	Zoug Bhannine 003	36	438
35277-01-018	Mhammaret 018	13	45
35269-01-037	Qoubber Chamra 037	2	9
35269-01-016	Qoubber Chamra 016	1	10
35261-01-066	Mqaiteaa 066	1	3
35234-01-046	Kfar Melki Aakkar 046	2	20
35233-01-049	Qaabrine 049	4	15
35227-01-107	Sammouniye 107	5	22
35277-01-108	Sammouniye 108	4	31
35224-01-004	Chir Hmairine 004	1	11
35224-01-007	Chir Hmairine 007	4	18
35224-01-028	Chir Hmairine 028	11	82
35224-01-021	Chir Hmairine 021	2	9
35498-01-002	Aandqet 002	8	36
Totals	**22 Settlements**	**195**	**1,235**

<u>Mitigation</u>

- A communications protocol under development for the transport of WTG components will be distributed to all Mayors two to three months prior to the start of transport.
- A separate communications protocol under development for the transport of WTG components will be distributed to all informal settlements within 1km of the transport route two to three months prior to the start of transport.
- Access to the grievance mechanism will be shared with all villages and informal settlements.

[5] The locations of the informal settlements in the table are shown in the series of maps provided in **Appendix Q**.

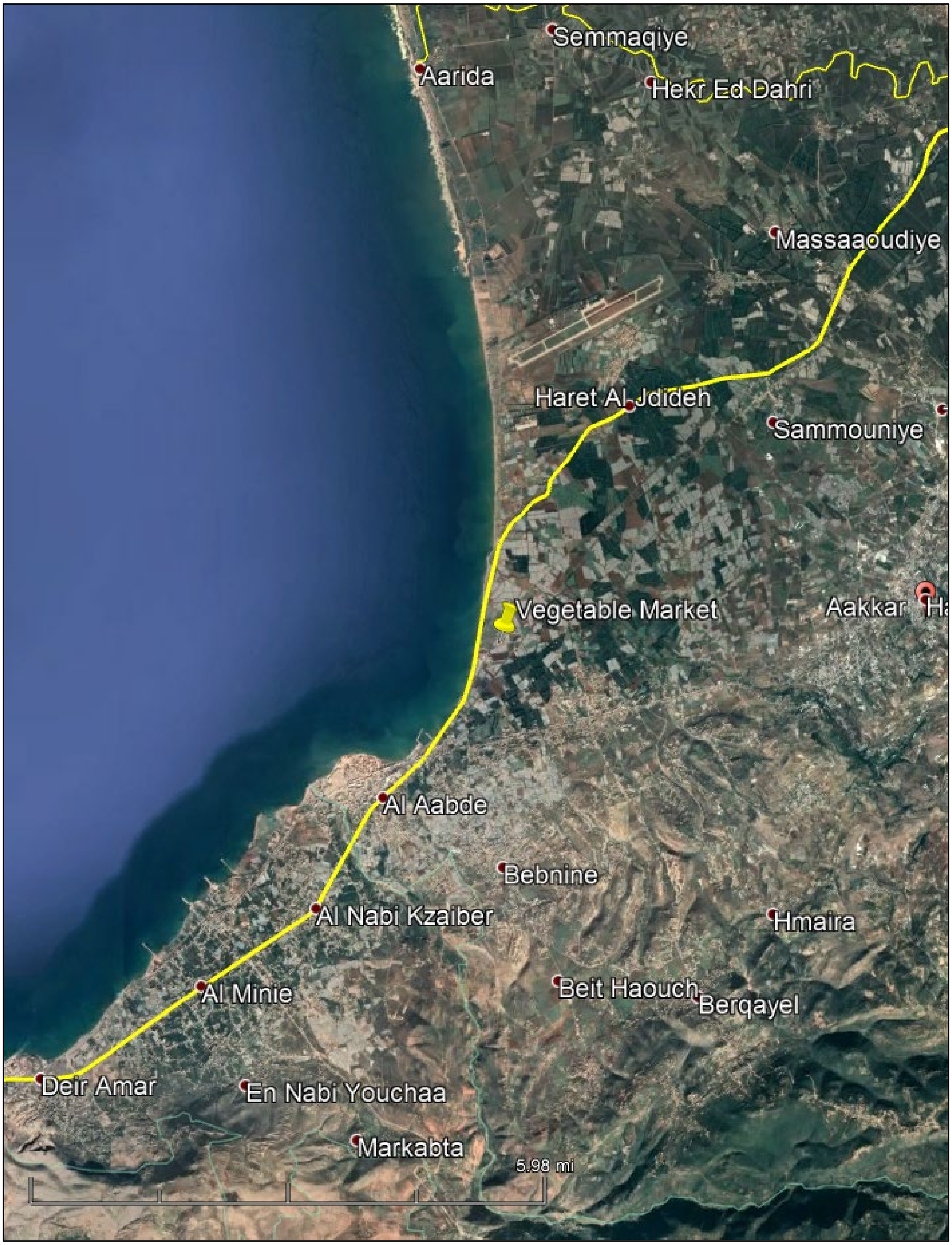
- A final transport route map will be provided to all villages and informal settlements.
- Advance notification of the scheduled transport will be provided to all communities along the route through radio, television, newsletters or postings at village municipal buildings.
- Informal settlements within 1km of the transport route will be notified in person in advance by the CRO and the Developer.
- The transport of WTG components will occur between 12am and 4am to avoid impacts to communities traveling to work and school.
- Municipal police will provide end-to-end escort for the transport convoy.
- The truck convoy will travel at a low speed to lessen the generation of noise, vibration and dust.
- Transport will be timed before and after farmers take their crops to the Akkar Vegetable Market, as shown in **Figure 17-17**.
- For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road.
- For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.

The mitigation measures will minimize the potential for transport of WTG components to impact community health, safety and security. As such, the impact severity of traffic and transport from transport of WTG components is considered Low and the receptor sensitivity considered High, resulting in a Moderate Impact as shown in **Table 17-32**.

Table 17-32 Assessment of WTG Component Transport during Construction

		Sensitivity of Receptor				
		Low	Low-Medium	Medium	Medium-High	High √
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor	**Moderate √**
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Figure 7-17 Akkar Vegetable Market



Transport of Construction Materials

The transport of construction materials will be limited to the following, as shown in **Figure 17-18**:

- The destination of all surplus excavated earth material will be the 6 quarries, using tracks internal to the Project site, the existing asphalt road (in red) and the existing quarry tracks (in green), approximately 86 trucks per day for a period of 90 days.
- The highest traffic volumes by the project are anticipated between the quarry and the wind farm site (yellow route near the Project entrance). The daily vehicle trip generation is estimated to be approximately 86 trips. This equates to approximately 7 two-way HGV trips per hour assuming a 12-hour working day, representing a minor number of trips over a temporary period.
- All ready-mix concrete will be sourced from the Batch Plant to be constructed in Rweimeh Village and will be transported to the Project site using the existing asphalt road (in yellow), approximately 13 trucks per day for a period of 90 days.
- Sand and gravel will be sourced from the 6 quarries using the existing quarry tracks (in yellow), the existing asphalt road (in red), and tracks internal to the Project site, approximately 9 trucks per day for a period of 80 days.
- All cement will be sourced from Chekkah, south of Tripoli and the location of two large cement plants, using approximately 1 truck per day for a period of 80 days.

The impact of the transport of cement from Chekkah is considered to be minimal, i.e. the addition of 1 truck per day along a route that carries nearly 57,000 heavy vehicles per week.

Given the presence of existing tracks and asphalt roads, and close proximity of the quarries, the batching plant and the Project site, the movement of construction materials will be limited to a 12.5km^2 area in Rweimeh Village, and therefore will likely not impact the wider community. It is noted that 50+ houses are located along the quarry tracks and existing asphalt roads, as shown in **Figure 17-19** (Note: the houses highlighted in red are vacant).

It is noted that members of Rweimeh Village are supportive of the location of both the SA/EDL Substation and the Batching Plant within the village, and they are accustomed to transport of quarry materials along the existing asphalt roads to supply the north Akkar region with sand and gravel. Further, over 90% of Rweimeh Village members are only present 3 months of the year. Whilst the residents of these houses are likely accustomed to quarry activities, including the movement of trucks, the construction will take place in summer and it is anticipated that the Project represents a significant increase in the volume of heavy vehicles to the quarry roads.

Mitigation

- The Developer will meet with Rweimeh Village residents of the houses located along the quarry tracks and existing asphalt roads to discuss the Project and nature and timing of the transport of construction materials.
- Advance notification of the start of construction will be provided.
- The trucks will travel at a low speed to lessen the generation of noise, vibration and dust.
- Occupational health and safety rules, codes and regulations will be followed during works.
- Negotiation of entry to quarry roads by resident vehicles will follow standard traffic safety/traffic control protocols, i.e. Stop/Go signage, flagman, etc.
- The OEM/EPC Contractor will be supervised by and accountable to the Developer.

Figure 17-18 Quarries and Existing Tracks (Green) Joining Existing Road (Yellow)

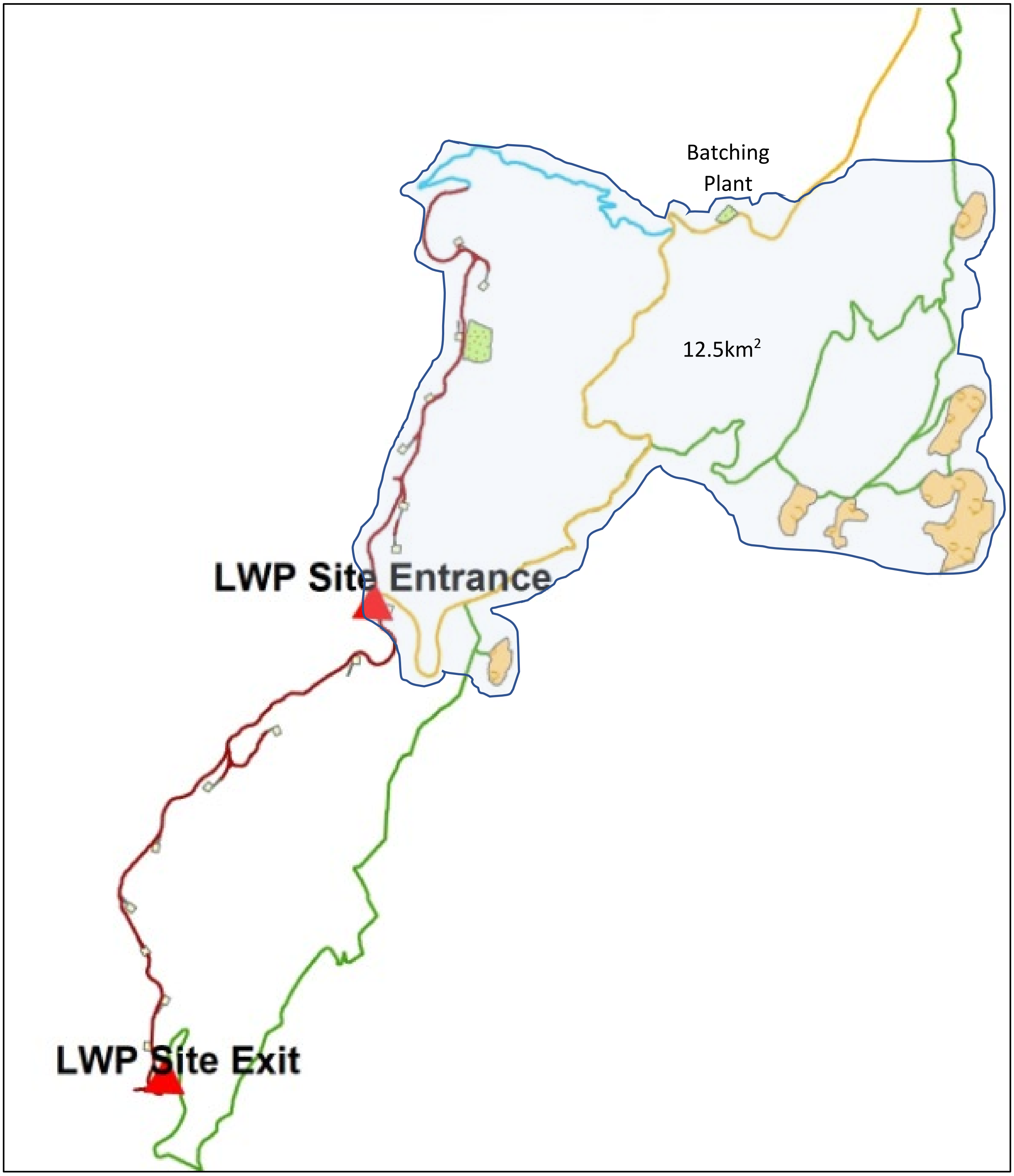
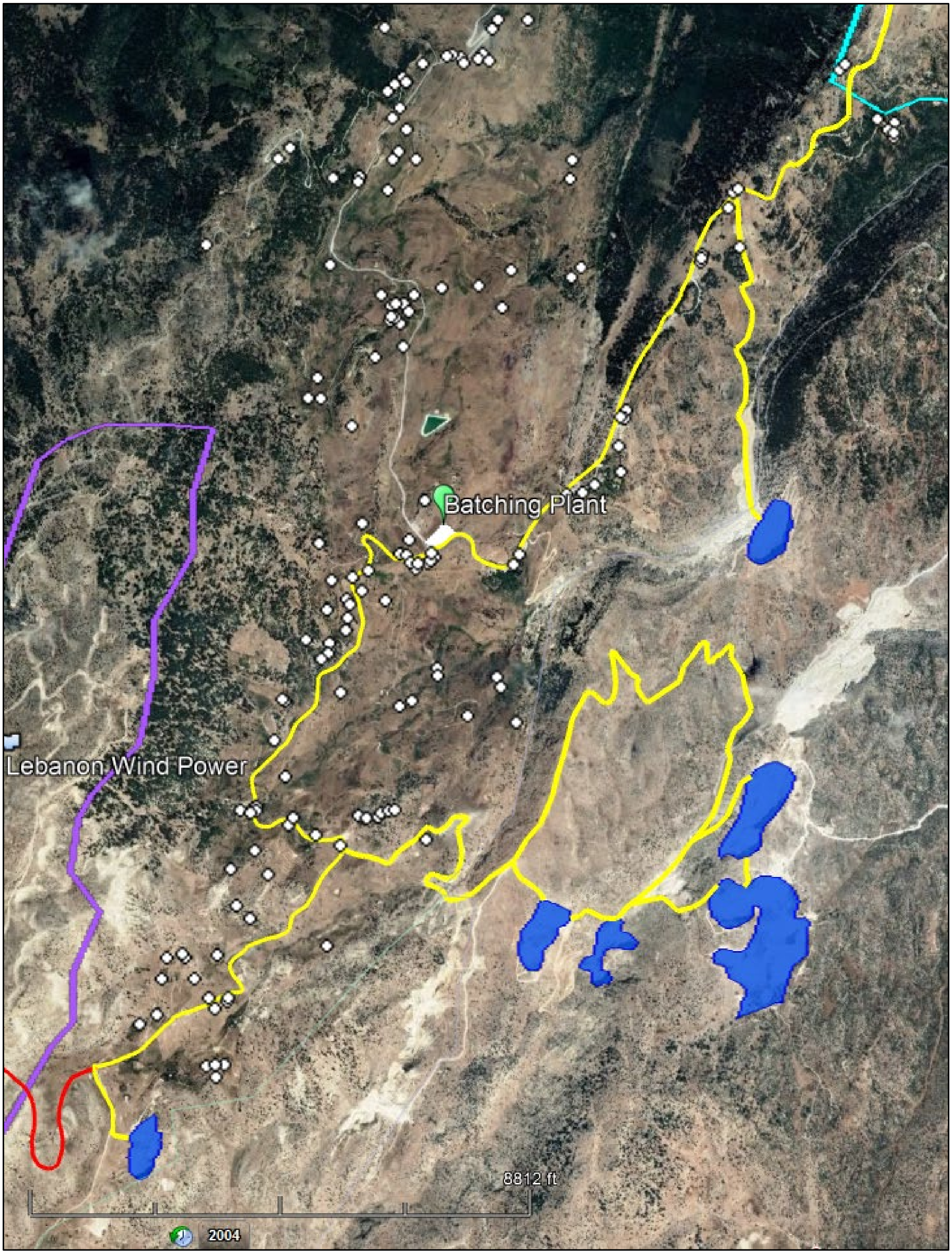


Figure 7-16 Houses Near Transport Routes for Construction Materials



The mitigation measures will minimize the potential for transport of construction materials to impact community health, safety and security. As such, the impact severity of traffic and transport from transport of WTG components is considered Low and the receptor sensitivity considered High, resulting in a Moderate Impact as shown in **Table 17-33**.

Table 17-33 Assessment of Construction Materials Transport during Construction

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High √**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	**Minor √**	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

17.4.3.2. Transport and Traffic Impacts During Operation

Traffic impacts during the operational phase are expected to be low to negligible and relate only to travel to the Project site by the EPC Contractor for periodic maintenance activities at the Project site.

17.4.3.3. Transport and Traffic Impacts During Decommissioning

During the decommissioning phase, the wind turbines will need to be dismantled and removed from the Project site. Traffic impacts are expected to be similar to that of the construction phase but will require assessment at the time to capture the most up-to-date traffic conditions along the expected disposal route.

18. LANDSCAPE

An assessment of the landscape effects deals of change on the landscape as a resource.

18.1. Baseline

Information regarding the existing landscape elements in the project area was obtained through physical survey of the area. Photographs were taken to support the assessment by SES during site visits conducted between September to December 2018.

The study area is located at an altitude between 400 m and 2,800 m, encompassing different ecosystems and habitats. The surveyed area extends between the upper middle mountain zone (Eu-Mediterranean) and the high mountain zone (Supra-Mediterranean) as indicated by the tree species observed onsite.

The study area (i.e. project plots and surrounding area) encompasses the following habitats: Calabrian pine forests, evergreen oak woods, juniper woodland, mixed forests, grassland, cliffs and rocky habitats. This zone is part of Akkar-Danniyeh-Hermel Important Plant Area (IUCN Important Plant Areas of the south and east Mediterranean region, 2011), and close to the proposed Akkar heights national park (SDATL, 2009).

The study area has been subject to major changes since antiquity[1]. Former dense forestation was displaced by human activities through housing, agriculture and forestry. However, still existing forests are subjected to managed forestry. Natural forests or forests containing the former existing potential vegetation are only present at small or medium sizes (forests with oak and pine).

The result is a large landscape mosaic, which can be summarized in landscape units as described below (refer to the landscape mosaic map in **Appendix P**).

18.1.1. Landscape Units

The classification of the landscape units was based on the latest official Lebanese land use cover survey.

Agricultural Areas

The agricultural units often have a clearly recognizable culture-historical landscape character. For example, from old stone walls bordered olive groves terracing as shown in **Figure 18-1**.

However, the tertiary development with modern influences is clearly recognizable, where historical elements are only recognizable on a small scale as a relic. In particular, high voltage power lines, quarries, semi-finished buildings, etc., have a strong influence on the historical agricultural shaped landscape. Agricultural areas near the Lebanon Wind Power project are mainly constituted of terraces planted with apple and cherry trees. While the Sustainable Akkar and the Hawa Akkar project sites do not have any agricultural areas.

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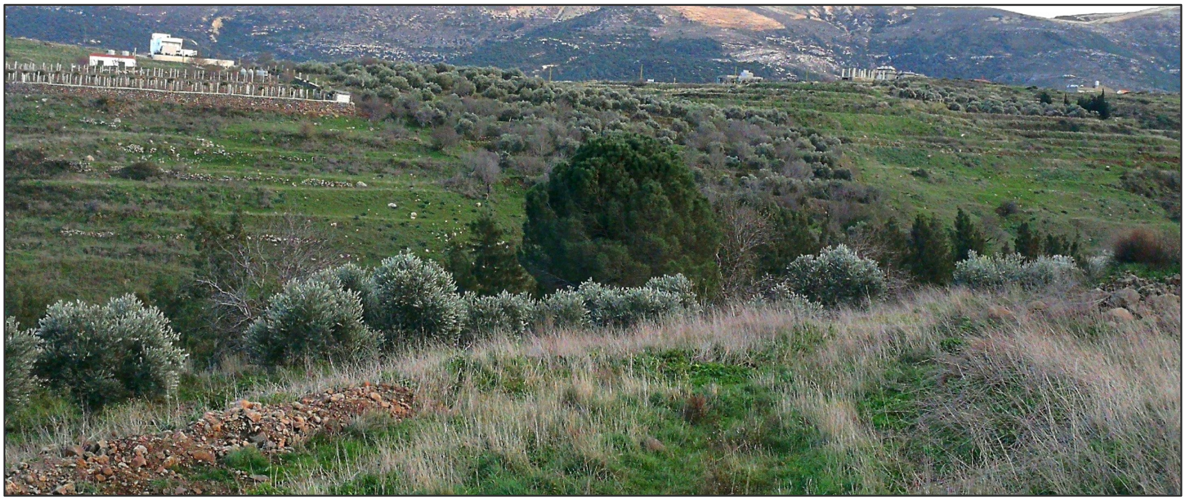
[1] Marvin W. Mikesell: The Deforestation of Mount Lebanon. In: Geographical Review, Vol. 59, No. 1, Januar 1969, S. 1–28.

Figure 18-1 Agriculture Area (here Olive Plantations)



Dense Pinus and Quercus Forests

This forestry units consists of native forests as shown in **Figure 18-2**; however, they are subjected to intensive use. These woods are the main source of wood-fuel for heating in winter season. The wood extracted from these forests is used for cooking and charcoal production. This applies in particular to the areas in the northern part of the study area[2]. Accordingly, the units are not classified in the highest value rating grade.

Figure 18-2 Example of a Dense Pinus Forest

[2] Lebanon's National Blueprint for a Sustainable Forest Biomass: promoting renewable energy and forest stewardship, Developed by: Biodiversity Program - Institute of the Environment – University of Balamand – Lebanon, 2016.

Dense Cedrus Forests

This forest type is the original forest-vegetation unit of the Lebanon Mountains. However, the cedar forests have been subjected to a strong utilization since 5,000 years BC. Consequently, only very small patches of the old cedar forest are still present. Since the ecological conditions have changed over time, the natural regeneration and survival of the last relicts of this forest form is endangered[3] . In the study area there are no cedar forests. There are only a few individual trees in the area. These individual stocks do not form a spatial unit in the sense of a landscape image and are accordingly not subject for the evaluation. The remaining Cedrus trees are part of the mixed woods in the area. These woods are a mixture of Cedrus, Abies, Juniperus Excelsa and Drupacea.

Abies Forests

The quality for Abies forest is classified as a lower medium grade since it is managed in a monoculture.

Mixed Forests

These areas are classified as having medium quality because they consist of large contiguous areas and also due to the variety of species within the unit, as shown in **Figure 18-3**. The present mixed forests are a mixture of Cedrus, Abies cilicica, and Juniperus species, with Abies dominating on northwest and north slopes, and Cedrus on northeast and east slopes. Goat grazing areas and summer farms are present in this landscape unit.

Figure 18-3 Example of a Mixed Forest Area Consisting of Conifer and Broadleaf Trees

Other Dense Leafy Forests

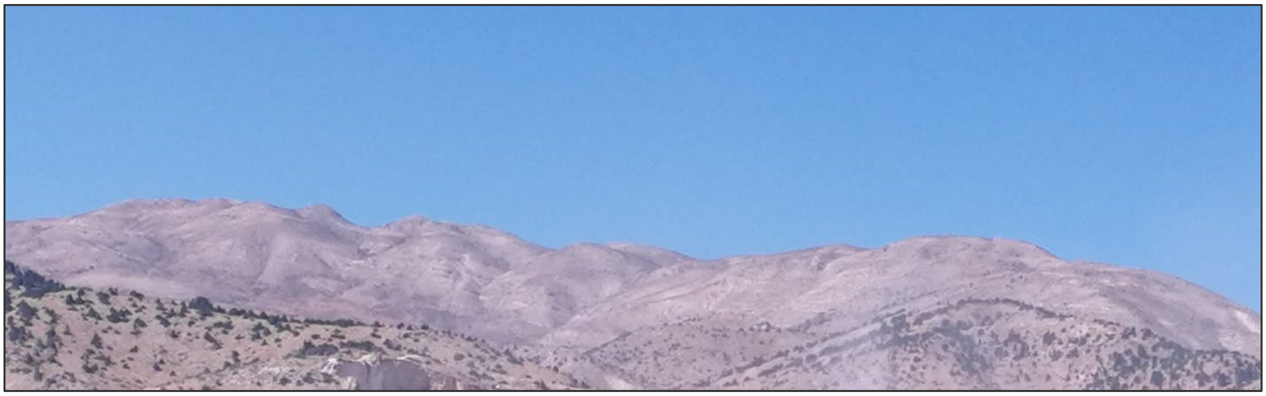
This unit is present only with very small proportions in the southwest of the study area. Special qualitative characteristics cannot be awarded to the unit.

[3] Der Zustand der Zedernwälder Libanons [The state of the cedar forests in Lebanon]; Ladislav Paule, Archiv für Naturschutz und Landschaftsforschung, Heft 4, 1975, Band 15.

Rocky Land

The vegetation-free areas of the ridges have a certain natural character, as shown in **Figure 18-4**. There is hardly any human activity in this area. However, it is to be assumed that in former times these were covered at least in the middle altitudes with vegetation/forest. Accordingly, the unit is classified with a medium to high scenic quality.

Figure 18-4 Rocky Areas on the High Ridges of the Project Site



Shrublands

This unit is represented on a large scale in the study area, as shown in **Figure 18-5**. These are secondary structures of anthropogenic origin. This unit is comparable to the macchie vegetation of the Mediterranean region in Europe. The existing shrublands are the result of human interventions such as cutting trees and grazing. Shrubland areas were formerly dominated by trees before the alteration made by human activity such as grazing and repetitive burnings. Due to the diverse structures and peculiarities, the unit is rated medium-high in terms of quality.

Figure 18-5 Example of Shrublands

Sparse Coniferous and Sparse Leafy Forests

Due to the rather degenerated nature and the partial occurrence of this atypically vegetation in terms of the local spatial context, the quality of the unit is classified with a rather low importance, as shown in **Figure 18-6**.

Figure 18-6 Example of Sparse Coniferous Area

Swamps

This unit is located in the south of the study area. Due to the rarity, the particular biotope type and naturalness, the unit is qualitatively rated high.

Urban Artificial and Urban Expansion

The urban areas, as part of the landscape, have hardly cultural-historical features that could justify a special qualitative claim. Most of them are modern buildings and local structures, as shown in **Figure 18-7**.

Figure 18-7 Example for Urban Area (Qobaiyat)

Protected Areas and Cultural-Historical Elements

There is a protected forest area in the immediate vicinity of the planned WTG (see landscape unit map in **Appendix T**). The Karm Chbat Protected Forest is shown in **Figure 18-8**. However, there is no information available that this area is protected in terms of landscape or scenic value. The majority of the area is the unit Sparse Coniferous. Accordingly, there is no particular scenic quality. In the study area, there are no significant cultural-historical elements that could be affected by the planned WTGs.

Figure 18-8 Protected Forest Area (Karm Chbat)

18.2. Assessment of Potential Landscape impacts

18.2.1. Landscape impacts during construction

During construction, the main visual impacts come from land clearing and excavation, stockpiling of equipment and materials, the use of large construction equipment such as cranes, and the construction of the turbines and transmission towers themselves. While the construction phase is anticipated to last about one year, the use of large construction equipment like cranes, which has the largest visual impact is limited to several weeks.

At the individual turbine locations, the cranes will be placed only for a couple of days. Due to the temporary nature of the construction process and the remote location of the project the visual construction impacts will be low in significance. Therefore, this section will focus on the operational phase of the project.

18.2.2. Landscape Impacts During Operation

The aim of the landscape impact assessment is to assess the potential effects of the proposed wind farm on the landscape in the study area.

18.2.2.1. Methodology

To judge the visual consequences for the landscape, zones of theoretical visibility (ZTV) of the proposed development and visualizations were generated. While the ZTVs give an estimation of which areas are affected by the wind farm, the use of key viewpoints and visualizations give a realistic impression on how views in the area will look like after the wind farm construction.

Using this methodology landscape assessment consists of predicting and evaluating the impact of the project on landscape units. The above-mentioned tools and methodology are recommended in IFC Environmental, Health, and Safety Guidelines for Wind Energy (2015).

Ideally the landscape assessment is based on existing Landscape Character Areas defined by local authorities. However, such studies were not available for the Akkar region. Since there is only limited information on existing landscape units (for instance by the authorities) the NOHL (1996/2001) methodology is regarded as very suitable to establish the landscape impact of the project. The NOHL methodology provides a comprehensive tool for evaluating the quality of the landscape and in a second step to judge in a very objective way the intervention of the planned turbines in the landscape. This methodology is very commonly applied in the German planning process.

The assessment is based on the regional structure of land use and landcover, the impressions gained during the site inspection and the review of literature. The landscape areas were evaluated in terms of their landscape aesthetic intrinsic value, their historical continuity and the existing technical overprinting of the cultural landscape. The landscape assessment considers a study area of 15 km which is recommended by the CEDRO Guideline for wind energy project in Lebanon[4]. For the landscape assessment different spatial units within the study area are determined. The details of the landscape units are described in the baseline section of the report. In the assessment section for each of the landscape units the relevance of the landscape change is examined.

NOHL

The assessment of the potential change of the landscape is based on the guideline by NOHL (1993/2001)135F137F[5]. The landscape assessment based on NOHL methodology is conducted in seven steps which will be described below.

In the first step, the three aspects nature quality, diversity and characteristic are rated on a scale from 1 to 10. 10 points represent a very large and 1 point represents a very low expression of the respective criteria. Afterwards, the sum (characteristic double weighted) of the three aspects is the basis for the total value of the aesthetic value of the landscape unit, as shown in **Table 18-1**.

In the second step, the three aspects (nature quality, diversity and characteristic) after the intervention on the landscape are assessed and lead to the prospective aesthetic value for each landscape unit. This is done on the basis of the visibility analysis and visualizations. Furthermore, the spatial characteristics (hub height, rotor diameter, rotor speed) of the planned wind turbines are considered in the assessment.

[4] Environmental Impact Assessment, CEDRO, Guideline Report, 2012.
[5] Nohl; Beeinträchtigungen des Landschaftsbildes durch mastartige Eingriffe, Kirchheim bei München 1993/2001.

Table 18-1 Aesthetic Value

Points	Total Value	Verbal Expression
4 - 9	1	Very low
10 - 13	2	
14 - 17	3	
18 - 20	4	
21 - 22	5	
23 - 24	6	
25 - 27	7	
28 - 31	8	
32 - 35	9	
36 – 40	10	Very high

In the third step, the difference of the sum of the three aspects of the aesthetic value before and after the intervention is calculated. The result is the aesthetic intensity of the intervention and its expression is defined in **Table 18-2**.

Table 18-2 Aesthetic Intensity of the Intervention

Points	Total Value	Verbal Expression
0	1	Very Low
1 - 2	2	
3 - 4	3	
5 - 6	4	
7 - 9	5	
10 - 12	6	
13 - 16	7	
17 - 21	8	
22 - 37	9	
28 – 36	10	Very High

In the fourth step, the visual vulnerability of the landscape is determined. The three aspects relief, diversity of elements and vegetation density are consulted. These aspects are assessed on a scale from 1 to 10 based on the impressions of the terrain survey, the available photographs of the site, the digital terrain model and map material for each landscape unit. The sum of the three aspects is the basis for the total value of the visual vulnerability of the landscape unit, as shown in **Table 18-3**. The grade rating ranges from very high (10 points: "flat terrain, monotonous structure, hardly any trees and shrubs") to very low (1 point: "mountainous terrain; diverse structure; dense woodland").

Table 18-3 Aesthetic Visual Vulnerability

Points	Total Value	Verbal Expression
3 - 6	1	Very Low
7 - 9	2	
10 - 12	3	
13 - 14	4	
15 - 16	5	
17 - 18	6	
19 - 20	7	
21 - 23	8	
24 - 26	9	
27 - 30	10	Very High

In the fifth step, the worthiness of protection is considered. According to NOHL (1993), factors such as uniqueness, irreplaceability, rarity and representativeness are decisive for determining the worthiness of protection. The evaluation bases on a scale from 1 to 10 and ranges from "Very High" (10 points: "nature reserves, natural monuments, protected landscape features, monuments [castles, palaces] and unique geomorphic landscape components") to "Very Low" (1 point: "low-structure, intensively used arable land, atypical housing estates, commercial areas").

In the sixth step, the aesthetic sensitivity of the landscape is determined for each unit. It results from the above-mentioned aesthetic value, visual vulnerability and worthiness of protection. The sum (aesthetic value double weighted) of these three aspects is the basis for the total value of the aesthetic sensitivity of the landscape, which is rated on a scale from 1 to 10, as shown in **Table 18-4**.

Table 18-4 Aesthetic Sensitivity of the Landscape

Points	Total Value	Verbal Expression
4 - 9	1	Very Low
10 - 13	2	
14 - 17	3	
18 - 20	4	
21 - 22	5	
23 - 24	6	
25 - 27	7	
28 - 31	8	
32 - 35	9	
36 - 40	10	Very High

In the final seventh step, the aesthetic relevance of the intervention is determined as a result of the intensity of the intervention and the sensitivity of the landscape. Both are equal weighted and according to their sum the total value of the relevance of the intervention is calculated, rated on a scale from 1 to 10, as shown in **Table 18-5**.

Table 18-5 Aesthetic Relevance of the Intervention

Points	Total Value	Verbal Expression
2 - 4	1	Very Low
5 - 6	2	
7 - 8	3	
9 - 10	4	
11	5	
12	6	
13	7	
14 - 15	8	
16 - 17	9	
18 - 20	10	Very High

The results of the respective evaluations for each landscape unit are presented in **Table 18-6.**

Table 18-6 Identification and Aesthetic Value of the Landscape Units

Unit	Natural Quality	Diversity	Characteristic
Agricultural Areas	Low-Medium	Low-Medium	Low-Medium
Dense Abies Forests	Low	Low	Low
Dense Pinus Forests	Medium-High	Medium-High	High
Dense Quercus Forests	Medium-High	Medium-High	High
Mixed Forests	Medium	Medium	Medium
Other Dense Leafy Forests	Medium-High	Medium	Low-Medium
Rocky Land	Medium	Low-Medium	Medium-High
Shrublands	Medium	Medium-High	Medium-High
Sparse Coniferous	Low	Low-Medium	Low
Sparse Leafy Forests	Low	Low-Medium	Low
Swamps	High	High	High
Urban Artificial	Low	Low	Low
Urban Expansion	Low	Low	Low

For a better understanding an example for the derivation of the relevance of the intervention is given.

Example:

1. First step: evaluation of the natural quality, diversity and characteristic before the intervention. Natural Quality: 4, Diversity: 5, Characteristic (double weighted): 4+4=8 → Sum: 17.

   14-17 points match value 3 according to the value table of the aesthetic intrinsic value.

   Resulting aesthetic intrinsic value: Low (3).

2. Second step: same evaluation of the natural quality, diversity and characteristic after the intervention.
   Natural Quality: 3, Diversity: 4; Characteristic (double weighted): 3+3=6 → Sum: 13.

   10-13 points match value 2 according to the value table of the aesthetic intrinsic value.

   Resulting aesthetic intrinsic value: Very Low (2).

3. Third step: evaluation of the intensity of the intervention.
   Difference of the aesthetic intrinsic value before (17) and after (13) the intervention → 4.

   3-4 points match value 3 according to the value table of the intensity of the intervention.

   Resulting aesthetic intensity of the intervention: Low (3).

4. Fourth step: evaluation of the visual vulnerability.
   Relief: 6, Diversity of elements: 5, vegetation density: 5 → Sum: 16.

   15-16 points match value 5 according to the value table of the visual vulnerability.

   Resulting visual vulnerability: Middle (5).

5. Fifth step: determination of the worthiness of protection.
   Worthiness of protection: 2.

   Resulting worthiness of protection: Very Low (2).

6. Sixth step: evaluation of the sensitivity of the landscape unit.
   Visual vulnerability: 5, worthiness of protection: 2, Aesthetic intrinsic value (double weighted): 4+4=8 → Sum: 15.

   14-17 points match value 3 according to the value table of the sensitivity of the landscape.

   Resulting aesthetic sensitivity of the landscape: Low (3).

7. Seventh step: evaluation of the relevance of the intervention.
   Intensity of the intervention: 3, Sensitivity of the landscape: 3 → Sum: 6.

   5-6 points match value 2 according to the value table of the relevance of the intervention.

   Resulting aesthetic relevance of the intervention: Very Low (2).

18.2.2.2. Landscape assessment

ZTV

The ZTV calculation of the area around the wind farm shows how many turbines are visible for the entire study area (see **Appendix P**). **Table 18-7** lists the size of area, where turbines are visible. A turbine is considered as visible when parts of the turbine are visible. This is referred as “tip ZTV”.

Table 18-7 Sum of Visibility of the Turbines in 15km Radius

WTG Visibility	Area (ha)	Area (%)
0	49,393.0	54.2
1-4	7,780.6	8.5
5-8	11,324.9	12.4
9-12	6,258.6	6.9
13-16	9,279.9	10.2
17	7,120.8	7.8

The ZTV maps presented in **Appendix P** are used for the sensitivity and magnitude analysis of the landscape units.

Sensitivity and Magnitude Analysis of the Landscape Units

For evaluation of the landscape units, the overall consideration takes place within the respective units. Therefore, an averaging is carried out with regard to the impairments. The general rule is, if the quality of the unit is high, the intensity of the impairment is also high. This depends on whether areas of the respective units are affected at all or the size and the proportions of the landscape units are within the 15 km radius.

For assessing the sensitivity and magnitude of change for the landscape units the following tools were used: the landscape units map, the ZTV maps, visualizations from key viewpoints.

<u>Agricultural Areas:</u> The agricultural spatial units have a low to medium quality (shaped by humans). There are only small areas with special characteristics (thereby cultural-historical elements). Accordingly, the intensity of intervention and visual vulnerability are rather low, so that the overall impact of the project on the aesthetic relevance of the unit can be rated as low (see details **Table 18-8**).

<u>Dense Abies Forests:</u> This spatial unit is strongly characterized by forestry and contains no or very little biodiversity in the tree layer (monoculture). Accordingly, the intensity of intervention and visual vulnerability are rather low, so that the overall impact of the project on the aesthetic relevance of the unit can be rated as low (see details in **Table 18-8**).

<u>Dense Pinus Forests and Dense Quercus Forests:</u> These forests, although managed by forestry, have diverse and natural character. Accordingly, the intensity of intervention and visual vulnerability is higher than the Dense Abies Forest unit for instance, so that the overall impact of the project on the aesthetic relevance of the unit can be rated as medium to high (see details **Table 18-8**). Although the large connected areas of the units are located at some distance (more than 5 km) from the southwestern planning area, these units are nevertheless perceptible in the context of the wind farm and due to the rather high quality of the unit, a medium to high impairment is to be expected.

Mixed Forests:

This spatial unit is strongly influenced by forestry and, although it contains a higher species diversity than the Dense Abies Forests unit, the indigenous tree species do not dominate. Accordingly, the intensity of intervention and visual vulnerability are rather medium, so that the overall impact of the project on the aesthetic relevance of the unit can be rated as low to medium (see details **Table 18-8**). In addition, large areas of this unit are not located in the direct vicinity of the wind farm, therefore the visual impairments will be very limited (see map).

Other Dense Leafy Forests: Only a small area of this unit exists at the north-south edge of the study area. Visual impairment can be ruled out due to the large distances and also due to the relief which will block the visibility of the wind farm.

Rocky Land: Due to the special nature and immediate proximity to the wind farm, there is a medium impairment after the intervention. The medium rating is due to the fact, that the large areas can still be perceived from the valley without disturbance and that the arrangement of the wind turbines in the aesthetic sense results in a reduction of the interference. Accordingly, the intervention intensity and visual vulnerability are medium rated, so that the overall impact of the project on the aesthetic relevance of the unit is to be assessed as medium (see details **Table 18-8**).

Shrublands: Due to the special nature, diversity and, in some cases, immediate proximity to the wind farm, there is a medium degree of impairment after the intervention. The classification is intermediate due to the fact, that many large areas are located in a large distance from the planning area (see map). Accordingly, the intensity of intervention is low to medium and the visual vulnerability is rather medium, so that the overall impact of the project on the aesthetic relevance of the unit is to be assessed as medium (see details **Table 18-8**).

Sparse Coniferous and Sparse Leafy Forests: With regard to these spatial units, it is very similar to the *Dense Abies Forests unit*, so that the overall impact of the project on the aesthetic relevance of the unit can be rated as low (see **Table 18-8**).

Judging the Overall Significance of the Landscape Impact

In general, the study area is characterized by forest and agricultural use. It does not include any wild and protected landscape areas. While some natural forest areas with a higher landscape value exists, in total the project hardly leads to significant changes within the 15 km radius. This can be deduced from the results of the evaluation of the individual landscape units and the results of the visualizations as well as from the ZTV.

In the immediate area of the wind farm views are often blocked due to the mountainous topography. In particular, the more sensitive forest units with oak and pine are barely visually impaired by the project. Experiencing and perceiving the mentioned units will remain largely unobstructed (see visualizations and ZTV).

As shown in **Table 18-9**, some landscape units are effected up to the medium range, namely the dense Pinus and the dense Quercus forest which have the highest aesthetic relevance of the intervention. In addition, the impact on the landscape was reduced by the careful design of the turbine array (see Jouer el Hachich Viewpoint). This is due to the fact, that the layout of the turbines follows the topography of the existing ridge.

Table 18-8 Evaluation of the Relevance of the Intervention for the Individual Landscape Units

Landscape Unit	Before the Intervention			Aesthetic Intrinsic Value	After the Intervention			Aesthetic Intensity of the Intervention	Relief	Diversity of Elements	Vegetation Density	Visual Vulnerability	Worthiness of Protection	Aesthetic Sensitivity of the Landscape	Aesthetic Relevance of the Intervention
	Natural Quality (1x)	Diversity (1x)	Characteristic (2x)		Natural Quality (1x)	Diversity (1x)	Characteristic (2x)								
Agricultural Areas	4	4	8	**3**	4	4	6	**2**	7	4	4	**5**	**4**	**3**	**2**
Dense Abies Forests	3	3	6	**2**	3	3	6	**1**	7	4	7	**6**	**4**	**3**	**1**
Dense Pinus Forests	7	7	16	**8**	6	6	14	**3**	9	6	7	**8**	**8**	**9**	**6**
Dense Quercus Forests	7	7	16	**8**	7	6	14	**3**	8	6	7	**8**	**8**	**9**	**6**
Mixed Forests	6	6	12	**6**	5	6	10	**3**	8	7	7	**8**	**7**	**7**	**4**
Other Dense Leafy Forests	7	5	8	**4**	7	5	8	**0**	7	5	7	**7**	**4**	**3**	**1**
Rocky Land	5	4	14	**6**	3	2	10	**5**	8	4	1	**4**	**4**	**4**	**4**
Shrublands	6	7	14	**7**	6	5	12	**3**	7	7	3	**6**	**4**	**6**	**4**
Sparse Coniferous	3	4	6	**2**	2	3	4	**3**	7	4	3	**4**	**4**	**2**	**2**
Sparse Leafy Forests	3	4	6	**2**	2	3	4	**3**	7	4	3	**4**	**4**	**2**	**2**
Swamps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urban Artificial	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Urban Expansion	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: No negative effects are expected for the units Swamps, Urban Artificial and Expansion. Therefore, they are not subject to the numerical rating. The same applies to the individual cedar trees (see above).

Table 18-9 Cumulative Visibility for Wind Farm Projects in 15km Radius of the Project Site

WF Visibility	Area [ha]	Area [%]
Lebanon Wind Power only	25,539.7	28.0
Hawa Akkar only	1,623.9	1.8
Sustainable Akkar only	3,040.0	3.3
LWP + SA + HA	9,000.6	9.9
LWP + HA	798.9	0.9
LWP +SA	6,425.7	7.0
SA + HA	5,107.1	5.6

Moreover, the ridge is emphasized in the sense of a landscape arrangement in the aesthetic sense.[6] An overprint, effect of dominance or blocking effect (phalanx) does not arise. This is due to the ordered juxtaposition of the WEA and the geomorphological arrangement on the ridge. Although the proposed wind turbines will introduce new technical elements in the landscape and certainly affect the perception of the landscape, the typological appearance of the ridge remains largely recognizable. In addition, the visual effects of turbines are entirely reversible at the end of the operational life of the wind farm.

Mitigation Measures

The following mitigation measures have been addressed within the design to mitigate elements of potential landscape impacts:

- Large, multi-MW turbines with large rotor diameters are considered. By using large, multi-MW turbines with large rotor diameters the number of turbines per generation capacity and the footprint of the Project will be reduced. In addition, large rotors have a reduced rotor speed compared to smaller turbines which will also reduce the visual impact of the Project.
- The most northern turbines of the layout (WTGs 1-6) were eliminated to minimize landscape impacts. In addition, the distance to the wind energy project Sustainable Akkar was also increased so that cumulative impacts were reduced.
- The wind farm layout was designed so that the array follows the existing landform of the mountain ridges. By considering the landform of the mountain ridges at the wind fam design, the wind farm layout follows the existing morphology of the mountain. Consequently, the typological appearance of the ridge remains largely recognizable. In addition, the overlapping of rotors of views from the east and the west are unlikely which can be perceived as visually restless.
- Tracks will be designed to follow the existing tracks and fit with contours as far as possible. By following the existing tracks and fitting the location of the tracks with the contours lines the landscape impact of the tracks can be reduced.

[6] Schöbel, Windenergie und Ästhetik [wind energy and aesthetic]; Berlin, 2012.

- The turbines and all the other aboveground structures will be removed at the end of the operational lifetime. By removing the turbines and all the other aboveground structures at the end of the operational lifetime, the landscape impact of the project will be entirely revisable and limited to the operation phase of the project.
- The internal cabling should be underground cabling. By designing the internal cabling as underground cabling the landscape impact in the immediate surrounding was reduced.

The largest impact on a single landscape unit is assessed to be Medium. This is due to the low sensitivity of the units and the reduced visibility caused by the topography. The likelihood of the impact is assessed to be High. The overall visual impact of the turbines during the operational phase is considered of Minor significance. Other expected landscape impacts of the project during the operational phase include power transmission lines, access roads and crane pads. The transmission lines will be buried and therefore are expected to have a negligible impact on the landscape. New roads and crane pads are expected to be of materials similar to existing bedrock and will therefore also not stand out from the surrounding landscape. Since the project area is mountainous, the visibility of the new tracks will be limited and partly blocked by the topography. Therefore, the landscape impact is expected to be of minor significance, as shown in **Table 18-10**.

Table 18-10 Landscape Assessment for Operation Phase

		Sensitivity of Receptor				
		Low	**Low-Medium √**	**Medium**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium √	Negligible	**Minor √**	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

Cumulative Landscape Impacts

Cumulative impacts are presented in Section 21 Cumulative Impact Assessment.

18.2.3. Landscape Impacts During Decommissioning

Decommissioning impacts are similar to construction impacts: the stockpiling of equipment and materials, the use of large construction equipment such as cranes, and the decommissioning process itself. Given the temporary nature of the decommissioning process, landscape impacts are expected to be of negligible significance.

19. ARCHAEOLOGY AND CULTURAL HERITAGE

19.1 Baseline Methodology

Baseline information regarding archaeology and cultural heritage was undertaken through literature review.

19.2 Baseline Findings

19.2.1 Archaeological Sites

The archaeological history of Lebanon is one of thousands of years ranging from the Lower Paleolithic, Phoenician, Jewish, Roman, Muslim, Christian, Ottoman, and Crusades history, including 460 World Heritage (including UNESCO), Archaeological and Historic Site Locations. Lebanon features several important Paleolithic sites associated with Neanderthals. These include Adloun, Chekka Jdidé, El-Masloukh, Ksar Akil, Nahr Ibrahim and Naame. Jbail is a well-known archaeological site, also known as ancient Byblos, a Phoenician seaport, where the tomb of Ahiram and the other Byblian royal inscriptions were found. Byblos, as well as archaeological sites in Baalbek, Tyre, Sidon, and Tripoli, contain artifacts indicating the presence of libraries dating back to the period of Classical antiquity.

The archaeological site mapped near the Project are shown as Sites 1 through 11 in **Figure 19-1** and described below. It is noted that detailed information regarding the sites is limited.

Site 1 – Khorab Beit Daher

Khorabe Beit Daher is an archaeological remains/ancient site located at decimal latitude 34.60889 and longitude 36.27194 at an elevation of 462 asl. It is listed as Site 423 by the ARCHI Worldwide Database.[1] An aerial map of the site is presented in **Figure 19-2**.

Site 2 – Obour el Bid

Khorabe Beit Daher is an archaeological remains/ancient site located at decimal latitude 34.61528, and longitude 36.29639. No elevation information is available. It is listed as Site 55 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-3**.

Site 3 - Khirbet Hbanjar

Khirbet Hbanjar is an archaeological remains/ancient site located at decimal latitude 34.63694 and longitude 36.29806 at an elevation of 248 asl. It is listed as Site 418 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-4**.

Site 4 – Khirbet Arhsar

Khirbet Hbanjar is an archaeological remains/ancient site located at decimal latitude 34.63278 and longitude 36.30417 at an elevation of 340 asl. It is listed as Site 421 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-5**.

[1] https://www.archiuk.com/worldwide

Figure 19-1 Archaeological Sites Near the Project

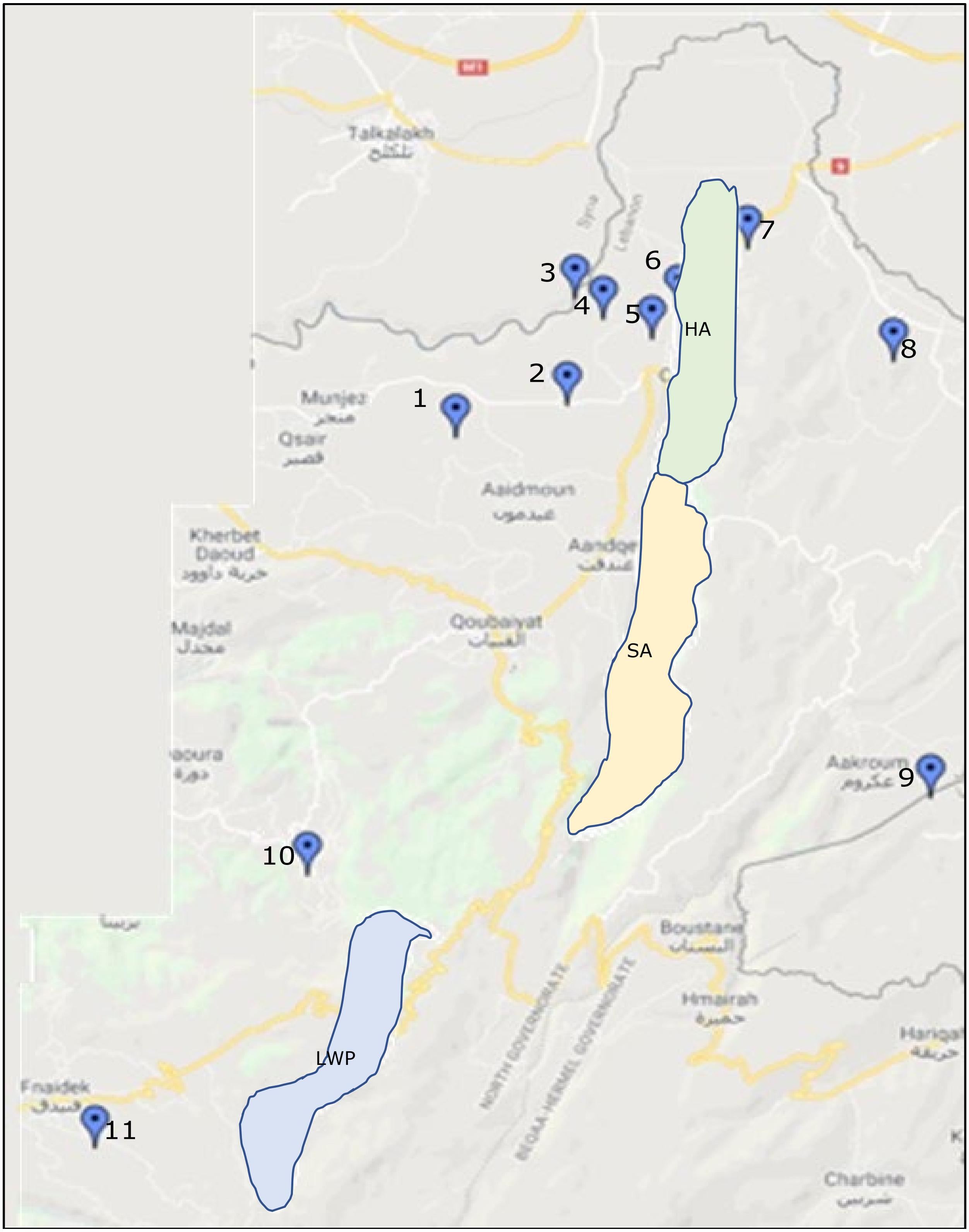


Figure 19-2 Khorab Beit Daher Site

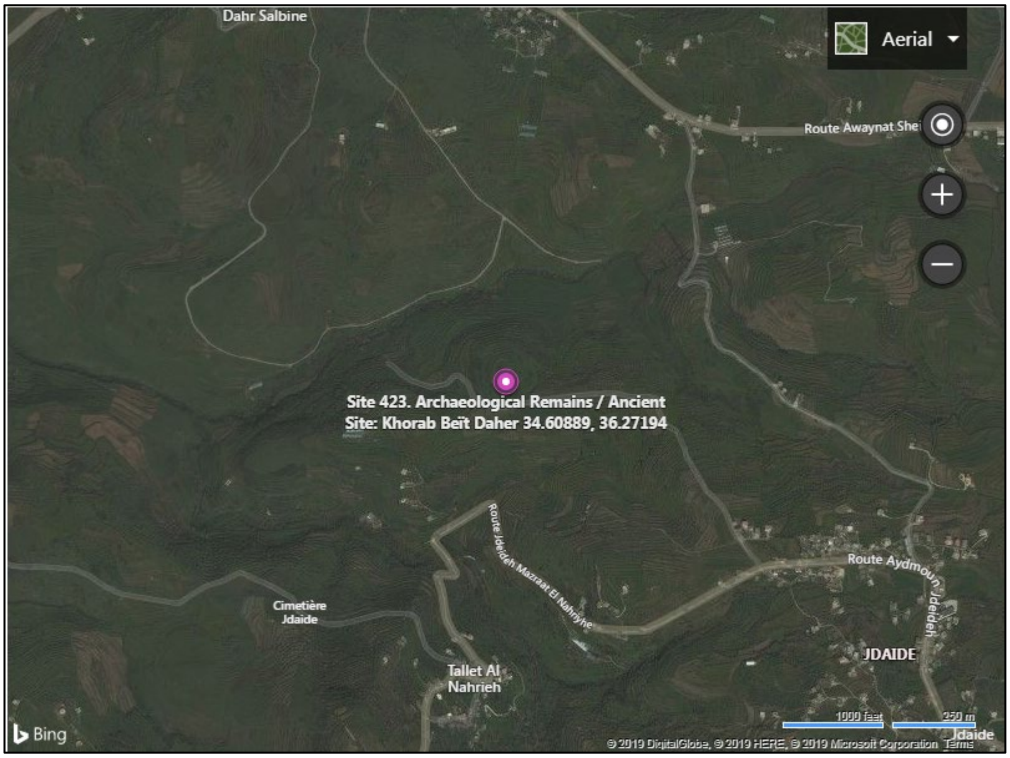


Figure 19-3 Obour el Bid

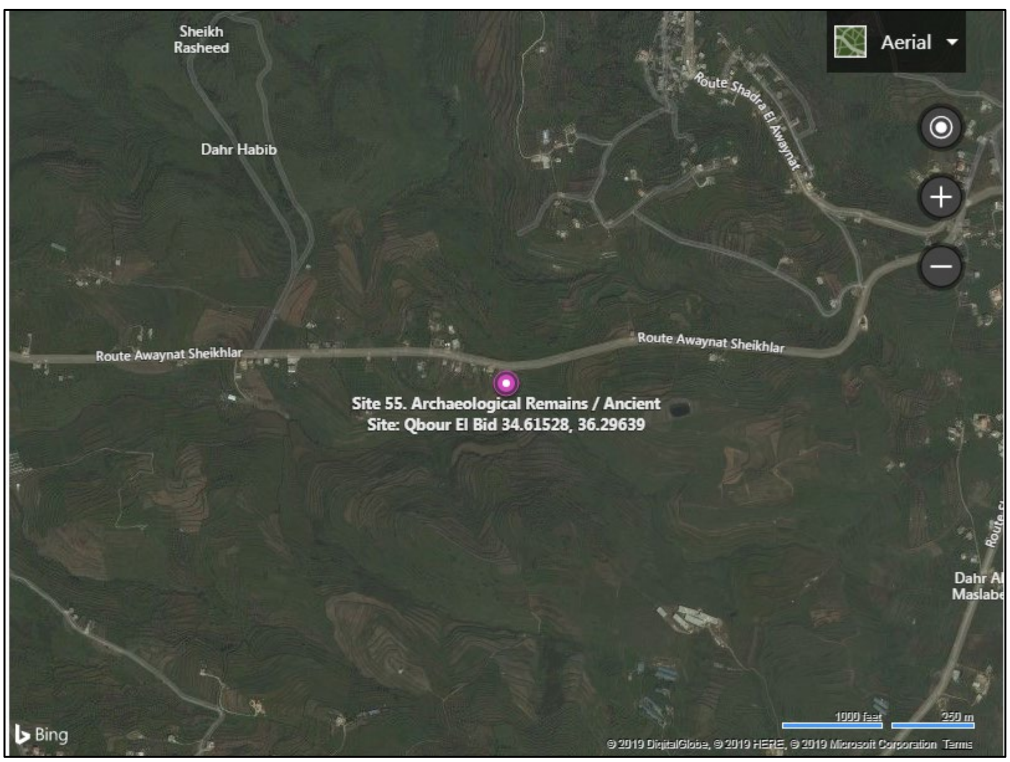


Figure 19-4 Khirbet Hbanjar

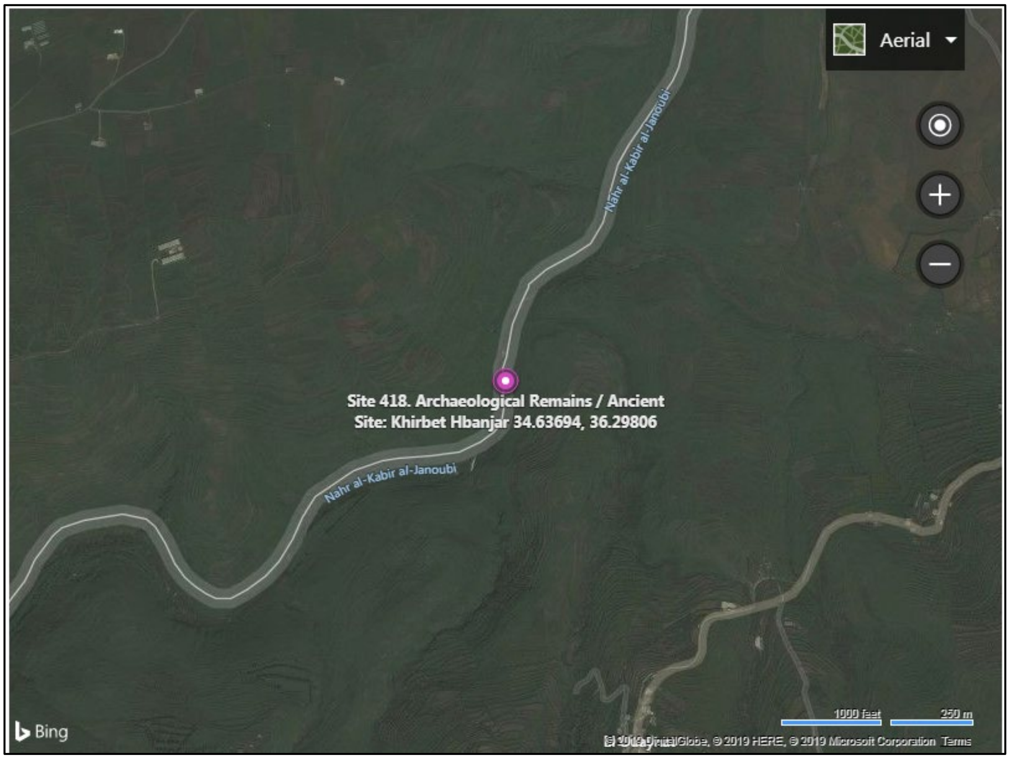
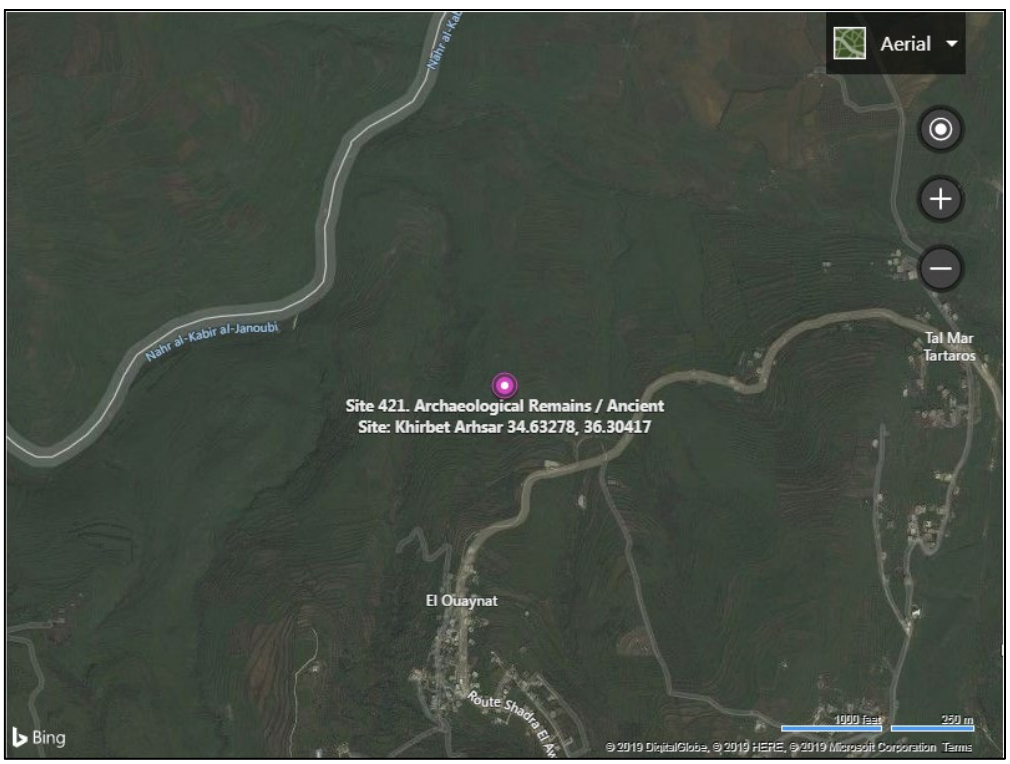


Figure 19-5 Khirbet Arhsar



Site 5 - El Mansoura

El Mansoura is an archaeological remains/ancient site located at decimal latitude 34.62861 and longitude 36.315. There is no elevation information. It is listed as Site 421 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-6**.

Site 6 – Tahoun Ksar

El Mansoura is an archaeological remains/ancient site located at decimal latitude 34.635 and longitude 36.32083. There is no elevation information. It is listed as Site 419 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-7**.

Site 7 - Khorab el Haïyat

Khorab el Haïyat is an archaeological remains/ancient site located at decimal latitude 34.64667 and longitude 36.33583 at an elevation of 558 asl. It is listed as Site 417 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-8**.

Site 8 – Qalaat Deïr Chir

Qalaat Deïr Chir is an archaeological remains/ancient site located at decimal latitude 34.62417 and longitude 36.36778 at an elevation of 508 asl. It is listed as Site 422 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-8**.

Site 9 – Khribet el Qasr

Khribtet el Qasr is an archaeological remains/ancient site located at decimal latitude 34.53778 and longitude 36.37667. There is no elevation information. It is listed as Site 413 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-9**.

Site 10 – Qalaat Aakkar (Citadel of Hosn Akkar)

Qalaat Aakkar is a 13th century fortified building/earthwork site located at decimal latitude 34.52222 and longitude 36.24. It is listed as Site 430 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-10**, with a photograph presented in **Figure 19-11**.

Elevated on a rocky mountain between the two valleys of Akkar, the citadel of Hosn Akkar is only reachable by goat path. It is said that the citadel was built by Mohrez Bin Akkar, who was killed in 864 A.D., and was later seized by the Seljuks, the Crusaders and the Mamluks. This site was included in the choice of viewpoints for visual impact assessment.

Site 11 – En Nabi Ayoûb

En Nabi Ayoûb is a tomb/shrine located in Mont-Liban at decimal latitude 34.46583 and longitude 36.19167 at an elevation of 1,308m. It is listed as Site 287 by the ARCHI Worldwide Database. An aerial map of the site is presented in **Figure 19-12**, with a photograph presented in **Figure 19-13**.

Figure 19-6 El Mansoura

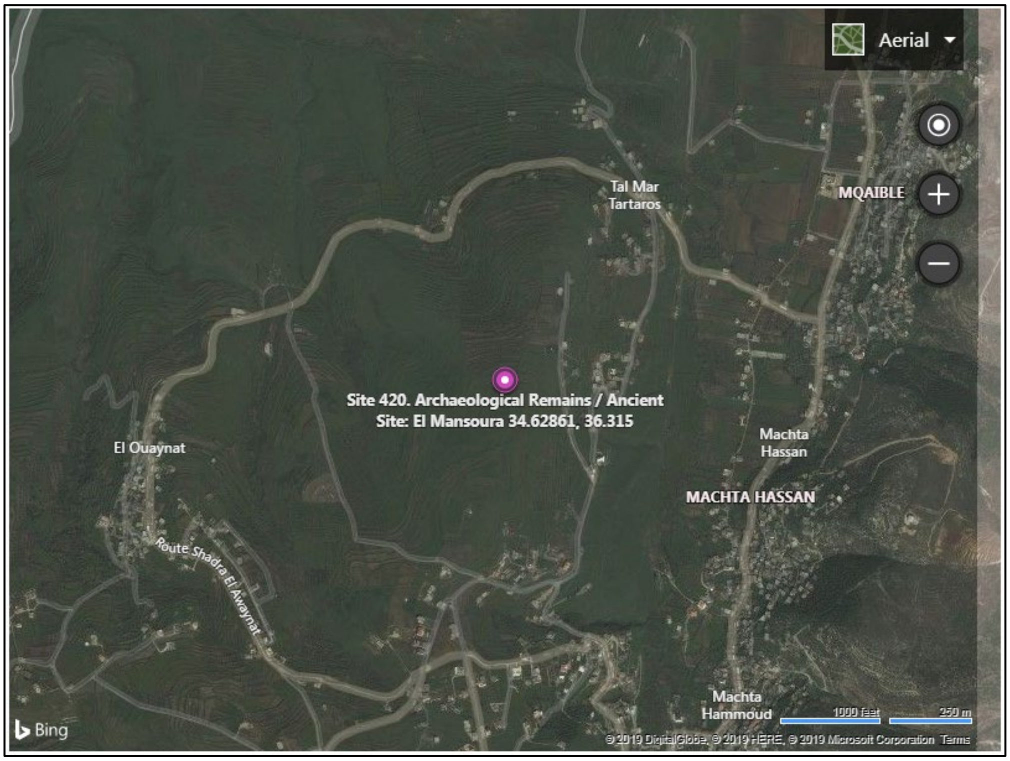


Figure 19-7 Tahoun Ksar

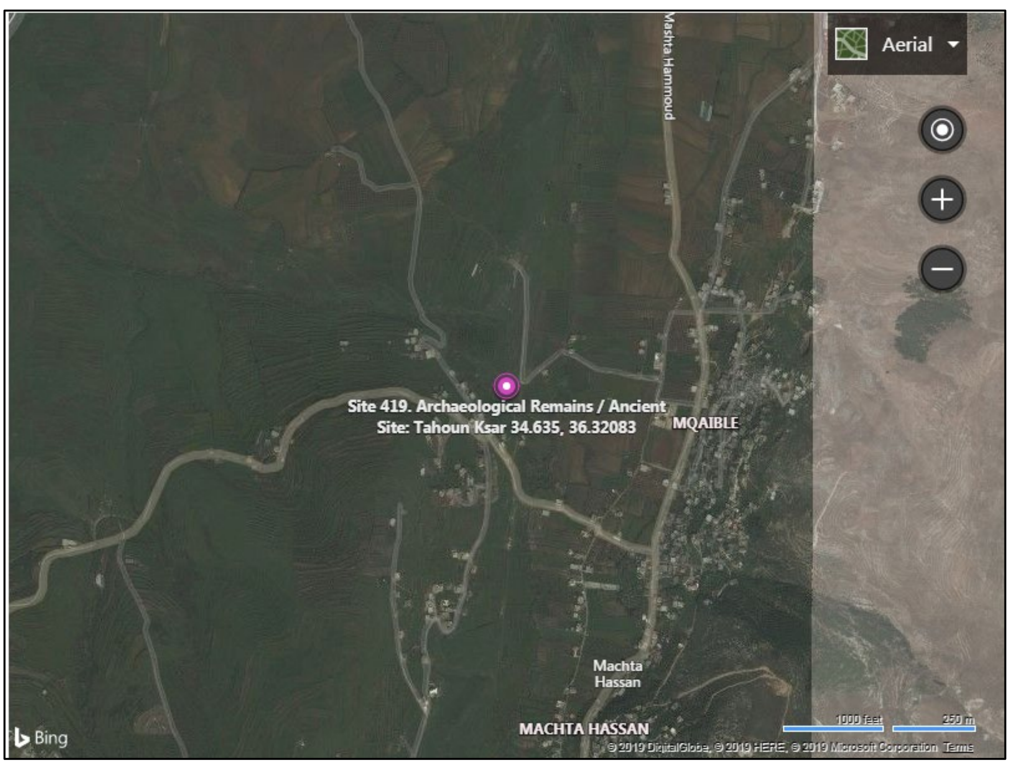


Figure 19-8 Khorab el Haïyat

Figure 19-9 Qalaat Deïr Chir

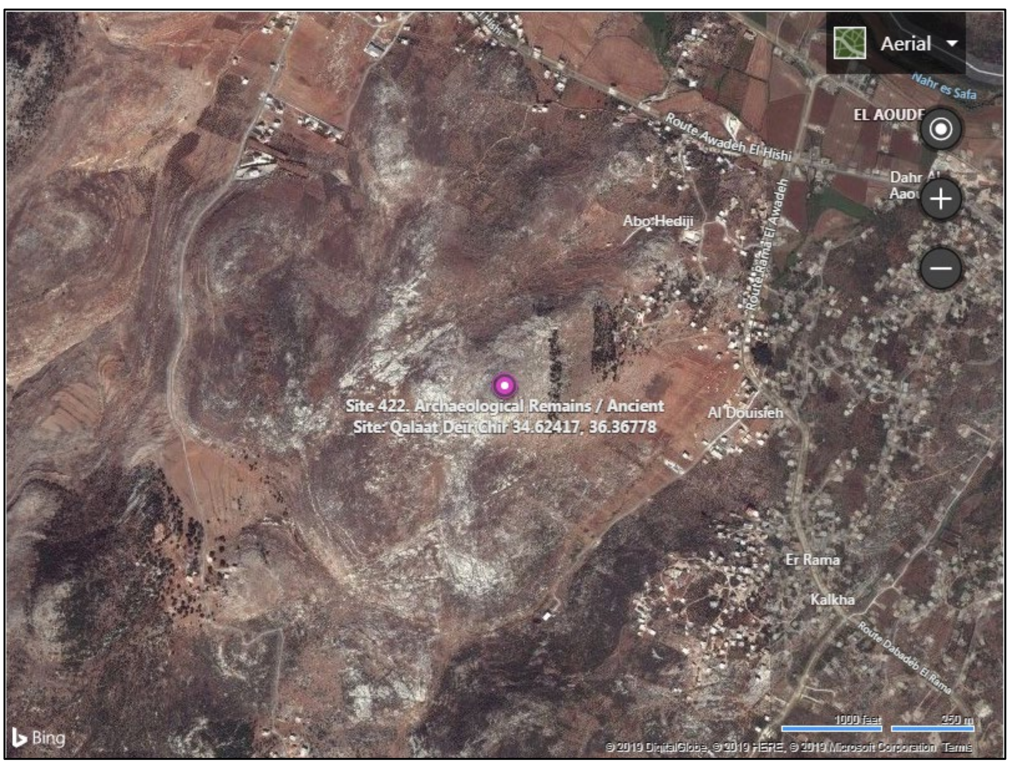


Figure 19-10 Qalaat Akkar

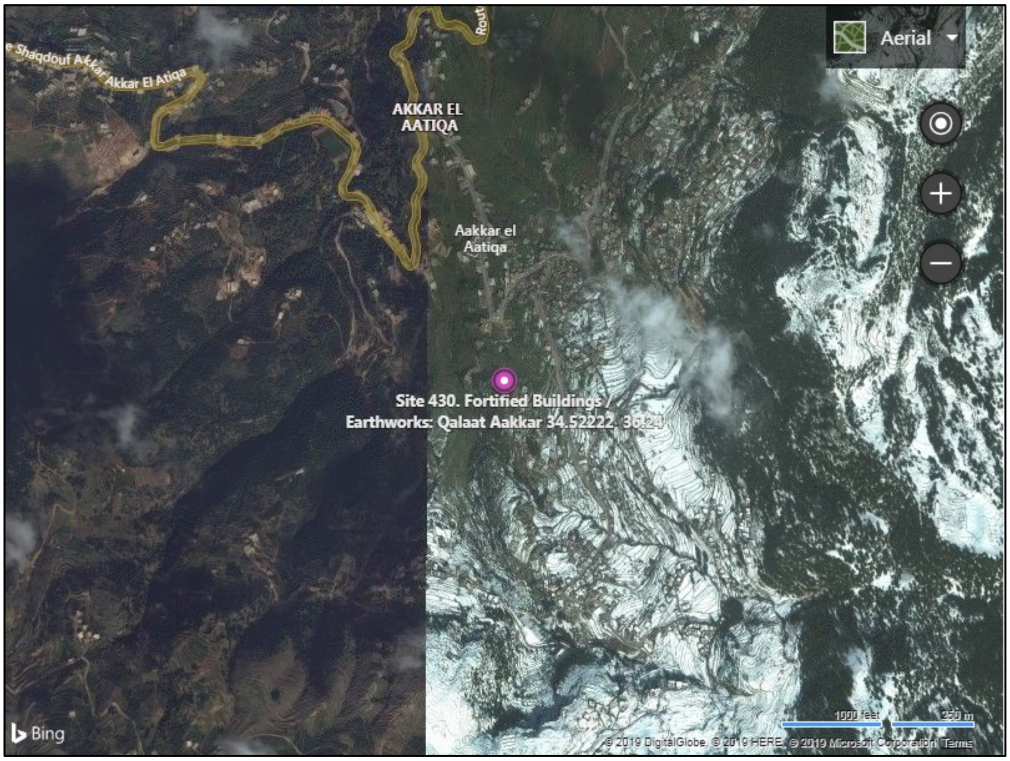


Figure 19-11 Qalaat Akkar Fortress

Figure 19-12 En Nabi Ayoûb

Figure 19-13 En Nabi Ayoûb

19.2.2 Cultural Resources and Attractions

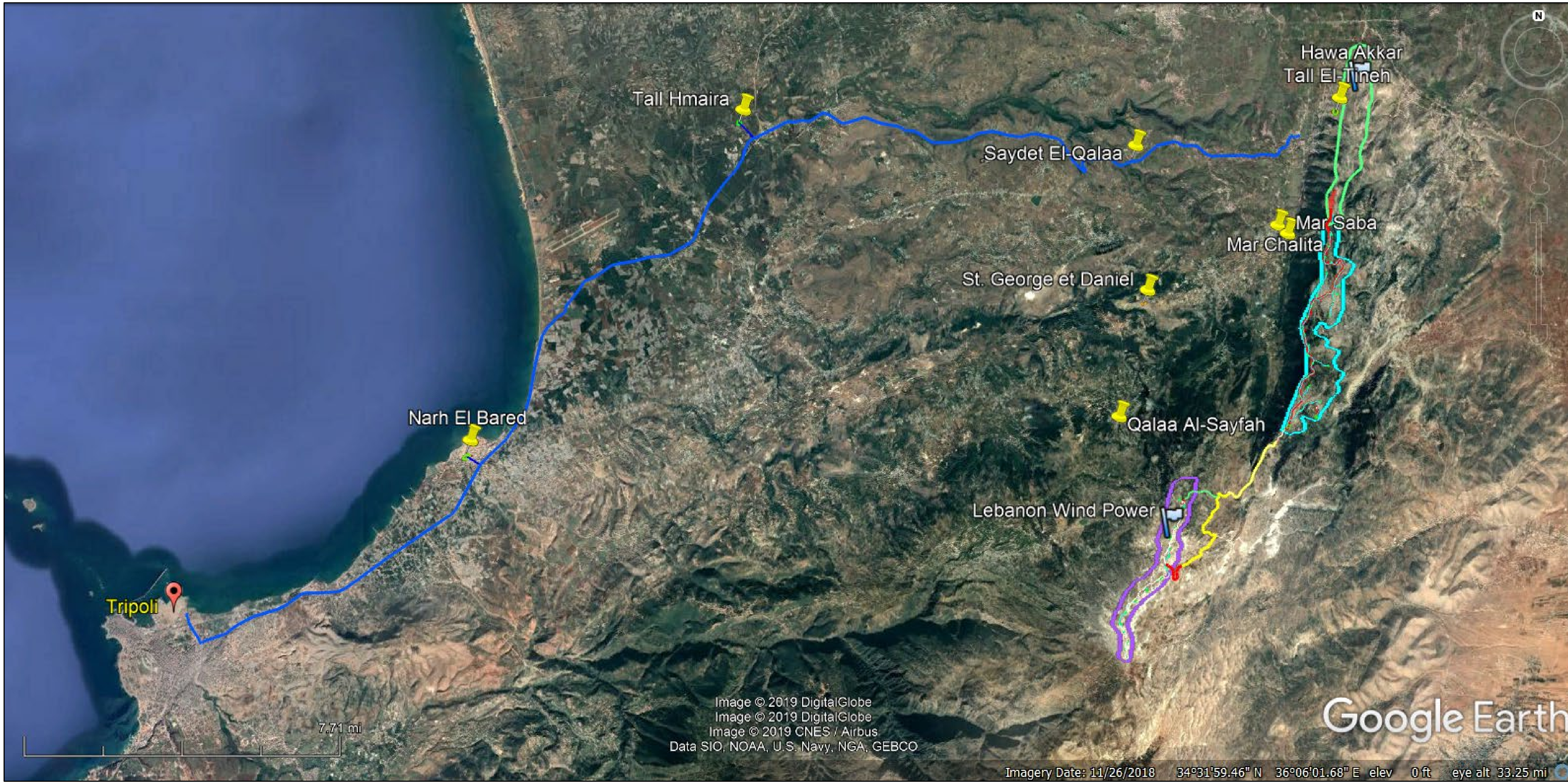
Based on the literature review, the Akkar region has several cultural resources and attractions, as follows:

- St. George et Daniel (included in the choice of viewpoints for visual impact assessment, as shown in **Figure 19-14**; refer to **Section 17**).
- Qalaa Al Sayfah Fortress (included in the choice of viewpoints for visual impact assessment, as shown in **Figure 19-14**; refer to **Section 17**).
- Silk plant and remains of old mills (also found in nearby Aandqet).
- Old olive press with caves and engraved rocks in Akroum.
- Citadels and mosques dating from the 19th century in Al Bireh and Bourj villages.
- Roman temples in Akroum.
- Cemeteries of Al Salha, Akroum.
- Tall Hmaira.
- Naher ElBared Camp.
- Saydet (Our Lady) Al-Ghisseleh Ancient Church.
- Mar Doumit Ancient Monastery for Carmelite Fathers.
- Mar Challita Ancient Monastery (Aandqet).
- Saint Joseph and Mar Saba Ancient Monasteries (Aandqet).
- Mar Gerges (Saint Georges) Ancient Monastery and Church, near an old well.
- Saydet Ghezrata Ancient Church.
- Old Church in Al-Chanbouq Area.
- Saydet Chahlo Church.
- Mar Eliane Monastery within Al-Bat'aneh Valley buried underground (Andqet).
- Our Lady of the Fort (Saydet el Qalaa) in Menjez.
- Mar Elias in Oudine.

In addition, the Akkar region offers numerous eco-tourism attractions as follows:

- Quobaiyat's Scientific Permanent Museum for Animals, Birds & Butterflies.
- The Lebanon Mountain Trail.
- Karm Chbat Nature Reserve; refer to **Section 13 Biodiversity**.
- Qammouaah Forest.
- The Al Atika Waterfalls.
- The Ouyoun el Samak Cascade in Safinet el Qaytaah.

Figure 19-14 Cultural Resources and Attractions



19.3 Impact Assessment

19.3.1 During Construction

19.3.1.1 Archaeology

No cultural heritage resources were found during the field work campaigns implemented in the immediate project zone. In addition, the elevation of the Project site lessens the likelihood of cultural resources and artifacts to be present. However, it is recognized that the Akkar region (and Lebanon in genera) is rich in archaeological, cultural and religious artifacts and sites.

During the construction phase, excavation and earth moving for the construction of roads, wind turbines, transmission lines, substations and buildings may uncover heritage resources.

Though the potential for impact is considered low, a Chance Finds Procedure has been developed (in accordance with guidance provided by the Ministry of Culture and the General Directorate of Antiquities) to appropriately respond to cultural resources encountered during construction, as follows:

Where historical remains, antiquity or any other object of cultural or archaeological importance are unexpectedly discovered during construction in an area not previously known for its archaeological interest, the following procedures should be applied:

1. Stop construction activities.
2. Delineate the discovered site area.
3. Secure the site to prevent any damage or loss of removable objects. In case of removable antiquities or sensitive remains, a night guard should be present until the Responsible Authorities takes over.
4. Notify the responsible foreman/archaeologist, who in turn shall notify the Responsible Authorities, the General Directorate of Antiquities and local authorities (within less than 24 hours).
5. The Responsible Authorities will be in control of protecting and preserving the site before deciding on the proper procedures to be carried out.
6. An evaluation of the finding will be performed by the General Directorate of Antiquities. The significance and importance of the findings will be assessed according to various criteria relevant to cultural heritage including aesthetic, historic, scientific or research, social and economic values.
7. The decision on how to handle the finding will be reached based on the above assessment and could include changes in the Project layout (in case of finding an irrevocable remain of cultural or archaeological importance), conservation, preservation, restoration or salvage.
8. The Responsible Authorities' decision concerning the management of the finding shall be implemented fully.
9. Construction work could resume only when permission is given from the Responsible Authorities after the decision concerning the safeguard of the heritage is fully executed.

The Chance Finds Procedure has been included in the stand-alone ESMP.

Based on the low likelihood of a discovery, and the implementation of the Chance Find Procedure, the impact severity is considered Slight, while the sensitivity is considered High given the value of the receptor. This results in a Minor impact, as shown in **Table 19-1**.

Table 19-1 Assessment of Potential Impact to Archaeology During Construction

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High**	**High √**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight √	Negligible	Negligible	Negligible	Minor	**Minor √**
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

19.3.1.2 Eco Tourism Sites

During the construction phase, access to certain portions of the 5.13M m^2 Karm Chbat Nature Reserve will be limited to ensure the health and safety of visitors. As shown in **Figure 19-15**, approximately 10-20% of the Karm Chbat Nature Reserve will involve construction activities at different times across the entire construction phase.

Given that other eco-tourism attractions in the area will not be affected, i.e. Quobaiyat's Scientific Permanent Museum for Animals, Birds & Butterflies, the Lebanon Mountain Trail, the Qammouaah Forest, the Al Atika Waterfalls and the Ouyoun el Samak Cascade in Safinet el Qaytaah, the impact severity of the temporary lack of access to the Karm Chbat Forest Reserve is considered Low. The sensitivity of the receptor (i.e. eco tourists) is considered Medium, resulting in a Minor impact, as shown in **Table 19-2**.

19.3.2 During Operation

19.3.2.1 Cultural Heritage

During the operation phase, impacts to cultural heritage are not considered significant.

19.3.2.2 Eco Tourism

As a green energy project, the Project is expected to become a tourist attraction, drawing citizens from other regions of Lebanon (particularly students) to visit the Project site and enjoy the remote setting. This tourism is considered to have a positive impact on the local economy and enhance opportunities to visit other nearby eco tourisms sites in the area.

Figure 19-15 Karm Chbat Nature Reserve

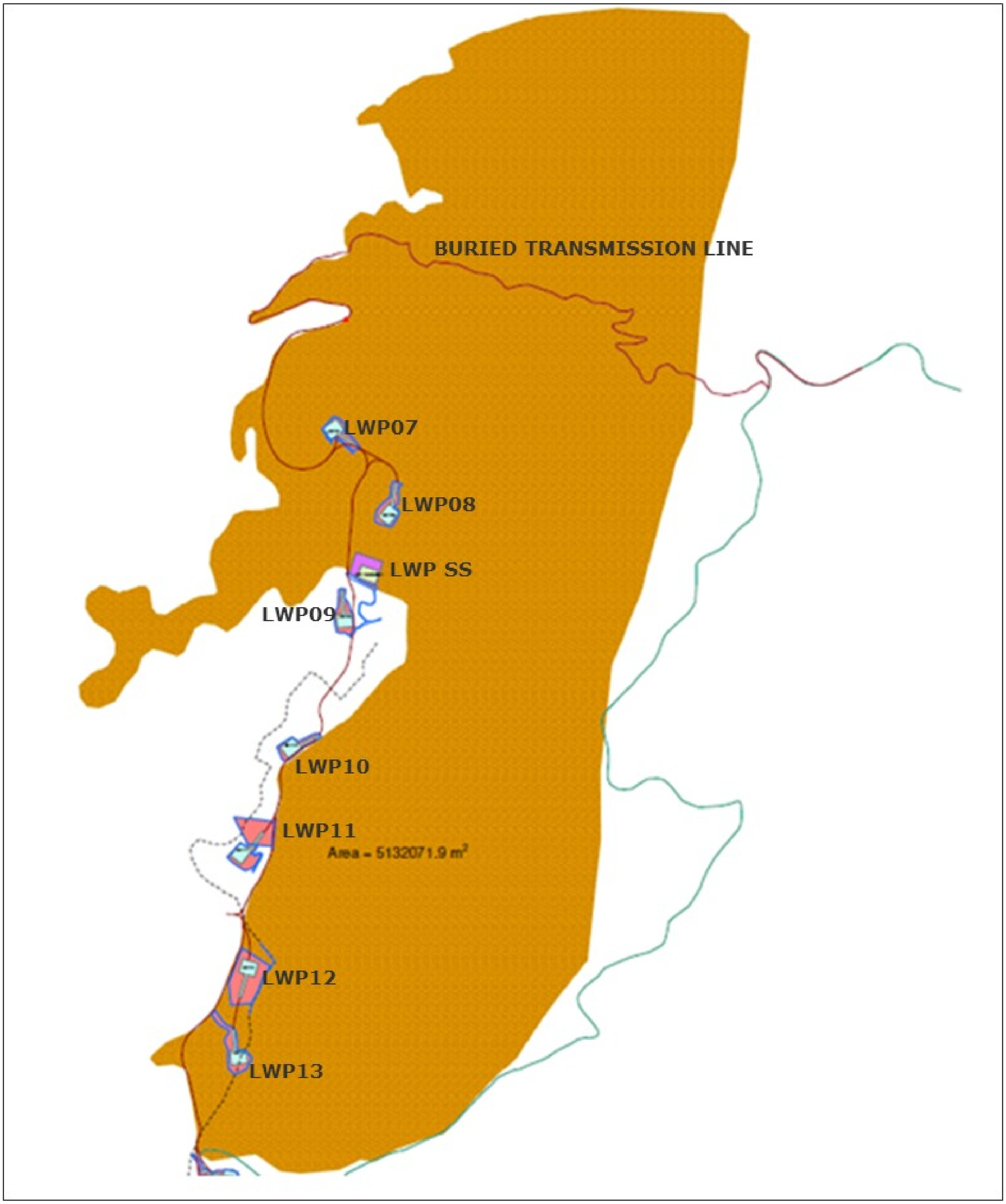


Table 19-2 Assessment of Access to Karm Chbat Nature Reserve During Construction

		Sensitivity of Receptor				
		Low	Low-Medium	Medium √	Medium-High	High
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

19.3.3 During Decommissioning

19.3.3.1 Cultural Heritage

During the decommissioning phase, impacts to cultural heritage are considered to be similar to the construction phase. Again, the low likelihood of encountering cultural resources and artifacts is low, and the implementation of the Chance Find Procedure reduces the potential for impact even further.

19.3.3.2 Eco Tourism

During the decommissioning phase, the impacts to eco-tourism are considered to be similar to the construction phase. Again, access to certain portions of the Karm Chbat Nature Reserve will be limited to ensure the health and safety of visitors. Approximately 10-15% of the Karm Chbat Nature Reserve will involve decommissioning activities at different times across the entire decommissioning phase.

20. OCCUPATIONAL HEALTH AND SAFETY

This section presents an assessment of health and safety hazards and sources and their potential impacts to workers. It is noted that the regulation of occupational health and safety in Lebanon is shared by the Ministry of Public Health and the Ministry of Labor, which includes the conduct of inspections to ensure adherence to public health and safety, project and site inspection and documentation of occupational health and safety conditions and a focus on local community health and safety expectations and needs.

20.1 Baseline Methodology

Occupational health and safety information was based on the activities to be undertaken by workers during the pre-construction, construction, operations and decommissioning phases of the Project.

20.2 Baseline Findings

Anticipated work activities are summarized in the following sections, as described in **Section 2**.

Occupational health and safety are considered primarily in terms of potential exposure to pollutants from various media (air, water, soil, other) and accident occurrence (direct and indirect) in relation to on-site workers and/or operators during both the construction and operation phases. In this respect, site health, safety and environmental regulations will be compiled for adoption by the OEM/EPC Contractor involved in construction. These guidelines will be part of the contractual obligations for the selected OEM/EPC Contractor who will be responsible for ensuring the implementation of such guidelines as well as training employees for the use of correct tools and procedures.

20.2.1 Pre-Construction Phase

Surveys and Studies

A final transport route review once the specific model of wind turbine has been selected and dimensions of the components are understood. This will ensure that any changes to the likely impacts along the route are identified. Additional topographical surveys as required to serve as a solid basis for the specification of the works. Geotechnical investigations on all proposed sites for wind turbines, substations, transformers and related structures and buildings, for structures of transmission lines, along all site road routes for the purpose of construction and further public use and at other sites. planned survey / monitoring (i.e. surveying of major karstic features, groundwater mapping, water quality monitoring of groundwater, local springs, etc.) to inform detailed design and address adverse impacts during construction.

Employment and Workforce Training

After contract award, the successful OEM/EPC Contractor will be asked to present a hiring plan, including both local and international workforce. The OEM/EPC Contractor shall provide comprehensive training to Employer’s designated personnel covering all aspects of the Facility and the technical operation of the wind farm, safety at work, equipment and system for operations and maintenance.

The training shall at least include the following:

- On the job training.
- Factory training.
- Wind Turbine maintenance and associated planning.
- Supervisory control and data acquisition (SCADA) software and hardware training.
- Operations and maintenance staff training.

Preparatory Works

Preparator works will include the following:

- Site preparation including compaction of soil, filling of low areas with imported fill and grading of the entire area of the site to the required lines levels and slopes, as required.
- Provision of temporary laydown areas, warehouses, workshops, vehicles, equipment etc. all as necessary for the construction phase.
- Provision of temporary firefighting and alarm system.
- Provision of temporary site drainage, storm water and sanitary drainage as necessary for the site, site facilities, temporary laydown areas, warehouses, workshops, as required.
- Disposal of sewage, as necessary.
- Provision of temporary site fencing including gates, as necessary.
- Provision of first aid, site safety and security system for the construction phase.
- Provision of temporary offices for the Employer and their representative.
- Provision of temporary offices for the Contractor

Procurement

The procurement and delivery of equipment and parts will be undertaken by the selected OEM/EPC Contractor. Shipping and clearance will be conducted in compliance with customs and other involved authorities' regulations.

20.2.2 Construction Phase

Obstacle Removal and Road Development

- The Port: Temporary concrete bund, curb, electric pole and overhead removal, will be necessary for trucks to navigate the Port. At the Port exit, 45m of concrete wall will need to be demolished to facilitate exit by trucks carrying the WTG components.
- Ramps, roundabouts and curves: Car parking will be prohibited during transport and removal of curbs, electric poles, trees, lamp posts, and fencing will be necessary.
- Pedestrian bridges: Raising of the bridges to provide a vertical clearance of 570cm will be required.
- At significant curves: Ground leveling and compaction to facilitate maneuverability.

Excavation, Land Clearing, Internal Road Network and Foundation Construction

- Platforms consisting of leveled areas adjacent to the turbines and their bases.
- Leveling and large rock removal would be undertaken within the surrounding areas within the Project site boundaries.
- The platforms will be used for installation and maintenance, to accommodate large vehicles and equipment.

Transportation of Wind Turbine Components to the Project Site

The transport of wind turbine components will include one turbine assembly, comprised of 5 tower sections, 2 nacelle sections, 1 hub and 3 blades per turbine, 2 times per week. The transport will required an escorted convoy of 11 oversized trucks traveling roundtrip from the Tripoli Seaport and Project site between 12am and 4am. Transport of the substation and associated switchgear will be undertaken separately, requiring 1 truck each.

Transportation of Construction Materials

- Sand and gravel sourced from the 6 quarries will require 86 trucks per day for a period of 90 days.
- Transport of surplus excavated material will require approximately 86 trucks per day for a period of 90 days.
- Ready-mix concrete sourced from the Batching Plant to be constructed in Rweimeh Village will require approximately 13 trucks per day for a period of 90 days.
- Cement sourced from Chekkah will require approximately 1 truck per day for a period of 90 days.

Installation of WTG Components through Onsite Mobile Cranes

On-site installation, civil and electrical works by the selected OEM/EPC Contractor, as well as the Developer.

Other Construction Works

Excavation, ground leveling, concrete works, foundation establishment, and structure erection for building infrastructure.

Excavation, Land Clearing and Electrical Work to connect each turbine to the power grid

These activities will be required to connect each turbine to the power grid. It includes excavation and the installation and laying of transmission and communication cables, the installation of the substation and installation of the buried transmission line along Quobaiyat-Qasr Road and the existing hunter’s track to the Project to connect the Project substation with the substation at the Sustainable Akkar wind farm.

Commissioning

Comprises the transfer of the plant from the state of mechanical completion into the state of continuous operation and includes mechanical tests will be performed to ensure compliance with manufacturer specifications, and the proper functioning of electrical and communication systems.

20.2.3 Operations and Maintenance Phase

The operations and maintenance phase will involve 3 full-time workers to undertake the following:

- Management and administration of the facility.
- Environmental, health and safety management.
- Spare parts management including delivery, shipping and logistics for components and parts.
- Remote monitoring 24 hours a day, 7 days a week.
- Planning and supervision of the maintenance and repair activities.
- Communication with grid operator as well as operating the wind farm to satisfy EDL requirements.
- OEM/EPC Contractor’s home office technical support.

20.2.4 Decommissioning Phase

The decommissioning and restoration process comprises removal of aboveground structures, below ground structures to a depth of 1m or greater, removal of access roads if required by the land owners (or local authorities), restoration of topsoil, re-planting and re-vegetation, seeding and implementation of a two-year monitoring and remediation period, in a manner aimed at reducing the damage that may affect the land.

20.3 Impact Analysis

20.3.1 Pre-Construction Phase

The pre-construction phase activities are not expected to pose occupational health and safety impacts that cannot be managed by standard field survey management plans.

20.3.2 Construction and Operations and Maintenance Phases

During both the construction and operations phases, occupational health and safety impacts are potentially posed by: work on active roads; the handling of hazardous materials; pressurized equipment hazards; working above and below grade and confine spaces; operation of lifting equipment (i.e. cranes, gantry and tuggers); transport of equipment and construction materials by heavy vehicles; electrical hazards; exposure to noise, vibration, air emissions, radiation and electromagnetic fields; adverse weather, ground stability and visibility; structural collapse and mechanical failure; manual handing; security; remote working conditions; and other issues including language differences.

The risk register is presented in **Table 20-1**.

Mitigation

<u>Construction</u>

During construction, it is important to plan and coordinate the efforts and on-site equipment use amongst the OEM/EPC Contractor, delivery/shipping company, and supervision and support team from the technology providers. As such, preparatory work for construction would entail the preparation of infrastructure for construction and maintenance, performance of civil engineering works, installation of machinery and installation and connection of electrical equipment.

Mitigation measures include, but are not limited to the following:

Air Quality

- Covering loads of dusty or excavated materials on a vehicle entering or leaving the construction site with impervious sheeting (such as nylon canvas).
- Undertaking proper enclosure and guarding to limit public access to the site.
- Drivers and workers in the vicinity of earth moving equipment would be supplied with ear mufflers, as well as goggles and nose masks, if necessary, in order to protect them from dust impacts.
- Water spraying at the excavation sites prior to, during and after excavation to limit airborne particles.

Table 20-1 Occupational Health and Safety Risk Register – Construction and Operations Phase

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
Hazardous Materials (e.g. toxic, flammable, asphyxiant, explosive)	Hazardous substances used/stored (e.g. paint, solvents, hydraulic fluids, diesel, herbicides, etc.)	X	X	Exposure to substance hazardous to health	Injury/illness	M/L	• Hazardous substance use, storage, handling arrangements, • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Pesticide Management Plans • Use of PPE • Subcontractor/supplier/equipment selection and management • Health risk assessment and monitoring • HSE auditing • Emergency response
	Flammable/ explosive gas (e.g. welding gases)	X	X	Loss of containment, ignition, fire/explosion/ missiles	Injury/fatality	M	• Hazardous substance use, storage, handling arrangements • Control of ignition sources • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response
	Bulk storage of flammable gas/liquid (e.g. propane for cooking, heating, diesel for vehicle fuel)	X	X	Loss of containment, ignition, fire, BLEVE	Injury/fatality	M/L	• Design basis of diesel storage (bunding, ignition control, safeguarding systems) • Hazardous substance use, storage, handling arrangements • Control of ignition sources • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response
	Cellulosic material (combustibles such as wood, paper, etc.)	X		Fire in construction camp accommodation area (accumulation, ignition of flammable materials)	Injury/fatality	M	• Induction briefing • Subcontractor/supplier/equipment selection and management • No smoking, housekeeping policies • Fire protection: building fire detection/alarm/protection • HSE auditing • Emergency response
	Cellulosic material (combustibles)	X	X	Fire in operational building (accumulation, ignition of flammable materials)	Injury/fatality	M/L	• Induction briefing • Subcontractor/supplier/equipment selection and management • No smoking, housekeeping policies • Fire protection: building fire detection/alarm/protection • HSE auditing • Emergency response
	Cellulosic material	X	X	Fire in wind turbine nacelle (e.g. due to ignition of insulation, lubricants construction, materials)	Injury/fatality	M	• Design basis of wind turbine, active, passive fire protection arrangements, escape/evacuation/rescue arrangements • Hazardous substance use, storage, handling arrangements • Control of ignition sources • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
	Transformer Insulating Fluid (SF6)	X	X	Loss of containment, e.g., during commissioning	Injury	L	• Hazardous substance use, storage, handling arrangements • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Subcontractor/supplier/equipment selection and management • Alarm warning systems • HSE auditing • Emergency response
Pressure Hazards	High pressure systems used to support construction phase (e.g. hydraulic, compressed air, bottled gases, HP water jetting)	X		Loss of integrity/ catastrophic failure, sudden, explosive release of pressure	Injury/fatality	L	• Control of work (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response
	Pressure systems in buildings and used for maintenance (e.g. compressed air, bottled gases)		X	Loss of integrity/ catastrophic failure, sudden, explosive release of pressure	Injury/fatality	L	• Control of work (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response
Differences in Height (e.g. working above grade, below grade)	Work at height during the construction phase (e.g. foundation construction, pylon, mast installation, scaffolding)	X		Fall from height	Injury/fatality	H	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment, Use of appropriate work procedures/standards) • Appropriate training of personnel • HSE auditing • Use of PPE, safe working platforms • Emergency response
	Work at height during the operations (e.g. maintenance in the nacelle, scaffolding)		X	Fall from height	Injury/fatality	H	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment) • Appropriate training of personnel • HSE auditing • Use of PPE, safe working platforms • Emergency response
	Objects at height (tools, equipment)	X	X	Dropped object	Injury/fatality	M	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment) • HSE auditing • Use of PPE, safe working platforms • Emergency response

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
	Work below grade (e.g. excavation, foundation construction	X		Excavation collapse, trapped personnel, exposure to asphyxiating environment	Injury/fatality	H/M	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment, Use of appropriate work procedures/standards) • HSE auditing • Use of PPE • Emergency response
Lifting (e.g. cranes, gantry and tuggers)	Cranes, mechanical lifting arrangements deployed during construction/ commissioning phase	X		Mechanical failure of lifting arrangements, loss of control of lift, leading to dropped object/impact.	Injury/fatality	H	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Lift Plans, Permit to Work, Job Hazard Assessment) • Certification, verification of lifting arrangements • HSE auditing • Use of PPE • Emergency response
	Cranes, mechanical lifting arrangements deployed during operation/ maintenance phase		X	Mechanical failure of lifting arrangements, loss of control of lift, leading to dropped object/impact.	Injury/fatality	M	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Lift Plans, Permit to Work, Job Hazard Assessment) • Certification, verification of lifting arrangements • HSE auditing • Use of PPE • Emergency response
Transport (e.g. land, marine, air)	Vehicle, plant, equipment movement – during construction/ commissioning phase	X		Road traffic accident: loss of control during land transport operations	Injury/fatality	H	• Design basis of road infrastructure • Vehicle land logistics/subcontractor/supplier/equipment selection and management • Road/land logistics HSE management arrangements (e.g. driver training and competence, safety briefings, journey management, auditing) • Emergency response
	Vehicle, plant, equipment movement – during construction/ commissioning phase	X		Vehicle impact with personnel	Injury/fatality	H	• Design basis of road infrastructure (segregation of roads, paths) • Control of work activities • Vehicle land logistics/subcontractor/supplier/equipment selection and management • Road/land logistics HSE management arrangements (e.g. driver training and competence, safety briefings, journey management, auditing) • Emergency response
	Vehicle, plant, equipment movement – during operation/ maintenance phase		X	Road traffic accident: loss of control during land transport operations	Injury/fatality	H/M	• Design basis of road infrastructure • Vehicle land logistics/subcontractor/supplier/equipment selection and management • Road/land logistics HSE management arrangements (e.g. driver training and competence, safety briefings, journey management, auditing) • Emergency response
	Vehicle, plant, equipment movement – during operation/ maintenance phase		X	Vehicle impact with personnel	Injury/fatality	H/M	• Design basis of road infrastructure (segregation of roads, paths) • Control of work activities • Vehicle land logistics/subcontractor/supplier/equipment selection and management • Road/land logistics HSE management arrangements (e.g. driver training and competence, safety briefings, journey management, auditing) • Emergency response
	Wind turbine structures, meteorological masts	X	X	Fixed/rotary wing aircraft impact with elevated structure	Injury/fatality	L	• Design basis of wind turbines, masts (location away from flight paths, equipped with beacons/lights/warning)

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
Electricity	High Voltage and Low voltage power generation systems and distribution infrastructure	X		Loss of control/ separation, personnel exposure to live electrical system	Injury/fatality	H	• Design basis of all electrical systems, in accordance with relevant safety/engineering codes, standards and legislation • Control of work (e.g. Permit to Work, Job Hazard Assessment). Appropriate procedures for electrical work, Lock-out and Tag-out procedures) • Subcontractor/supplier/equipment selection and management • HSE auditing • Use of PPE • Emergency response
	High Voltage and Low voltage power generation systems and distribution infrastructure		X	Loss of control/ separation, personnel exposure to live electrical system	Injury/fatality	M	• Design basis of all electrical systems, in accordance with relevant safety/engineering codes, standards and legislation • Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment). Appropriate procedures for electrical work, Lock-out and Tag-out procedures) • HSE auditing • Use of PPE • Emergency response
	Electrical distribution system/ transmission line - overhead		X	3rd party, uncontrolled access to pylons, loss of separation with transmission lines	Injury/fatality	L	• Design basis of pylons and overhead transmission lines, in accordance with relevant safety/engineering codes, standards and legislation • Control of work (e.g. Permit to Work, Job Hazard Assessment). • Asset security arrangements, access control • Community engagement • Warning signs
	Electrical distribution system/ transmission line - underground		X	3rd party, uncontrolled access to underground transmission lines	Injury/fatality	L	• Design basis of buried transmission lines in accordance with relevant safety/engineering codes, standards and legislation • Asset security arrangements, access control • Community engagement • Warning signs
	Electrical distribution system/ transmission line - underground		X	Excavation of/impact on underground transmission line	Injury/fatality	L	• Design basis of buried transmission lines in accordance with relevant safety/engineering codes, standards and legislation • Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment), Appropriate procedures for electrical work, Lock-out and Tag-out procedures) • Use of PPE • Emergency response

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
	Energized electrical systems	X	X	Fire/explosion, from short circuit or fault	Injury/fatality	M	• Design basis of electrical systems in accordance with relevant safety/engineering codes, standards and legislation. • Subcontractor/supplier/equipment selection and management • Protection systems, active passive fire protection • Asset integrity (maintenance, inspection, verification) • Control of work (e.g. Permit to Work, Job Hazard Assessment). Appropriate procedures for electrical work, Lock-out and Tag-out procedures. • Use of PPE • Emergency response
Noise	Construction, commissioning plant and equipment (e.g. generators)	X		Exposure to high, damaging noise levels	Injury	M/L	• Design basis of plant and equipment to minimise noise • Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • HSE auditing, noise monitoring, health risk assessment
	Noise sources present during the operational phase (e.g. turbine machinery, blade/air movement)		X	Exposure to high, damaging noise levels	Injury	L	• Design basis of plant and equipment to minimise noise • Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • HSE auditing, noise monitoring, health risk assessment
Emissions	Fumes, dusts during construction/ commissioning phase	X		Exposure to fumes, dusts , reduced ambient air quality	Injury	L	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Subcontractor/supplier/equipment selection and management • Use of PPE • HSE auditing, air quality monitoring, health risk assessment
Radiation	Construction integrity assurance/ verification activities (e.g. weld radiography)	X		Exposure to radioactive source	Injury	L	• Subcontractor/supplier/equipment selection and management • Control of work (e.g. Permit to Work, Job Hazard Assessment, appropriate work procedures) • HSE auditing • Use of PPE • Emergency response
	Microwaves associated with Line of Sight (LOS) comms systems	X	X	Loss of separation, exposure to microwaves	Injury	L	• Design basis of communications equipment, location, shielding • Access control • Control of work (e.g. Permit to Work, Job Hazard Assessment) • HSE auditing, health risk assessment

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
Electromagnetic Fields	Electrical equipment, generation and distribution infrastructure (e.g. transformers, generators, turbines etc)	X	X	Exposure to Electromagnetic Fields	Injury	L	• Design basis of electrical systems in accordance with relevant safety/engineering codes, standards and legislation • Control of work (e.g. Permit to Work, Job Hazard Assessment) • HSE auditing, health risk assessment
Vibration (e.g. use of tools, equipment)	Equipment, plant used during the construction phase (e.g. heavy machinery, jackhammer, piling)	X		Frequent exposure to vibration from equipment – Whole body vibration, hand arm vibration	Injury	M/L	• Design basis of plant and equipment to minimise vibration • Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • HSE auditing, health risk assessment
	Equipment, plant used during the operations/ maintenance phase (e.g. hand tools)		X	Frequent exposure to vibration from equipment – hand arm vibration	Injury	L	• Design basis of equipment, tools to minimise vibration • Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Use of PPE • HSE auditing, health risk assessment
Confined Space	Below grade excavation, construction, commissioning phase	X		Exposure to oxygen deficient/ asphyxiating atmosphere/restricted access	Injury/fatality	H/M	• Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment, Appropriate work procedures)
	Turbine nacelle and shaft, inspection rooms/hatches	X	X	Exposure to oxygen deficient/ asphyxiating atmosphere/restricted access	Injury/fatality	M	• Design basis of wind turbine, ventilation arrangements • Subcontractor/supplier/equipment selection and management • Control of work activities (e.g. Permit to Work, Job Hazard Assessment, Appropriate work procedures) • HSE auditing, health risk assessment
Environment/ Weather (adverse weather, ground stability, visibility)	Reduced visibility (e.g. Fog)	X	X	Reduced worksite visibility, increased likelihood of incident (e.g. slips, trips, falls, impacts, collisions)	Injury/fatality	L	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures
	High ambient temperature	X	X	Working in high heat environment, heat stress, sunstroke, sunburn, dehydration	Injury/fatality	M/L	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures • HSE auditing, health risk assessment • Use of PPE

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
	Low ambient temperature (ice, snow)	X	X	Working in low temperature environment/ increased likelihood of incident (e.g. slips, trips, falls, impacts, collisions)	Injury/fatality	M/L	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures • HSE auditing, health risk assessment • Use of PPE • Asset maintenance (de-icing, gritting roads)
	Low ambient temperature (ice, snow)		X	Ice accumulation and shedding, projectiles (ice throw)	Injury/fatality	L	• Design basis of wind turbines; designed to accommodate expected loads • Location of wind turbines (nearest significant community 2km away) • Adverse weather policy and procedures • Ice detection warning systems • Wind turbine operational control • Emergency response
	High wind	X	X	Working in high wind environment, increased likelihood of incident (e.g. slips, trips, falls, impacts, projectiles)	Injury/fatality	M	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures • HSE auditing, health risk assessment • Use of PPE
	High Wind	X	X	Turbine overspeed, catastrophic blade failure, projectiles	Injury/fatality	L	• Design basis of wind turbine, overspeed protection systems • Wind turbine operational control • Emergency response
	High precipitation	X	X	Working in high precipitation environment, increased likelihood of incident (e.g. slips, trips, falls, impacts, collision)	Injury/fatality	M/L	• Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures • HSE auditing, health risk assessment • Use of PPE
	Flooding – construction/ commissioning phase	X		Working in waterlogged environment, increased likelihood of incident (e.g. slips, trips, falls, impacts, collision)	Injury/fatality	L	• Temporary worksite, access roads, camp flood protection, drainage arrangements • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures
	Flooding – operation/ maintenance phase		X	Working in waterlogged environment, increased likelihood of incident (e.g. slips, trips, falls, impacts, collision)	Injury/fatality	L	• Site flood protection, drainage arrangements • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures

Hazard Category	Hazard Source	Project Phase		Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
		Construction/ Commissioning	Operation/ Maintenance				
	Ground stability	X		Ground instability, structural failures, collapse	Injury/fatality	M	• Geotechnical design basis for all structures, roads • Siting of equipment
	Ground stability		X	Ground instability, structural failures, collapse	Injury/fatality	L	• Geotechnical design basis for all structures
	Lightning	X	X	Lightning strike	Injury/fatality	L	• Structure lightning protection arrangements • Control of work activities (e.g. Permit to Work, Job Hazard Assessment) • Adverse weather policy and procedures
	Earthquake	X	X	Earthquake, ground instability, structural failures, collapse	Injury/fatality	L	• Site selection • Design basis of all facilities and structures
Biological (e.g. health, hygiene)	Illness, disease, bacteria, virus	X	X	Disease spread among workforce, contamination, illness	Injury/fatality	H	• Design basis of all facilities • Welfare arrangements • Health risk policies, management and assessment • Medical screening, treatment and arrangements
Biological (e.g. health, hygiene)	Illness, disease, bacteria, virus	X	X	Disease spread among workforce, contamination, illness	Injury/fatality	L	• Design basis of all facilities • Welfare arrangements • Health risk policies, management and assessment • Medical screening, treatment and arrangements
Mechanical (e.g. structural collapse, mechanical failure)	Turbine pylon	X	X	Catastrophic structural failure	Injury/fatality	L	• Design basis of wind turbines; designed to accommodate expected static and dynamic loads. • Manufacturing, installation, commissioning QA arrangements • Asset integrity (maintenance, inspection, verification) • Emergency response
	Turbine blade	X	X	Catastrophic failure, blade throw, projectiles	Injury/fatality	L	• Design basis of wind turbines; designed to accommodate expected loads • Location of wind turbines (nearest significant community 2km away) • Manufacturing, installation, commissioning QA arrangements • Wind turbine operational control • Asset integrity (maintenance, inspection, verification) • Emergency response

Hazard Category	Hazard Source	Project Phase: Construction/ Commissioning	Project Phase: Operation/ Maintenance	Scenario	Consequences (to People)	Risk (H/M/L)	Key Control Arrangements (Prevention/Mitigation)
Impact	Moving machinery, equipment	X	X	Impact with machinery, equipment (crushing, piercing, trapping etc.)	Injury/fatality	M/L	• Design basis of wind turbine equipment; • Asset integrity (maintenance, inspection, verification) • Control of work activities (e.g. Permit to Work, Job Hazard Assessment, Lock-out and tag-out) • HSE auditing, Risk assessment • Emergency response
Manual handling	Lifting/moving of loads	X		Injury through unsuitable manual handling of equipment	Injury/fatality	H	• Subcontractor/supplier/equipment selection and management • Appropriate training and work procedures • Health risk assessment and monitoring • HSE auditing
	Lifting/moving of loads		X	Injury through unsuitable manual handling of equipment	Injury/fatality	M	• Subcontractor/supplier/equipment selection and management • Health risk assessment and monitoring • HSE auditing
Security	3rd Parties	X	X	Unauthorized access to assets, security/terrorism incident, sabotage	Injury/fatality	H	• Appropriate secure design of facilities/assets • Security arrangements
Remote Working (including lone working)	Various	X	X	Incidents/injuries during remote or lone working	Injury/fatality	M	• Remote and lone working management arrangements • Subcontractor/supplier/equipment selection and management • HSE auditing • Emergency response
Other	External vegetation	X	X	Ignition of vegetation external to assets, bush fire.	Injury/fatality	L	• Vegetation management, clearance
	Workforce language barrier issues	X		Communication problems, leading to the increased likelihood of accidents/incidents	Injury/fatality	M	• Communication and training arrangements • Multi-lingual safety representatives

- Proper unloading of materials on-site to minimize dust.
- Limiting the use of heavy equipment during periods of high winds.
- Forbidding construction vehicles from keeping engines running (waiting to enter site or on-site).
- Adopting weight limits for trucks and not exceeding vehicle loading capacity.
- Ensuring adequate maintenance and repair of construction machinery.
- Maintaining good housekeeping practices; and effective operational and waste management practices.
- Implementing H&S measures (masks, work gloves, proper clothing, H&S rules) as needed.
- Providing suitable rehabilitation and maintenance of road network surfaces to ease traffic flow.
- Using environmentally friendly equipment with higher fuel efficiency or air pollution control.
- Maintaining and operating equipment using appropriate fuel mixtures.
- Enforcing speed limits for vehicles and maintaining normal traffic speed on-site and recommended traffic speed and driving time on the roads.
- Applying dust suppression methods such as watering at access and internal roads.
- Adopting good house-keeping measures to reduce dust build-up.
- Maintaining stockpiles at minimum heights and forming long-term stockpiles into the optimum shape (i.e. stabilization) to reduce wind erosion.
- Avoiding open burning of solid waste.
- Enclosing the construction site with a dust mesh, as applicable.
- Carrying out loading and unloading of material without scattering.
- Covering access roads and internal roads with plant mix.
- Washing construction vehicles leaving site to prevent transmission of soil.
- Keeping drop height of materials that have potential to generate dust at a minimum.
- Using well-maintained vehicles and ensuring regular maintenance of these vehicles.
- Collecting and addressing complaints and suggestions through grievance mechanism.

Water and Soil Resources Protection

- Awareness on the efficient use of water.
- Minimizing water and soil exposure.
- Minimizing and if possible eliminating chemical usage (oil, lubricants and fuel) onsite.
- Using as much as possible non-toxic and biodegradable chemicals to be stored on-site.
- Reporting in case of spills from generator or disposed waste on-site in order to seek immediate remedial measures.
- Routine inspection and maintenance of equipment to ensure that risk of leak/spill is minimized.
- Promotion of good housekeeping during operation and maintenance.
- Control and supervision of refueling at all times by appropriate personnel.
- Development and implementation of training program for management of hazardous substances.
- Temporarily store hazardous waste on-site in a designated and enclosed area.
- Forbidding hazardous waste storage outside designated area.
- Ensuring that oil changes, refueling, or lubrication of vehicles will be conducted offsite or in a dedicated area.
- Equipping fuel storage tanks with drip trays and spill control equipment.
- In case of spills, hazardous materials would be controlled via absorbents, and contaminated soil would be removed and disposed of in compliance with applicable legislation.

Topsoil Management

- Strip topsoil from project footprint (turbine bases and platform) at suitable depths and store separately at specialized areas.
- Minimize topsoil losses via use of suitable equipment, procedures and construction work schedule - avoid soil disturbance during heavy windy and rainy periods.
- Identify topsoil storage areas at relatively low slope areas.
- Ensure that top soil stockpiles do not exceed 2m in height.
- Ensure that only soil material will be stored at topsoil storage areas.
- Maintain slope stability and a safe working environment for heavy construction vehicles.
- Ensure that surface grading is done with appropriate vehicles to avoid soil compaction.
- Enclose topsoil storage area(s) with fencing and place explanatory signboards
- Ensure drainage of temporary topsoil site(s).
- Within completed construction areas (turbine bases and platforms), reuse stored top soil for rehabilitation and landscaping.
- Do not use vegetative soil or topsoil as fill material under any circumstances.
- Ensure unnecessary soil stripping to minimize disturbance to vegetation, ecosystems and soils.

Noise and Vibration

- Choosing equipment with lower sound power levels when possible.
- Using noise mufflers, and minimizing machinery or equipment idling conditions.
- Optimizing internal-traffic routing to minimize vehicle reversing needs and maximize distances from closest sensitive receptors.
- Keeping the main access road in well-maintained condition.
- Ensuring mobile vehicles use only designated roads to reduce traffic through community areas
- Proper site logistics and planning.
- Performing proper maintenance on construction vehicles and equipment.
- Limiting site working hours if possible.
- Conducting construction activities closest to noise sensitive receptors during day time only.
- Informing local municipalities and residents of the construction schedule and time of planned noisy activities.
- Informing noise sensitive receptors about construction schedule in their proximity in advance.
- Scheduling potentially noisier activities during daytime and/or less intrusive times.
- Conducting noise monitoring during construction to verify compliance with regulatory limits.
- Keeping equipment speed as low as feasibly possible without compromising performance.
- Collecting and addressing complaints and suggestions through grievance mechanism.

Solid Waste Management

- Proper site clearing.
- General cleanliness and organization of the site.
- Use of excavated material as fill material, e.g. topsoil.
- Segregation and proper disposal waste oils, paint barrels, lubricants, etc. from other wastes.

Traffic and Transport

- Planning, development and implementation of traffic management
- Maintaining minimal traffic speed on-site and recommended traffic speed and driving time off-site
- Implementing working hour limits for drivers and inform drivers periodically on working schedule
- Implementing restrictions for night time driving
- Adopting proper weight guidelines for trucks and not exceeding vehicle loading capacity
- Providing alternate routing plans during all phases of construction
- Restricting operation of heavy vehicles to those who are trained, competent and licensed
- Providing traffic trainings to all relevant personnel and specialized trainings to personnel who will operate industrial, heavier or critical vehicles.
- Including traffic issues in the scope of the trainings and instructions for site visitors.
- Limiting visitor mobility in the construction area.
- Installing and maintaining signage and other traffic visuals.
- Implementing right of way practices.
- Implementing proper vehicle maintenance at all times.
- Conducting or enforcing periodic medical examinations for drivers.
- Conducting awareness raising activities for affected communities through established mechanism.
- Collecting and addressing complaints and suggestions through the grievance mechanism.

Health and Safety

- Restriction of access to project construction areas by patrolling and guarding.
- Provision of training on the fundamentals of occupational Health and Safety procedures.
- Developing an Emergency Response Plan and training personnel on the actions to be taken in risk situations.
- Installation of warning signs at the entrance to the site to inform people about the Project and risks associated with entry.
- Availability of personal protective equipment (PPE) such as protective clothing, goggles, gloves, boots, masks, rubber boots, brightly colored working overalls equipped with light reflecting stripes, safety helmets, rubber or plastic type of equipment (broom, shovel, other) for personnel as needed.
- Covering excavated ground (e.g. anchorage pits for turbines before filling) to prevent fall-in accidents for people and animals alike.
- Provision of on-site medical facility/first aid and medical insurance for the workers/construction site.
- Installing retaining nets to hold falling debris during site clearing and construction.
- Prevention of stagnation of exposed water volumes to hamper insect and vector breeding.
- Implementation of speed limits for trucks entering and exiting the site.
- Installing proper signage to avoid accidental injury.
- Implementing good housekeeping practices.
- Ensuring that the project elements (turbines, bases, offices, substation, etc.) are designed incompliance with applicable legislations related to natural hazards, especially seismic safety
- Conducting regular maintenance of equipment.

Following the implementation of these mitigation measures, the impact severity is considered Low, and the sensitivity of the receptor as High, resulting in a residual impact categorized as Moderate as shown in **Table 20-2**.

Table 20-2 Construction Phase Assessment

		Sensitivity of Receptor				
		Low	Low-Medium	Medium	Medium-High	High √
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor	**Moderate √**
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

<u>Operations and Maintenance Phase</u>

Air Quality

For generators and other equipment:

- Using good quality fuel (from reputable sources).
- Performing regular and preventive routine maintenance according to manufacturer recommendations.
- Looking out for and fixing potential leakage and spillage of any kind at an early stage.
- Outfitting of the generators with an effluent filter for Particulate Matter (PM).

Water and Soil Management

- Collecting domestic wastewater from toilets and sinks and conveying to public sewer network.
- Ensuring that no sanitary wastewater is discharged onto the land.
- Identify high risk spill areas, e.g. fuel tanks and generator – and have impervious surfaces and capture facilities in place.
- Limit activities during adverse weather conditions to reduce potential wind and water erosion.

<u>Noise and Vibration</u>

- Adopting proper scheduling for noisy wind turbine / sub-station maintenance activities.
- Selecting adequate noise muffling equipment and minimizing machinery idling.
- Ensuring good maintenance and repair of equipment.
- Optimizing turbine operation as per wind speed to minimize noise generation.
- Keeping turbines in good working order throughout the operational life of the project via routine maintenance, inspection and operational diagnostics.
- Limiting the cutting/clearing of vegetation.
- Planting trees near sensitive receptors to act as a noise barrier.

- Ensuring equipment that may be intermittent in use is shut down between work periods or throttled down to a minimum.
- Implementing a rigorous inspection and maintenance program applicable to equipment on-site.
- Providing adequate Personnel Protective Equipment (PPE) to workers at noisy activities/locations that exceed permissible occupational noise level limits.
- Conducting noise monitoring (1st year of operation, continuous at local municipalities, and in case of complaints) to verify compliance with regulatory limits and take corrective action.

Solid Waste Management

- Storage of SW in a pre-determined area in covered drums for collection and disposal.
- Keeping the site free of litter.

Health and Safety

- Restricting access to project elements (turbines, substation) by patrolling and guarding areas around the site – noting that local residents, shepherds/herders, herb gatherers, and land users will not be subject to area access restrictions, rather restrictions to accessing Project elements.
- Installation of warning signs at site entrances to warn people about the Project and associated risks.
- Provision of appropriate monitoring instruments
- Conducting regular maintenance of equipment.
- Enforcing on-site transportation regulations.
- Covering excavated ground (e.g. anchorage pits for turbines before filling) to prevent fall-in accidents for people and animals alike.
- Prevention of stagnation of exposed water volumes to hamper insects and vector breeding.
- If needed, employees should be provided with PPE such as hand gloves, helmets, safety shoes, goggles, aprons etc. and ear protecting devices like earplugs/earmuffs and breathing masks.
- Prohibition of dirt accumulation, dampness, water, oil, and other substances which may adversely affect electrical safety within electrical areas or the sub-station.
- Training of workers and staff for fire-fighting, work permit system, first aid, safe handling of chemicals and integrating safety during operation.
- Provision of safety and warning signs where needed (displayed in Arabic and English).
- An accident / incident reporting and information system for employees for good awareness levels.
- Provision of first aid boxes at key points at the project facilities with prominent marking.
- Regulations prohibiting smoking in potentially fire prone or sensitive areas and all indoor areas.
- Provision of fire-fighting equipment and/or system if/where needed within site facilities; and regular testing of fire extinguishers.
- Ensuring electrical switchboards are not accessible to the public and related cautionary signs are in place.
- Ensuring access to turbine ladders is closed off and related cautionary signs are in place.
- Grounding installed conducting objects, as applicable.
- Ensuring maintenance schedule for turbines is strictly followed.

Specific to hazards due to accidents and/or incidents and lifting objects to heights can be applicable during construction and operation:

- Ensuring use of applicable PPEs and other protective means
- Installing guard rails and signs

- Ensuring sufficient overall illumination during working hours and special illumination on hazard areas during nighttime
- Conducting regular visual checks and clean-up of excavation debris
- Restricting operation of heavy machinery to those who are trained, competent and licensed
- Providing regular H&S trainings
- Conducting labor audits to contractors' work force by an external third party
- Limiting manual lifting/handling needs by providing mechanical alternatives
- Ensuring personnel who conduct lifting operations receive special training
- Ensuring lifting operations are well planned and risks discussed in advance
- Ensuring lifting equipment is properly maintained and has sufficient capacity to support the weight
- Setting exclusion zones below any activities working at height, to account for falling objects
- Abiding by weather condition limits set by the lifting equipment manufacturer
- Implementing the worker internal occupational grievance mechanism
- Conducting regular labor audits to contractors' workforce (by independent third party auditors)

Mitigation measures specific to blade and ice throw, and lightning applicable during operation:

- Installing, maintaining and updating lightning protection systems for turbines and other elements.
- Installing and maintaining vibration sensors reacting to imbalance and shut down turbines.
- Using de-icing mechanism, especially during fall and winter seasons.
- Carrying out periodic blade inspections and repairing defects that could affect blade integrity.
- Ensure heat control mechanism is maintained properly.
- Ensure static and illuminated warning signs are used to inform/warn receptors.

Following the implementation of these mitigation measures, the impact severity is considered Low, and the sensitivity of the receptor as Medium-High, resulting in a residual impact categorized as Minor as shown in **Table 20-3**.

Table 20-3 Operations and Maintenance Phase Assessment

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High √**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor √	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21. CUMULATIVE IMPACT ASSESSMENT

This section presents the Cumulative Impact Assessment (CIA) for the construction and operation of the Project. Cumulative impacts are contextual and encompass a broad spectrum of impacts at different spatial and temporal scales. In this instance, cumulative impacts may occur because the series of three wind farms, Lebanon Wind Power, Sustainable Akkar and Hawa Akkar, will be constructed in close proximity, as shown in **Figure 21-1**, and will used the same transport route from Tripoli. Therefore, this ESIA must take into consideration the cumulative impacts of the three wind farms.

21.1 Wind Farm Descriptions

Three wind farms are to be developed in the Akkar region, the Project and the Sustainable Akkar and Hawa Akkar wind farms.

21.1.1 Lebanon Wind Power

The Project is as described in the previous sections of this ESIA Report.

21.1.2 Hawa Akkar

The Hawa Akkar wind farm comprises the construction and operation of wind turbines to provide a maximum licensed capacity of 68.3MW. A potential for a 10% expansion as stipulated in the Power Purchase Agreement (PPA) arranged between Hawa Akkar and the GOL, which will be delivered to the public grid. The wind turbine layout is shown in **Figure 21-2**. Hawa Akkar is considering installation of VESTAS 4.2MW wind turbines at up to 16 locations, for a total power generation of 67.2MW.

21.1.3 Sustainable Akkar

The Sustainable Akkar Project comprises the construction and operation of wind turbines to provide a maximum licensed capacity of 82.5MW. A potential for a 10% expansion as stipulated in the Power Purchase Agreement (PPA) arranged between SA and the GOL, which will be delivered to the public grid. The wind turbine layout is shown in **Figure 21-3**. Depending on the OEM/EPC Contractor selected, the following scenarios are considered. The ESIA for Sustainable Akkar addressed the worst case-scenario, i.e. installation of 5.3MW wind turbines at a maximum of 21 locations, as in **Table 21-1**.

Table 21-1 Potential OEMs, Turbine Power Ratings and Turbine Locations

Potential OEM	Turbine Power Rating	Turbine Locations	Power Generated
Siemens	3.8MW	21	79.8MW
VESTAS	4.2MW	19	79.8MW
GE	5.3MW	15	79.5MW

Figure 21-1 Proximity of the 3 Wind Farms

Figure 21-2 Hawa Akkar Turbine Layout

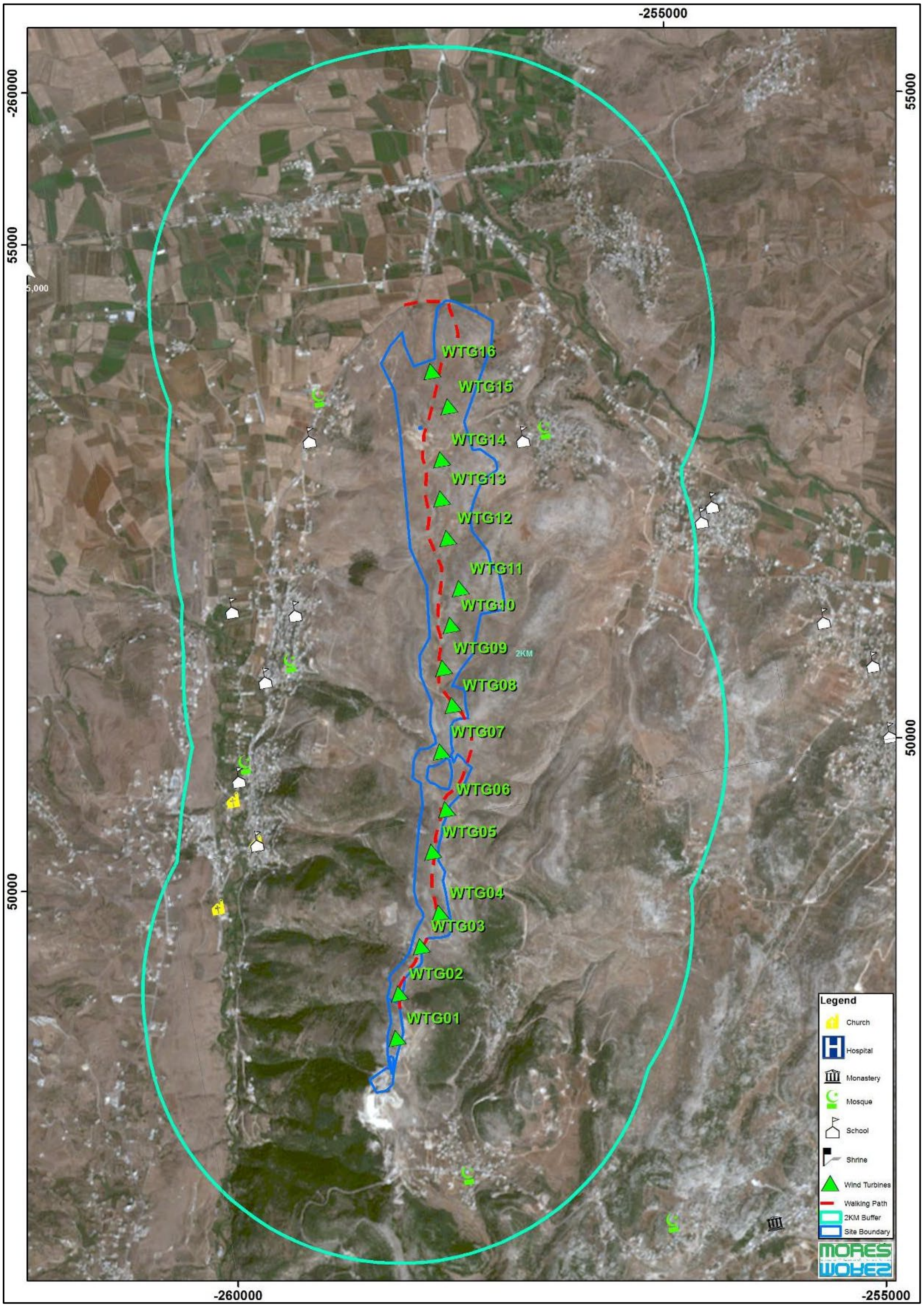
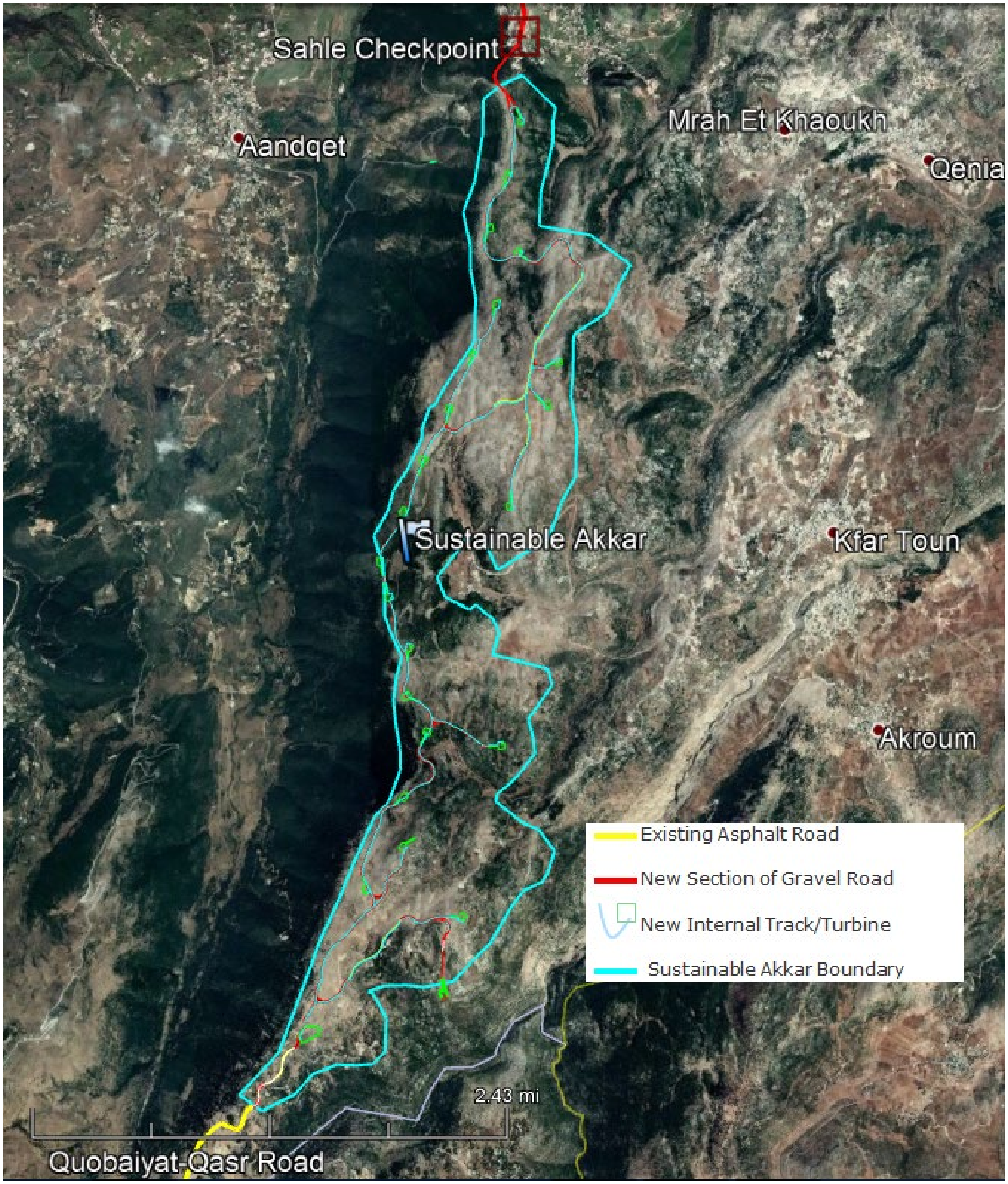


Figure 21-3 Sustainable Akkar Turbine Layout



A new sub-station is proposed to be installed between Turbines 8 and 9 on an estimated footprint of 3,500m^2. Two possible design options are currently being negotiated with Electricité du Liban (EDL) consisting of either a 33KV to 66KV or a 33KV to 220KV sub-station to be connected to the neighboring SA Wind Farm Project sub-station in El Rweimeh Village.

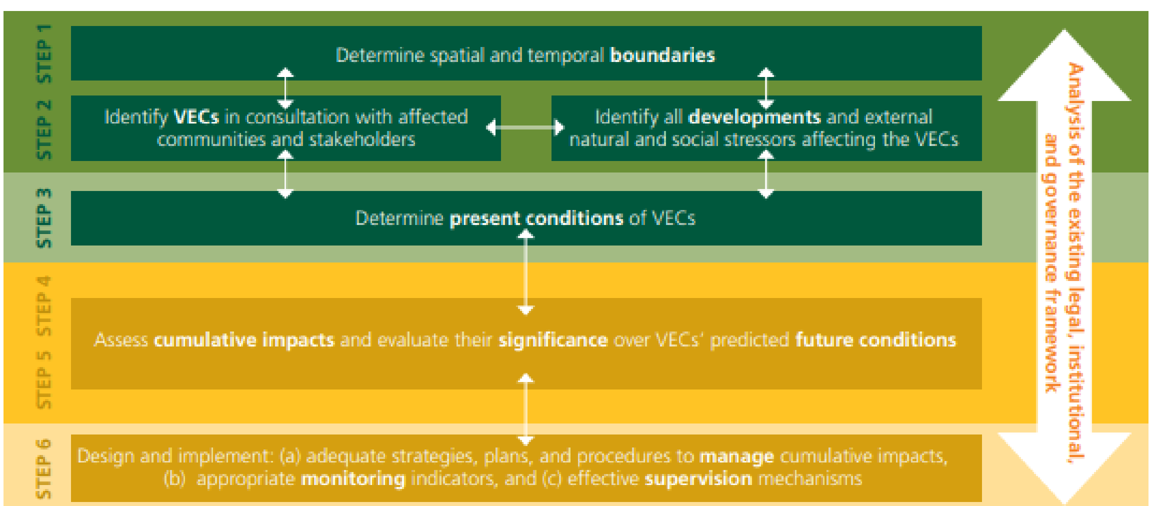
As previously detailed, a buried transmission line will be established underground between the Project's substation and that of the Sustainable Akkar wind farm, which will run 7km through El Rweimeh Village along the existing road corridor. Project land will be secured through long term lease agreements with the land owners. Land preparation and road widening works are expected to start in July 2019 and turbine mounting in March 2020. The start of operation is expected in June 2020.

21.2 Cumulative Impact Assessment Methodology

CIA is an evidence-based procedure which sets out the likely combined, significant effects of the proposed developments on social and environmental resources, so they can be considered in the planning process. Specifically, IFC PS1: Assessment and Management of Environmental and Social Risks and Impacts recognizes that because of the increasing significance of system-wide risk factors such as climate change, water availability, decline of species biodiversity, degradation of ecosystem services, and modification of socioeconomic and population dynamics, among others, cumulative impact assessment and management is an essential framework for risk management. In addition, an assessment of the cumulative impacts from all three proposed wind farms was undertaken per the request of the MOE stipulated in Minister's Letter #14175 dated 19/12/2017.

The objective of the CIA is to consider factors that contribute to the cumulative impact of wind turbine developments to avoid, manage or mitigate cumulative impacts to physical features, ecosystems services, natural processes, social conditions and cultural assets. In undertaking the CIA, the six-step approach presented in **Figure 21-4** was applied.

Figure 21-4 Cumulative Impact Assessment Approach[1]



[1] International Finance Corporation, Good Practice Handbook, Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, 2013.

In a first step, the compiled dataset for Lebanon Wind Power, Sustainable Akkar and Hawa Akkar were reviewed to identify the potential for additive and/or synergistic impacts to Valued Environmental Components (VECs) that could be generated over time by the 3 wind farms.

VECs are the environmental and social attributes that are considered important in assessing cumulative risks and can include:

- Physical features.
- Natural processes, habitats, wildlife populations.
- Social conditions.
- Cultural aspects.

Following review of the data set, it was considered that VECs to be considered in the assessment of cumulative impacts comprise the following:

- Air Quality.
- Transport and Traffic
- Biodiversity:
  - Habitats and Flora.
  - Terrestrial Fauna.
  - Bats.
  - Ornithology.
- Socioeconomic Conditions
- Noise.
- Shadow Flicker.
- Visual Amenity.
- Landscape.

In the second step the key potential impacts and risks that could affect the long-term sustainability and/or viability of the VEC were identified. The potential for additive and/or synergistic impacts to VECs, including known or predictable cause-effect relationships, was considered.

A third step comprised the assessment of the significance of potential cumulative impacts and the need for mitigation.

21.3 Cumulative Impact Assessment

21.3.1 Air Quality

Impacts to air quality are presented in **Section 11 Air Quality**. The total emissions originating from the three wind farms are presented in **Table 21-2**.

The construction phase will emit the most emissions but is also of a short duration when compared to the projects' lifetime.

When compared to the emissions of Waked et al. (2012) for the Akkar area (i.e. emissions of Cells 6, 7, and 10 for Lebanon Wind Power, Cells 4 and 5 for Sustainable Akkar, and Cells 1 and 2 for Hawa Akkar), the incremental contribution of the emissions are as follows:

Table 21-2 Cumulative Emissions from the Three Wind Farms During Phases

Emissions in kg	NOx	PM10	PM2.5	SO2	CO
Construction	45,105	2,007,619	403,815	349	11,632
Operation (1yr)	671	81,083	12,138	58	4,905
Decommissioning	4361	71,249	13,866	3	1,558
Total	**50,137**	**2,159,951**	**429,819**	**410**	**18,095**

- NOx is less than 20%.
- CO is less than 2%.
- SO2 is less than 1%.

On the other hand, the PM emissions are more than an order of magnitude higher than those calculated by Waked et al. (2012). That means that the CO, NOx, and SO2 incremental emissions are not expected to breach the air quality standards in any of the phases, while PM (which originates mainly from fugitive emissions) shall be mitigated during construction. It is noted that most public receptors are located more than 350m from the construction site; therefore, the receptor considered in this assessment is the construction worker.

Mitigation

The main concern in the mitigation measures to implement is due to PM emissions and specifically fugitive PM. IAQM (2016) and Mojave Desert (2013) suggest the following mitigation measures, which will be implemented at the three wind farms individually:

- Use of wind screens or enclosures around dusty activities or the site boundary. Mojave Desert Air Quality Management District assumes that complete coverage by wind screens (on the windward side) will provide a control efficiency of 75%.
- Water spray is also used to reduce fugitive dust as it increases the moisture content of the material. Therefore, and according to Mojave Desert, water spray (application point) will ensure a control efficiency of 75%.
- For unpaved roads, water flushing is the essential with 0.48 gallons per square yard twice per day to maintain a control efficiency above 50%.
- For paved roads, water flushing with 0.48 gallons per square yard followed by sweeping is very effective and can reach 96%. If conducted directly before the passage of the turbines convoy or the morning and evening passages of the project vehicles to and from the site, a consequent decrease will occur.
- A combination of the different above-mentioned measures will give a higher control efficiency that when applied individually.

Practically, it is considered that fugitive PM can easily be decreased by 75%. As such, with the application of the above mitigation measures, the severity of the impact from PM is considered Low, with the receptor sensitivity (the construction worker) considered Medium-High, resulting in a Minor impact as shown in **Table 21-3.**

Table 21-3 Cumulative Impact of PM During Construction

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High √**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	Minor	Minor √	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21.3.2 Transport and Traffic

The transport route for the WTG components will begin at the Tripoli Port and proceed to the Project site using existing roads and new road or links, as was previously shown in **Figure 2-7** through **Figure 2-11**. All three wind farms will use a common transport route for the WTG components, involving the following:

- Road Obstacle Removal.
- New Road Development.
- Transport of the WTG Components, Construction Materials and Workers.

Road Obstacle Removal

Minor civil works will be necessary for trucks carrying the WTG components to navigate from the Tripoli Port to the three wind farms as follows:

- The Port: Temporary concrete bund, curb, electric pole and overhead removal, will be necessary for trucks to navigate the Port. At the Port exit, 45m of concrete wall will need to be demolished to facilitate exit by trucks carrying the WTG components.
- Ramps, roundabouts and curves: Car parking will be prohibited during transport and removal of curbs, electric poles, trees, lamp posts, and fencing will be necessary.
- Pedestrian bridges: Raising of the bridges to provide a vertical clearance of 570cm will be required.
- At significant curves: Ground leveling and compaction to facilitate maneuverability.

Such works will be coordinated and permitted by the Project Proponent and the Ministry of Transport and scheduled for time periods when traffic levels and/or pedestrian use are lowest.

Mitigation

- The temporary removal of concrete bund, curb, electric pole and overhead cable, and demolition of the 45m of concrete wall be coordinated with the Port Authority.
- Raising of pedestrian bridges, prohibition of car parking, removal of curbs, electric poles, trees, lamp posts, and fencing at ramps and roundabouts and ground leveling and compaction of significant curves will be coordinated with the Ministry of Transport.
- Any modification required for the Al Abdeh roundabout will be discussed with the municipality as it is under their authority.

Asphalt speed bumps will be replaced with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass.

New Road Development

Construction of new segments of road will occur at the following locations:

- In order to avoid impacts to Chadra, Machta Hassan and Machta Hammoud, a new 0.65km section of asphalt road will be constructed through currently vacant land purchased from private land owners (shown as #1 in **Figure 2-8**). The new road section will connect with the existing asphalt road outside of Machta Hammoud.
- A new 0.15km section of asphalt road will be constructed (shown as #2 in **Figure 2-8**) between two existing sections of asphalt road in order to avoid hairpin turns near homes.
- A new 3.0km section of gravel road will be constructed within the existing railroad right of way (ROW) managed by Machta Hammoud Village (shown as #3 in **Figure 2-8**), traveling east before connecting to an existing asphalt road to enter the Hawa Akkar Wind Farm.

Mitigation

The construction of asphalt roads will occur for a period of 6 months and will be coordinated and permitted by Ministry of Transport and scheduled for time periods when traffic levels are lowest. Construction of internal track will occur for a period of 3 months and will be coordinated with the Ministry of Transport and the Lebanese Army. It is considered that construction of the internal tracks will have no impact on access to and operations at the Lebanese Army Military base and/or external receptors.

Transport of WTG Components, Construction Materials and Workers

The construction of the three wind farms will be staggered such that the quantities of WTG components and transport of construction materials can be assumed in succession, as shown in **Table 21-4 and Table 21-5.**

The construction phase may require a worst-case scenario of up to 200 staff working in a single day. The EPC Contractors for the three wind farms have not yet been selected; however, approximately 25% of the workers (up to 50) will be hired from the local communities in the northeastern part of Akkar, including Wadi Khaled. The EPC Contractor will be required to transport local workers from local villages through carpooling and/or van transport to minimize traffic impacts to rural roads.

The balance of the workforce (up to 150) will be accommodated in nearby villages in hotels and/or apartments. Again, the EPC Contractor will be required to provide carpooling and/or van transport of

Table 21-4 Vehicle Trips Required for Transport of WTG Components, Construction Materials and Workers

Component	Quantity	Maximum Turbines	Total Units	Vehicle Type	Estimated Roundtrips From Tripoli Port to Project Site		
					Maximum Turbine Transport/Week	Maximum Truck Trips/Week	Duration =
Lebanon Wind Power							
Tower	5 sections/ tower/turbine	16	80	5 oversize trucks/ tower/turbine	2	10	8 weeks
Nacelles	2 sections/ nacelle/turbine	16	32	2 oversize trucks/ nacelle/turbine		4	
Hub	1 hub/turbine	16	16	1 oversize truck/ hub/turbine		2	
Blades	3 blades/turbine	16	48	3 oversize trucks/ 3 blades/turbine		6	
		Totals	**176**	**11 oversize trucks/turbine**	**2**	**22**	
Substation	1 substation/17 turbines	NA	1	1 oversize truck/substation	1	NA	
Switchgear	1 substation/17 turbines	NA	1	1 semi-trailer (20-ton)/ switchgear	1	NA	
Sustainable Akkar							
Tower	5 sections/ tower/turbine	27	135	5 oversize trucks/ tower/turbine	2	10	13.5 weeks
Nacelles	2 sections/ nacelle/turbine	27	54	2 oversize trucks/ nacelle/turbine		4	
Hub	1 hub/turbine	27	27	1 oversize truck/ hub/turbine		2	
Blades	3 blades/turbine	27	81	3 oversize trucks/ 3 blades/turbine		6	
		Totals	**297**	**11 oversize trucks/turbine**	**2**	**22**	
Substation	1 substation/27 turbines	27	1	1 oversize truck/substation	1	NA	
Switchgear	1 substation/27 turbines	27	1	1 semi-trailer (20-ton)/ switchgear	1	NA	
Hawa Akkar							
Tower	5 sections/ tower/turbine	17	85	5 oversize trucks/ tower/turbine	2	10	8.5 weeks
Nacelles	2 sections/ nacelle/turbine	17	34	2 oversize trucks/ nacelle/turbine		4	
Hub	1 hub/turbine	17	17	1 oversize truck/ hub/turbine		2	
Blades	3 blades/turbine	17	51	3 oversize trucks/ 3 blades/turbine		6	
		Totals	**187**	**11 oversize trucks/turbine**	**2**	**22**	
Substation	1 substation/17 turbines	17	1	1 oversize truck/substation	1	NA	
Switchgear	1 substation/17 turbines	17	1	1 semi-trailer (20-ton)/ switchgear	1	NA	

Table 21-5 Vehicle Trips Required for Transport of Construction Materials

Lebanon Wind Power	Quantities		Transport		Total Number of Trips		No. of Working Days	Total Number of Trips/Day		
	Low Range	High Range	Description	Capacity	Low Range	High Range		Low Range	High Range	Average
Surplus from excavation managed in m³	137,427	171,784	Semi-Trailer (m³)	20	6,871	8,589	90	76.35	95.44	85.89
Ready-mixed concrete in m³ sourced from Batching Plant in Rweimeh Village	10,737	12,884	Concrete Mixer Truck (m³)	10	1,074	1,288	90	11.93	14.32	13.12
Cement in tonnes sourced from Chekkah	4,295	5,154	Powder Cement Tank Trailer (tonnes)	45	95	115	80	1.19	1.43	1.31
Sand in m³ from 6 Quarries	4,295	5,154	Semi-Trailer (m³)	20	215	258	80	2.68	3.22	2.95
Gravel in m³ from 6 Quarries	8,589	10,307	Semi-Trailer (m³)	20	429	515	80	5.37	6.44	5.91
Construction steel in tonnes tonnes	1,074	1,503	Semi-Trailer (m3)	20	54	75	80	0.67	0.94	0.81
Sustainable Akkar	**Quantities**		**Transport**		**Total number of Trips**		**No. of working days**	**Total No. of Trips/day**		
	Low Range	**High Range**	**Description**	**Capacity**	**Low Range**	**High Range**		**Low Range**	**High Range**	**Average**
Surplus from excavation managed in m³	182,573	228,216	Semi-Trailer (m³)	20	9,129	11,411	90	101.43	126.79	114.11
Ready-mixed concrete in m³ sourced from Batching Plant in Rweimeh Village	14,263	17,116	Concrete Mixer Truck (m³)	10	1,426	1,712	90	15.85	19.02	17.43
Cement in tonnes sourced from Chekkah	5,705	6,846	Powder Cement Tank Trailer (tonnes)	45	127	152	80	1.58	1.90	1.74
Sand in m³ from 6 Quarries	5,705	6,846	Semi-Trailer (m³)	20	285	342	80	3.57	4.28	3.92
Gravel in m³ from 6 Quarries	11,411	13,693	Semi-Trailer (m3)	20	571	685	80	7.13	8.56	7.84
Construction steel in tonnes tonnes	1,426	1,997	Semi-Trailer (m3)	20	71	100	80	0.89	1.25	1.07
Hawa Akkar	**Quantities**		**Transport**		**Total Number of Trips**		**No. of Working Days**	**Total Number of Trips/Day**		
	Low Range	**High Range**	**Description**	**Capacity**	**Low Range**	**High Range**		**Low Range**	**High Range**	**Average**
Surplus from excavation managed in m³	137,427	171,784	Semi-Trailer (m³)	20	6,871	8,589	90	76.35	95.44	85.89
Ready-mixed concrete in m³ sourced from Batching Plant in Rweimeh Village	10,737	12,884	Concrete Mixer Truck (m³)	10	1,074	1,288	90	11.93	14.32	13.12
Cement in tonnes sourced from Chekkah	4,295	5,154	Powder Cement Tank Trailer (tonnes)	45	95	115	80	1.19	1.43	1.31
Sand in m³ from 6 Quarries	4,295	5,154	Semi-Trailer (m³)	20	215	258	80	2.68	3.22	2.95
Gravel in m³ from 6 Quarries	8,589	10,307	Semi-Trailer (m³)	20	429	515	80	5.37	6.44	5.91
Construction steel in tonnes tonnes	1,074	1,503	Semi-Trailer (m3)	20	54	75	80	0.67	0.94	0.81

workers to reduce traffic impacts to rural roads. The exact details are to be determined following selection of the EPC Contractor and the location of hired construction workers.

- A communications protocol being developed for the transport of WTG components will be distributed to all Mayors two to three months prior to the start of transport. A final transport route map will be provided to all municipalities.
- All three wind farms will use the same traffic access plan.
- Announcements will be made to all villages along the WTG transport route from the Tripoli Port to the entrance of the Project site).
- WTG components will be transported 2 days per week, a total of 22 trucks roundtrip per week.
- Municipal police will provide an escort for the WTG transport convoy.
- Transport will be timed before and after farmers take their crops to the Akkar Vegetable Market.
- The road that passes through El Rweimeh Village is the main access of the trucks transporting rocks and gravel, and maintenance activities will be undertaken by the Project Proponent.
- For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road.
- For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.
- Once the EPC Contractor has been selected, and the number and location of construction numbers are known, measures will be put in place to maximize mitigation of traffic impacts through carpooling and group transport by van.

Given the above, the cumulative impacts of traffic and transport for the three wind farms is not considered to be much greater than for the individual Project. Collectively, therefore, the impact severity is considered Low, with the sensitivity of the receptor considered Medium, resulting in a Minor impact as shown in **Table 21-6**.

Table 21-6 Cumulative Impact of Traffic and Transport During Construction

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low √	Negligible	Negligible	**Minor √**	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21.3.3 Biodiversity

21.3.3.1 Habitats and Flora

Habitat loss impacts from Lebanon Wind Power are predicted to be negligible. Impacts associated with Sustainable Akkar and Hawa Akkar wind farms are also predicted to be negligible based on the similar requirement for infrastructure and on the lower importance of the habitats around both Sustainable Akkar and Hawa Akkar. No cumulative impacts are predicted from the three wind farms in combination on habitats and flora.

21.3.3.2 Terrestrial Fauna

While ecologically significant impacts on terrestrial faunal species and their resting places are possible, they can be effectively reduced to an insignificant level through the effective implementation of the proposed mitigation, e.g. pre-construction surveys and subsequent temporal or seasonal avoidance of impacts. The same methods of mitigation would be utilized at both Sustainable Akkar and Hawa Akkar, resulting in non-significant impacts at all wind farm sites. It is considered that the cumulative impact on terrestrial fauna is not significant.

21.3.3.3 Bats

Bats can be vulnerable to collision risk or disturbance from wind turbines when foraging and migrating. There is potential for ecologically significant impacts on bats resulting from Lebanon Wind Power, with this also being the case for Sustainable Akkar and Hawa Akkar.

A survey protocol during the construction and operation phase of the proposed development has been recommended as mitigation along with the protection of bat roosts caves that have been identified. This provides a conservation benefit for bats by providing safe locations for them to breed and roost.

The monitoring protocol would be the first of its kind in Lebanon and would lead the way in monitoring wind farm impacts on bats within the Middle East. It is considered that the implementation of this mitigation strategy would prevent any cumulative impacts on bats from the three wind farm developments.

21.3.3.4 Ornithology

All three wind farm developments sit near bottle necks for migrating birds, with these migration flyways being of international importance. Collision Risk Assessments were undertaken by Ramboll for each development based on VP and PC survey data. The outputs of these assessments are summarized in **Table 21-7**, along with a cumulative estimate of collision mortality for each species where a collision risk above zero is predicted.

It should be noted that the mortality estimates for Hawa Akkar are assessed on an incomplete data set and include some precautionary presumptions which have elevated the collision risk for species such as common crane, honey buzzard, long-legged buzzard and

Table 21-7 Cumulative Collision Risk

Species	LWP Mortality Estimate	SA Mortality Estimate	HA Mortality Estimate	Cumulative Mortality Estimate	Population Estimate	% Loss
Black Kite	0	0	0.05893	0.05893	1,636	0.00360
Booted Eagle	0	0	0.10849	0.10849	621	0.01747
Common Buzzard	0.19839	0	0.57759	0.77598	1,835	0.04230
Common Crane	0	0.13795	2.25258	2.39053	113,000	0.00212
Eurasian Sparrowhawk	0.08914	0.11761	0	0.20675	520	0.03973
Hen Harrier	0	0	0.03532	0.03532	4	0.88300
Honey Buzzard	4.84456	0.30728	2.92929	8.08113	437,000	0.00185
Kestrel	0.70946	2.57164	7.14391	10.42501	10,000[2]	0.10425
Lesser Spotted Eagle	0.16488	0.70698	0.38402	1.25588	141,000	0.00089
Levant Sparrowhawk	0.86261	0	0	0.86261	44,000	0.00196
Long-legged Buzzard	0	0.11407	0.60412	0.71819	44	1.61755
Short-toed Eagle	0.03730	3.32685	1.09335	4.45750	3,368	0.13236
Steppe Buzzard	0.48258	0.05306	0.14049	0.67613	1,835	0.03685
White Stork	0	0.25113	0.83125	1.08238	359,085	0.00030

[2] This revised number is based off a population estimate for Arabia from http://osme.org/sites/default/files/pdf/A_Non-passerine_ORL_V4.1_Final_2017.pdf

The only species for which a significant risk of collision mortality (greater than 1%) is predicted is long-legged buzzard. As can be seen in the table this number is mostly attributed to Hawa Akkar. Hawa Akkar records also inflate the results for hen harrier which were recorded at very low levels, yet produce a mortality estimate of 0.88% of the population estimate. This species is extremely rare in the region, so any records during the surveys get an inflated importance. Aside from these anomalies, the highest cumulative loss % belong to kestrel and short-toed eagle, both species present on the wind farm sites through the summer (in for kestrels, through the winter too). These are the only species with a cumulative collision risk greater than 0.1% of the baseline population estimate. Overall no significant effects are predicted from collision risk on avifauna, however given the importance of the flyway and level of uncertainty associated with collision risk estimates mitigation is still proposed.

Following the successful implementation of the mitigation proposals for Sustainable Akkar (including carcass searches and operational phase VPs), which would be undertaken concurrently at Lebanon Wind Power and Hawa Akkar, no significant cumulative impacts are predicted.

21.3.4 Socio-Economic Environment

On a cumulative basis, the Lebanon Wind Power, Sustainable Akkar and Hawa Akkar wind farm projects will have a positive and very significant impact on the Akkar Region. The three projects together will require the purchasing locally of a large amount of construction materials and other goods and services. The three projects together will provide approximately 300 jobs to local workers. The three projects will also require upgrades to several local roads in order to accommodate the heavy trucks during the construction phase and local community members will also benefit from improved travel to work and/or school on these upgraded roads. The three projects together, once in operation, will generate a significant amount of new renewable energy to the local villages, the Akkar region and the other regions in Lebanon.

Also, once in operation, the three projects together may be considered new tourist attractions. Tourists, while in the area viewing the wind turbines, will spend money in shops and restaurants, thereby generating additional revenue for the local SMEs. There are no perceived negative cumulative socioeconomic impacts from these three wind farm projects.

21.3.5 Noise

The primary noise sources associated with the three proposed projects would be a maximum of 56 wind turbines. The final wind turbine model has not yet been selected for the Lebanon Wind Power and for the Sustainable Akkar Project. Therefore, for these sites the cumulative noise assessment was based on the Nordex turbine as a worst-case approach since this turbine has the highest noise levels of the considered turbines. The considered turbine data is presented in **Table 21-8** through **Table 21-10.**

Table 21-8 Technical WTG Data LWP Site (Worst Case Assumption)

LWP	Planned WTG
Name(s) on Print Out	7-23
Number	17
Manufacturer	Nordex
WTG-Type	N149 Without serrations
Rotor Diameter [m]	149
Hub Height [m]	105
Rated Power [MW]	4.5
Operating Mode, Nighttime	Mode 0
Serrations	No
Source of Sound Power Level	F008_271_A12_DE
LWA [dB(A)], Nighttime	108.1
LWA [dB(A)], Daytime	108.1
Surcharge*) [dB(A)]	1
LWA Total [dB(A)], Nighttime	**109.1**

Table 21-9 Technical WTG Data SA Site (Worst Case Assumption)

SA	Planned WTG	Planned WTG	Planned WTG	Planned WTG	Planned WTG	Planned WTG
Name(s) on Print Out	02-08, 18-22	13, 15, 17, 23	09-11, 29	24	25	14
Number	12	4	4	1	1	1
Manufacturer	Nordex	Nordex	Nordex	Nordex	Nordex	Nordex
WTG-Type	N149 With serrations	N149 With serrations	N149 With serrations	N149 With serrations	N149 With serrations	N149 With serrations
Rotor Diameter [m]	149	149	149	149	149	149
Hub Height [m]	105	105	105	105	105	105
Rated Power [MW]	4.5	4.5	4.5	4.5	4.5	4.5
Operating Mode, Nighttime	Mode 0	Mode 4	Mode 8	Mode 10	Mode 11	Mode 16
Serrations	Yes	Yes	Yes	Yes	Yes	Yes
Source of Sound Power Level	F008_271_A12_DE	F008_271_A12_DE	F008_271_A12_DE	F008_271_A12_DE	F008_271_A12_DE	F008_271_A12_DE
LWA [dB(A)], Nighttime	106.1	104.1	102.0	100.0	99.5	97.0
LWA [dB(A)], Daytime	106.1	106.1	106.1	106.1	106.1	106.1
Surcharge*) [dB(A)]	1	1	1	1	1	1
LWA Total [dB(A)], Nighttime	107.1	105.1	103.0	101.0	100.5	98.0

Table 21-10 Technical WTG Data HA Site

HA	Planned WTG	Planned WTG
Name(s) on Print Out	01-13	14-16
Number	13	3
Manufacturer	Vestas	Vestas
WTG-Type	V150	V150
Rotor Diameter [m]	150	150
Hub Height [m]	105	105
Rated Power [MW]	4.2	4.2
Operating Mode, Nighttime	P01	SO3
Serrations	Yes	Yes
Source of Sound Power Level	0067-7067 V08	0067-7067 V08
LWA [dB(A)], Nighttime	104.9	99.5
LWA [dB(A)], Daytime	104.9	104.9
Surcharge*) [dB(A)]	1	1
LWA Total [dB(A)], Nighttime	**105.9**	**100.5**

The cumulative load of the planned wind turbines at the surveyed noise sensitive areas was calculated according to the ISO 9613-2:1996. Noise levels were calculated at a maximum of 56 WTG locations, as shown in **Table 21-11**. However, since the number of turbines will be reduced once the OEM is selected, the noise levels will be lower as indicated in the calculations.

Due to the array of the three wind farms which stretch from north to south, there are very limited cumulative noise impacts. The only place which will experience a small amount of cumulative impacts is the area between the Sustainable Akkar and Hawa Akkar site (see **Figure 21-5**). However, these small cumulative impacts will not cause an exceedance of the IFC limit of 45 dB(A).

Therefore, there are negligible cumulative noise impacts, as shown in **Table 21-12**.

Table 21-11 Cumulative Noise Calculation based on Nordex N-149 (Worst-Case)

Receptor	Nighttime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	Daytime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	IFC Noise Level Guideline Daytime/Nighttime [dB(A)]
LWP: 30 house under construction	32.4	32.5	55/45
LWP: 33 house	30.5	30.5	55/45
LWP: 46 occupied house in summer	33.9	34.0	55/45
LWP: 53 house	37.3	37.3	55/45
LWP: 55 villa	39.1	39.1	55/45
LWP: 57 house	40.5	40.5	55/45
LWP: 61 house	41.2	41.2	55/45
LWP: 68 house	43.5	43.5	55/45
LWP: 73 house	44.5	44.5	55/45
LWP: 78 house	39.6	39.6	55/45
LWP: 82 house	37.5	37.5	55/45
LWP: 85 house	41.5	41.5	55/45
LWP: 89 house	40.6	40.6	55/45
LWP: 94 house	43.3	43.3	55/45
LWP: 97 house	44.4	44.4	55/45
LWP: 98 house	41.5	41.5	55/45
SA 34: house	44.1	48.7	55/45
SA 42: summer house	40.3	44.3	55/45
SA 31: summer house	43.3	47.9	55/45
SA 06: house	42.7	42.8	55/45
SA 09: house	41.7	41.7	55/45
SA 13: house	37.6	38.2	55/45
SA 17: house	33.7	35.6	55/45
SA 16: house	34.7	36.4	55/45
SA 37: house	44.7	49.2	55/45
SA 20: house	44.8	46.5	55/45
SA 19: house	44.1	46.2	55/45
SA 21: house	44.9	46.4	55/45

Receptor	Nighttime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	Daytime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	IFC Noise Level Guideline Daytime/Nighttime [dB(A)]
SA 29: house	44.9	47.0	55/45
SA 28: summer house	42.8	44.6	55/45
SA 23: house	37.6	38.5	55/45
SA 32: summer house	42.6	47.5	55/45
SA 11: house	38.4	38.7	55/45
SA 12: house	37.1	38.0	55/45
SA 14: house	37.7	39.7	55/45
SA 15: house	37.7	39.5	55/45
SA 18: house	38.2	39.7	55/45
SA 22: house	39.3	40.3	55/45
SA 38: restaurant in construction	39.9	44.3	55/45
SA 36: house	41.2	45.7	55/45
SA 39: house	40.1	44.4	55/45
SA 44: house	39.0	42.9	55/45
SA 45: house	37.0	40.8	55/45
HA: 10 house	43.5	48.1	55/45
HA: 12a house	44.6	49.3	55/45
HA: 15 house	42.5	46.6	55/45
HA: 17 house	41.2	44.7	55/45
HA: 23 house	42.9	44.0	55/45
HA: 29 house	37.1	37.4	55/45
HA: 35 house	34.7	34.8	55/45
HA: 39 house	42.6	42.6	55/45
HA: 40 house	41.5	41.5	55/45
HA: 46 house	40.4	40.4	55/45
HA: 45 army base / quarry	43.8	43.8	55 (no residential receptor)
HA: 44 house	35.6	35.7	55/45
HA: 37 house	37.2	37.3	55/45
HA: 38 house	35.3	35.4	55/45

Receptor	Nighttime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	Daytime Noise Levels Cumulative Noise Level LWP + HA + SA Wind Farm [dB(A)]	IFC Noise Level Guideline Daytime/Nighttime [dB(A)]
HA: 34 house	37.3	37.4	55/45
HA: 33 house	37.9	38.0	55/45
HA: 32 house	40.5	40.5	55/45
HA: 26 house	39.5	39.7	55/45
HA: 25 house	39.4	39.7	55/45
HA: 24 house	39.2	39.6	55/45
HA: 19 house	37.0	38.3	55/45
HA: 14 house	38.0	40.3	55/45
HA: 11 house	38.1	40.8	55/45
HA: 09 house	38.1	41.4	55/45
HA: 04 house	37.8	41.9	55/45
HA: 01 house	37.7	42.4	55/45
HA: 02 house	36.7	41.2	55/45
HA: 43 temporary army base	54.4	54.4	55 (no residential receptor)
HA: 12b house	44.0	48.5	55/45
SA 51: summer house	44.9	50.0	55/45

Figure 21-5 Cumulative Noise Isolines for the 3 Wind Farm Projects

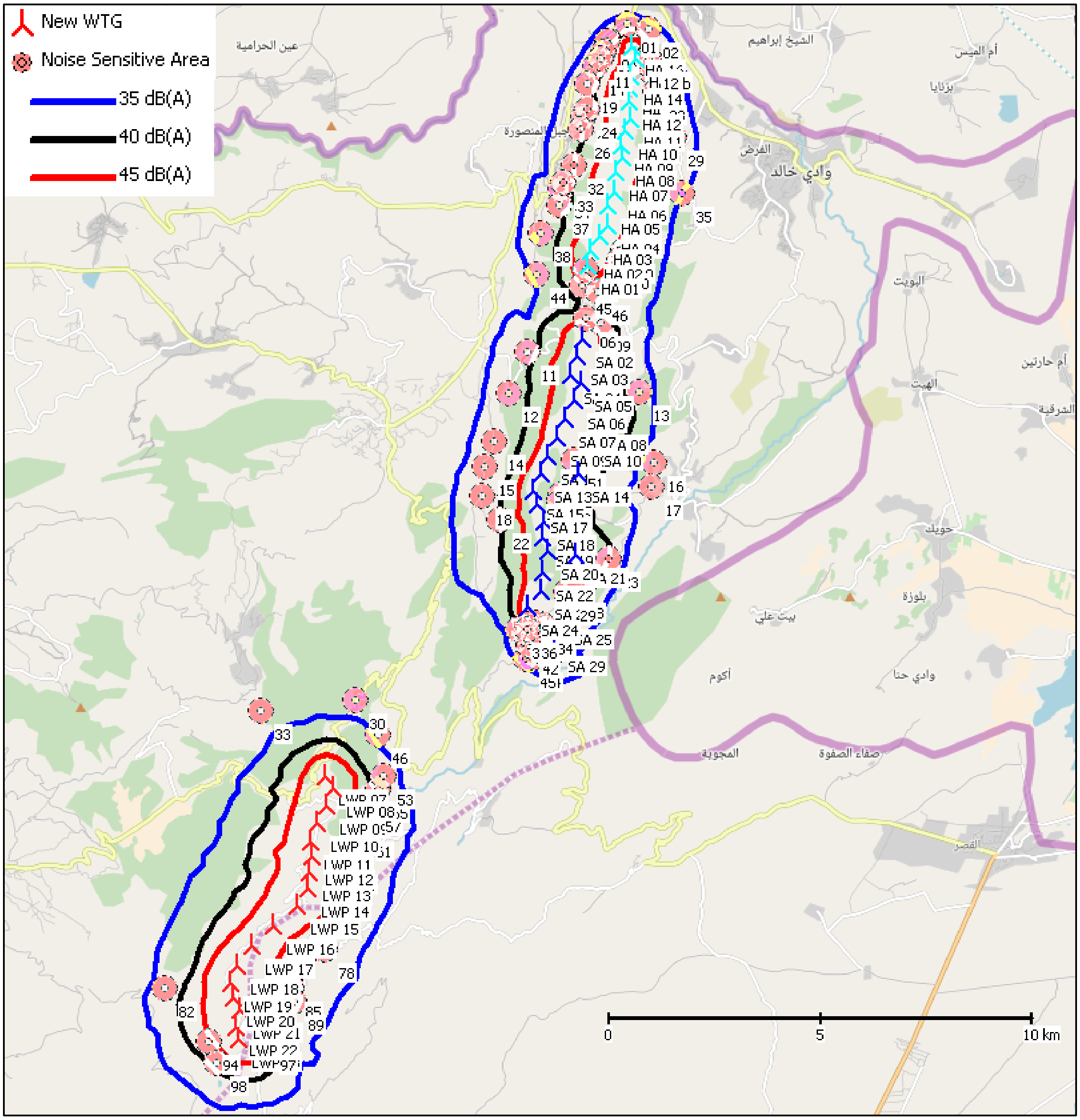


Table 21-12 Cumulative Noise Impact

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight√	Negligible	Negligible	Negligible√	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21.3.6 Shadow Flicker

Based on the worst-case assumptions derived from the EHS Guideline (2015) and the turbine locations of the three projects a shadow flicker map was calculated to show potential overlapping shadow areas of the three projects which could cause cumulative impacts.

Due to the distance of more than 5,000m between the Lebanon Wind Power project and the Sustainable Akkar project, there will be no overlapping shadow flicker areas (see **Figure 21-6**), and consequently no cumulative impacts arising from these projects in terms of shadow flicker.

In the north of the Sustainable Akkar project there is a very small area which overlaps with the shadow area of the Hawa Akkar project (see **Figure 21-7**). Since there are no sensitive receptors like dwellings for instance in the overlapping area, there is also no cumulative impact from shadow flicker for the Hawa Akkar and the Sustainable Akkar project.

In summary, there will be no cumulative shadow flicker impacts due to the distance between the parallelly planned wind farms, as shown in **Table 21-13**.

Figure 21-6 Shadow Flicker Area (HA+SA+LWP)

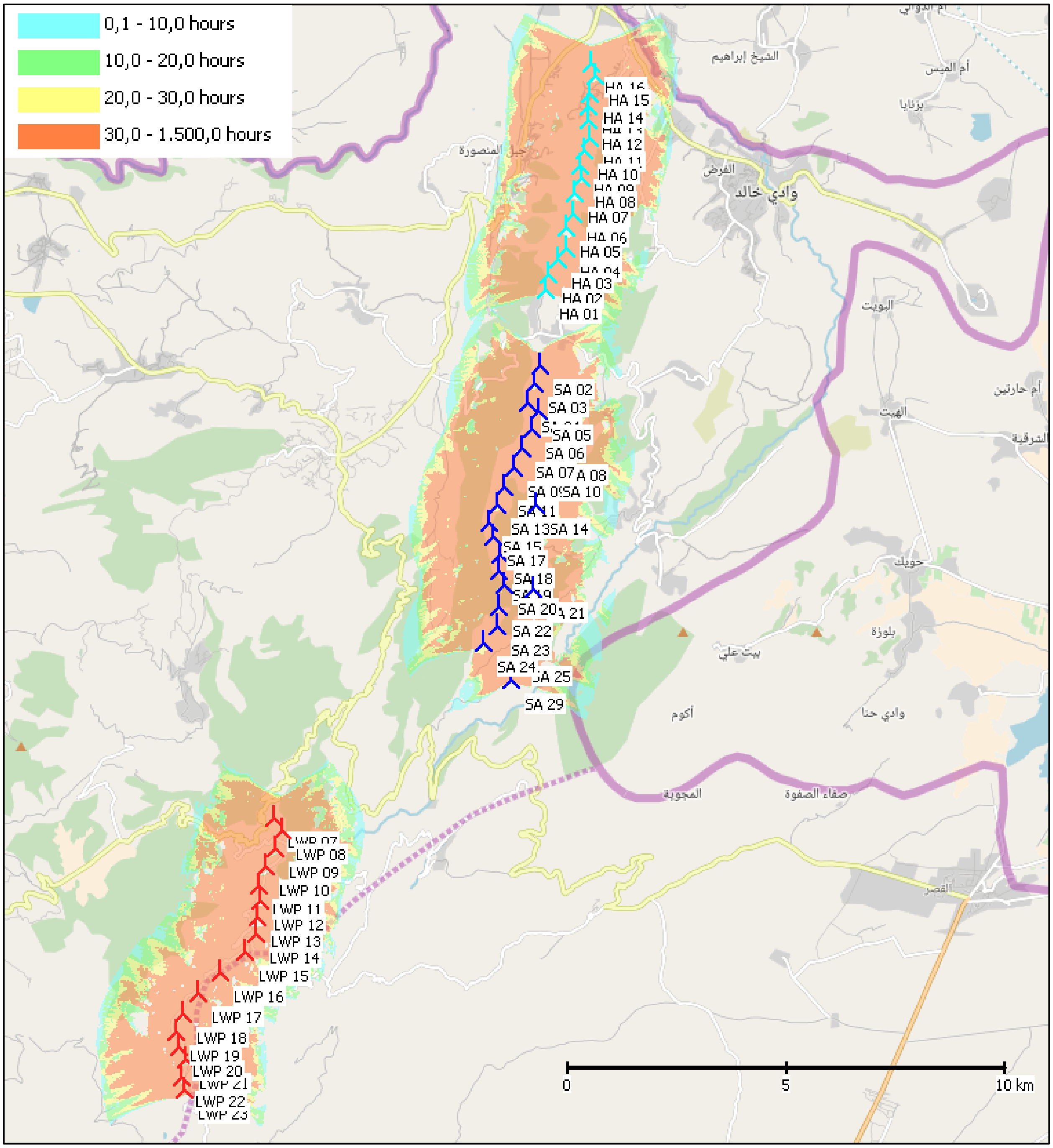


Figure 21-7 Shadow Flicker Areas between the SA and the HA Projects

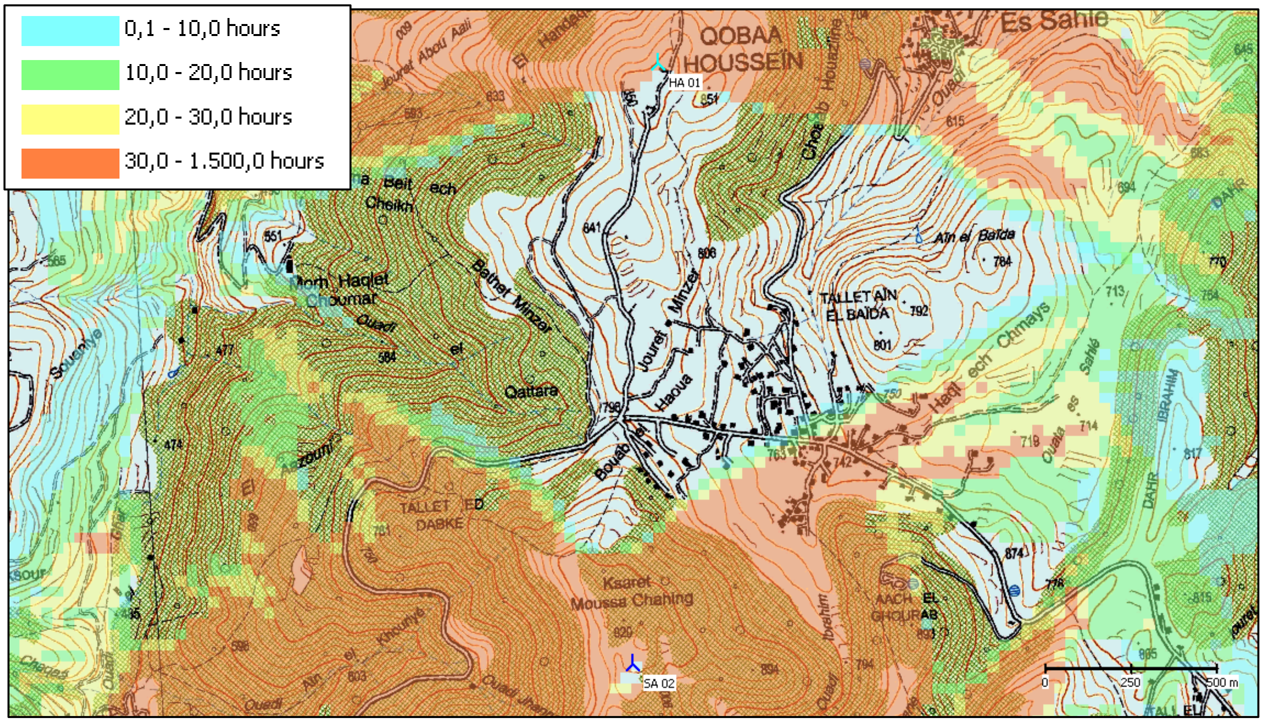


Table 21-13 Cumulative Impact Shadow Flicker

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium √**	**Medium-High**	**High**
Impact Severity	**No Change√**	Negligible	Negligible	Negligible√	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium	Negligible	Minor	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21.3.7 Visual and Landscape

Inter-visibility between wind farms is normally found to be highest in those areas located between the developments. However, the actual pattern of cumulative inter-visibility (CIV) dependent on the land-cover, land-use and landform of the area is subjected to combined visibility. Since there is only little vegetation, which usually reduces the visibility, the landcover and land use was not considered in the calculation. Due to the large height differences in the area, the local topography is the most important factor which determines the visibility of the wind farm.

The cumulative ZTV demonstrates that the individual visibility of the Sustainable Akkar wind farm development will mostly occur in the eastern and southern part of the 15km study area, as shown in **Table 21-14**. The cumulative ZTV also clearly shows that the most sensitive receptor in the area, the Qammouaah Plain and its surrounding, does not have any visibility from the Sustainable Akkar and the Hawa Akkar wind farms (see visualization of all three wind farms).

Table 21-14 Cumulative Visibility for Wind Farm Projects in 15km Radius of the Projects

WF Visibility	Area [ha]	Area [%]
Lebanon Wind Power only	30,222.2	20.0
Hawa Akkar only	3,964.8	2.6
Sustainable Akkar only	3,556.6	2.4
LWP + SA + HA	48,592.0	32.1
LWP + HA	1,531.3	1.0
LWP +SA	8,394.3	5.5
SA + HA	7,311.9	4.8

<u>Cumulative Effects on Visual Amenity</u>

Due to the large distance (12km) of the nearest turbine of the Hawa Akkar project to Lebanon Wind Power Project, the cumulative impacts between these two projects will be negligible. Therefore, the cumulative assessment rather focuses on the cumulative effects between Sustainable Akkar and Hawa Akkar as well as between Sustainable Akkar and Lebanon Wind Power.

The highest inter-visibility in the study area can be found at the small settlement El Rwaimeh which is located between the Project and the Sustainable Akkar wind farm. By erasing the turbines SA 26, SA 27 and SA 28 of the project the cumulative impact between the two wind farms was reduced. In addition, by eliminating the most northern turbines (SA 01) of the Project, the distance between the wind farms Hawa Akkar and Sustainable Akkar was increased, so that the two projects act more as individual projects rather than one large wind farm.

Due to the closer distance, El Rwaimeh will be more visually influenced by the Sustainable Akkar project than in combination by the Lebanon Wind Power wind farm. The viewpoint El Rwaimeh is located on an imaginary line between the two projects. Therefore, in the field of view of a potential observer only one of the two projects or even only one part of one project is visible at once. This also limits the cumulative impacts. In addition, trees and buildings will further reduce the cumulative visibility in the El Rwaimeh settlement.

In Qobaiyat all three wind farms will be visible in some areas: However, the cumulative visual impact is limited to views in southern and eastern directions and the Lebanon Wind Power wind farm will only appear at a very small scale due to the large distance (see visualization of the project together with the Sustainable Akkar project) and has no cumulative effects with the Sustainable Akkar wind farm.

Due to its different view directions the Lebanon Wind Power and the Hawa Akkar wind farm cannot be seen from viewpoints El Rwaimeh and Sahle in the same field of view together with the Sustainable Akkar wind farm. There is a small cumulative effect at the Aandqet viewpoint with the Hawa Akkar project in combination with the turbines of the Sustainable Akkar Project. However, due to the array of two projects, located on a ridge from north to south, both projects will usually not be seen in one field of view considering a potential observer located in Aandqet.

In total, the cumulative impacts of the Sustainable Akkar project in combination with the neighboring Hawa Akkar and Lebanon Wind Power Project on the relevant receptors are considered of slight to moderate significance.

Cumulative Effects on Landscape Units

Due to the mountainous topography there is hardly cumulative visibility in the southern part of the study area. Consequently, the northern part of the study area is assessed in detail in terms of cumulative impact.

The cumulative ZTV shows that the northern and the eastern part of the study area experience most of the cumulative impact. The contribution of the visual impact by Sustainable Akkar wind farm and Lebanon Wind Power is relatively low in this area due to the large distance of the turbines. Consequently, these turbines will only appear at a small scale. From some elevated and exposed areas in the northern part of the study area, the ZTV shows that turbines of all three projects can be seen. However, the largest areas of cumulative visibility in which all three projects will be seen together, will occur mostly in the lower elevated areas in Syria.

Effected by the visibility of the three wind farms are in particular the large landscape units; namely the forests, the scrublands, the agricultural areas as well as the urban areas. The visibility of the SA and LWP turbines in the northern part of the study area will be very limited due to the large distance of the turbines, so that they appear in a small scale. In addition, due to the wind park array, which is oriented from north to south, the SA and LWP turbines only take a very small percentage of the horizontal field of view (see the Ej Joumrok viewpoint for instance). Consequently, at the plain in the northern part of the study area the turbines of the Hawa Akkar project will have the main visual effect on the landscape. There are no significant cumulative impacts caused by the SA and the LWP project although the turbines will be visible at good weather conditions on a small scale. Therefore, there are no significant cumulative impacts within the northern plain of the study area, although the ZTVs indicates that a large number of turbines will be visible.

Due to the location of the three wind farms, orientated from north to south, cumulative impacts are very low and mainly occur in the small areas between the projects. However, in these areas the visibility of the project is reduced due to the topography. At the forest areas close to Aandqet there is a moderate cumulative effect caused by Hawa Akkar and the Sustainable Akkar wind farm on the landscape unit of the pine forest.

In total, there are no significant cumulative visual impacts on the discussed landscape units, as shown in **Table 21-15**.

Table 21-15 Cumulative Impact Visual Amenity and Landscape

		Sensitivity of Receptor				
		Low	Low-Medium√	Medium	Medium-High	High
Impact Severity	No Change√	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium√	Negligible	Minor√	Moderate	Moderate	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

The cumulative effects on the visual amenity were considered for each receptor in **Table 21-16** and **Table 21-17**.

Table 21-16 Cumulative Assessment of the Significance on Key Receptors

Receptor	Sensitivity	Cumulative Magnitude of change	Cumulative Significance
Qobaiyat Metraniyye	small	- Small- At this exposed viewpoint all three wind farms will be visible. However, due to the distance of more than 9 km the Lebanon Wind Power wind farm will only appear at a very small scale (see visualization of the Project together with the Sustainable Akkar project) Therefore, the LWP turbines will only contribute with a small amount to the cumulative visual impact at this viewpoint.	Slight
Al-Saifa Fortress Akkar el-Atiqa'a	High	-None- The ZTV and visualizations indicate that the Sustainable Akkar and the Hawa Akkar turbines will not be visible from the receptor. Therefore, the will not be any cumulative impacts.	Negligible
Qammouaah Plain	High	-None- The ZTV and visualizations indicate that the Sustainable Akkar and the Hawa Akkar turbines will not be visible from the Qammouaah Plain. Therefore, the will not be any cumulative impacts.	Negligible

Table 21-17 Cumulative Assessment of the Significance on Settlements

Receptor	Sensitivity	Magnitude of change	Significance
Jouar El Hachich	Medium	-Small - Most of the LWP turbines will be clearly visible in the west. However, the turbines will only be relatively small features in the landscape due to the distance of approx. 5 km to the planned wind farm. The turbines of the SA project are located about 4 km north of the receptor. Due to the location of the viewpoint at an altitude of 1,390 m, the highest turbines of the SA project (1,230 m) will be located about 160 m below the viewpoint and only cover a small part of the horizontal view due to the array of the SA wind farm (which is oriented from north to south). The Hawa Akkar turbines will not be visible.	Slight to Moderate
El Rweimeh	Medium	-Small to Medium- The turbines will be clearly visible. However, the LWP turbines will only be relatively small features in the landscape due to the distance of approximately 4 km to the planned wind farm. The WTGs of the southern part of the wind farm will appear even smaller due to the larger distance to the viewpoint Due to the closer distance, El Rweimeh will be much more visually influenced by the Sustainable Akkar project than by the Lebanon Wind Power wind farm. The viewpoint El Rweimeh is located on an imaginary line between the two projects. Therefore, in the field of view of a potential observer, only one of the two projects or even only one part of one project is visible at the same time. This limits the cumulative impacts. In addition, trees and buildings will further reduce the cumulative visibility in the El Rweimeh settlement. Consequently, there is only a minor contribution to the cumulative visual impact context by the LWP turbines.	Slight to Moderate

Receptor	Sensitivity	Magnitude of change	Significance
Qobaiyat Village	Medium - High	-Small- In Qobaiyat turbines of all three farms will be visible. However, the visual impact is limited to views in southern and eastern directions. The Lebanon Wind Power wind farm will only appear at a small scale due to the large distance of over 8 km to the closest WTG. Due to the wind park array of the LWP project stretching from north to south the turbines will also only cover a small percentage of the field of view from a potential observer located in the north of the project which will also reduce the cumulative visual impacts in the village Qobaiyat. Consequently, there is only a minor contribution to the cumulative visual impact context by the LWP turbines.	Slight
Akkar El-Atiqa'a village	Medium - High	-None- The ZTV and visualizations indicate that the Sustainable Akkar and the Hawa Akkar turbines will not be visible from the receptor. Therefore, the will not be any cumulative impacts.	Negligible
Es Sayeh village	Medium - High	-None- The ZTV and visualizations indicate that the Sustainable Akkar and the Hawa Akkar turbines will not be visible from the receptor. Therefore, the will not be any cumulative impacts.	Negligible
Fnaidek village	Medium - High	-None- The ZTV and visualizations indicate that the Sustainable Akkar and the Hawa Akkar turbines will not be visible from the receptor. Therefore, the will not be any cumulative impacts.	Negligible

The highest inter-visibility in the study area can be found at the small settlement El Rweimeh which is located between the Lebanon Wind Power wind farm and the Sustainable Akkar wind farm. By erasing the most northern WTGs 01-06 of the Project the cumulative impact between the two wind farms was reduced. In addition, by eliminating the most northern turbines of the Project, the distance between the two wind farms was increased, so that the two projects appear more as individual projects rather than one large wind farm.

Visualizations of the cumulative effect of all three wind farms from El Rweimeh and Jouar el Hachich were not considered. Due to its different view directions the Sustainable Akkar and the Hawa Akkar wind farms cannot be seen from these viewpoints in the same field of view together with the Lebanon Wind Power wind farm.

Due to the large distance (12 km) of the nearest turbine of the Hawa Akkar project, the cumulative impacts of this project on the relevant receptors of the Project are slight to negligible.

Mitigation Measures

The following mitigation measures have been addressed within the design to mitigate elements of potential visual impacts:

- A remote area was chosen for the wind farm.
- Large, multi-MW turbines with large rotor diameters are considered.
- The most northern turbines of the layout (WTGs 1-6) were eliminated.
- The wind farm layout was designed so that the array follows the existing landform of the mountain ridges.
- Tracks will be designed to follow the existing tracks and fit with contours as far as possible.
- The turbines and all the other aboveground structures will be removed at the end of the operational lifetime.
- The internal cabling should be underground cabling.

Effects of the Mitigation Measures

- By choosing a remote area for the project site the number of effected residential areas and sensitive receptors was reduced at a very early project stage.
- By using large, multi-MW turbines with large rotor diameters the number of turbines per generation capacity and the footprint of the Project will be reduced. In addition, large rotors have a reduced rotor speed compared to smaller turbines which will also reduce the visual impact of the project.
- The most northern turbines of the layout (WTGs 1-6) were eliminated to minimize visual impacts to receptors. In altering the wind farm array this way, the distance to potential visual receptors in the north of the site was increased. In addition, the distance to the wind energy project Sustainable Akkar was also increased so that cumulative impacts were reduced.
- By considering the landform of the mountain ridges at the wind fam design, the wind farm layout follows the existing morphology of the mountain. Consequently, the typological appearance of the ridge remains largely recognizable. In addition, the overlapping of rotors of views from the east and the west are unlikely which can be perceived as visually restless.
- By following the existing tracks and fitting the location of the tracks with the contours lines the visual impact of the tracks can be reduced.
- By removing the turbines and all the other aboveground structures at the end of the operational lifetime, the visual impact of the project will be entirely revisable and limited to the operation phase of the project.
- By designing the internal cabling as underground cabling the visual impact in the immediate surrounding was reduced.

Table 21-18 Visual Impact Assessment for Operation Phase

		Sensitivity of Receptor				
		Low	**Low-Medium**	**Medium**	**Medium-High √**	**High**
Impact Severity	No Change	Negligible	Negligible	Negligible	Negligible	Negligible
	Slight	Negligible	Negligible	Negligible	Minor	Minor
	Low	Negligible	Negligible	Minor	Minor	Moderate
	Medium √	Negligible	Minor	Moderate	**Moderate √**	Major
	High	Minor	Moderate	Moderate	Major	Major
	Very High	Moderate	Moderate	Moderate	Major	Critical

21.4 Summary

The Cumulative Impact Assessment was undertaken per the request of the MOE stipulated in Minister's Letter #14175 dated 19/12/2017 and in accordance with International Finance Corporation, Good Practice Handbook, Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets, 2013.

The Proponents for Lebanon Wind Power, Sustainable Akkar and Hawa Akkar and their contractors will be responsible for the implementation of the Environmental and Social Management Plan (ESMP) across all project phases to mitigate identified impacts. The purpose of this ESMP is to specify the standards and controls required to manage and monitor environmental, social and health and safety impacts of the Project during construction and operation phase in accordance with the applicable national legislation and regulations and lender standards. The health, safety and security aspects are included as a separate section of the ESMP. The specific objectives of this ESMP are as follows:

- Provide an institutional mechanism with well-defined roles and responsibilities for ensuring that measures identified in ESIA are implemented.
- Minimizing any adverse environmental, social and health and safety impacts resulting from the Project activities by implementing all suggested mitigation measures and control technologies, safeguards identified through the ESIA process.
- Prevent or compensate for any loss of the affected persons.
- Conducting all project activities in accordance with the relevant Lebanese Laws and the international guidelines.
- Prevent environmental degradation as a result of either individual subprojects or their cumulative effects.
- Enhance positive environmental and social outcomes.

- Ensure that the ESMP is feasible and cost-efficient.
- Provide a Project monitoring program for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and risk control systems in place.
- Ensure that all stakeholders concerns are addressed.

To achieve this, the ESMP identifies potential adverse impacts from the planned activities and outlines mitigation measures required to reduce the likely negative effects on the physical, natural and social environment, and manage health and safety risks. It provides an overview of the environmental and social baseline conditions of the Project's Area of Influence, summarizes the potential impacts associated with the proposed development works and sets out the management measures required to mitigate any potential impacts in a series of discipline specific ESMP sections. In the risk register completed for the project (see Section 6) the potential health, safety and security risks for the project have been assessed and control measures identified.

This ESMP is to be implemented by the Engineering, Procurement and Construction (EPC) Contractor to be commissioned by LWP for the Project. Implementation and management of certain plans, i.e. the Stakeholder Engagement Plan and Grievance Mechanism, will remain the responsibility of LWP. In addition, a Committee responsible for the follow up on environmental and social management at wind farms is proposed to be formed at the MOE. Finally, a grievance record and redress mechanism will be developed and implemented throughout all project phases.

22. SUMMARY OF ANTICIPATED IMPACTS

The Project will result in significant and positive environmental and economic impacts on the strategic and national level and are crucial given the current challenges the energy sector in Lebanon is facing. The Project will offer energy security as well as alleviate a source of major economic burden to the Lebanese economy.

Compared with the current conventional way of producing electricity in Lebanon through thermal power plants using heavy fuel oil and/or natural gas, generating electricity through wind power is expected to reduce consumption of fossil fuels, and will thus help in reducing greenhouse gas emissions, as well as air pollutant emissions. The Project will:

- Assist in solving the problem of electricity shortage on the local and national scales.
- Assist in achieving the commitment to 12% supply of energy through RE.
- Reduce GHG emissions since it will be displacing a largely fossil fuel-based electricity generating system.
- Save millions of cubic meters of water per year in comparison to an oil-burning power plant which utilizes water for cooling.

Anticipated environmental and social impacts on various receptors throughout the Project phases are summarized in **Table 22-1**.

Table 22-1 Summary of Anticipated Impacts

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
Climate and Climate Change	Construction	GHG Emissions	• The GHG emissions are considered offset by the beneficial impact of generating clean energy through the operation of the wind farm. • Since the EDL emission rate is 630 t CO2eq/GWh, the carbon payback period is 83 days.	Low	Medium	**Minor**
	Operations and Maintenance	Flood Risk	• The selected OEM/EPC Contractor, as part of the detailed design prepared for the Project, avoid locating any of the Project components within the buffer distances developed under the flood risk assessment to eliminate any risks for flood. • A detailed hydrological study must be undertaken to identify and determine the required engineering structures to be considered as part of the detailed design for new asphalt and gravel road segment and internal tracks (e.g. drainage structures, culverts).	Slight	Medium	**Negligible**
	Operations and Maintenance	Wildfire	• It is recommended that the selected OEM/EPC Contractor, as part of the detailed design prepared for the Project, avoid locating any of the Project components within the buffer distances (if any) developed for the Karm Chbat Nature Reserve. • The selected OEM/EPC Contractor must identify and determine the required fire detection and protection equipment to be considered as part of the detailed design.	Low	High	**Moderate**
Geology and Hydrology	Construction, Operations and Maintenance	Impacts from Improper Management of Waste Streams	Solid Waste Generation: • Coordinate with the appropriate Municipality or hire a competent private contractor for the collection of solid waste from the site to the municipal approved disposal area. • Prohibit fly-dumping of any solid waste to the land. • Distribute appropriate number of properly contained litter bins and containers properly marked as "Municipal Waste". • During construction, distribute a sufficient number of properly contained containers clearly marked as "Construction Waste" for the dumping and disposal of construction waste. Where possible, the OEM/EPC Contractor must seek ways to reduce construction waste by reusing materials (for example through recycling of concrete for road base course). • Implement proper housekeeping practices on the construction site at all times. • Maintain records and manifests that indicate volume of waste generated onsite, collected by contractor, and disposed of at the landfill. The numbers within the records are to be consistent to ensure no illegal dumping at the site or other areas. Wastewater Generation: • Coordinate with Akkar Water Directorate to hire a private contractor for the collection of wastewater from the site to the appropriate WWTP. • Prohibit illegal disposal of wastewater to the land. • Maintain records and manifests that indicate volume of wastewater generated onsite, collected by contractor, and disposed of at the WWTP. The numbers within the records are to be consistent to ensure no illegal discharge at the site or other areas. • Ensure that constructed septic tanks during construction and those to be used during operation are well contained and impermeable to prevent leakage of wastewater into soil. • Ensure that septic tanks are emptied and collected by wastewater contractor at appropriate intervals to avoid overflowing.	Low	High	**Moderate**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			Hazardous Waste Generation: • Coordinate with the MOE and hire a private contractor for the collection of hazardous waste from the site to a hazardous waste treatment facility. • Follow the requirements for management and storage as per hazardous waste management and handling of the MOE. • Prohibit illegal disposal of hazardous waste to the land. • Ensure that containers are emptied and collected by the contractor at appropriate intervals to prevent overflowing. • Maintain records and manifests that indicate volume of hazardous waste generated onsite, collected by contractor, and disposed of at a hazardous waste treatment facility. The numbers within the records are to be consistent to ensure no illegal discharge at the site or other areas. Hazardous Materials: • Ensure that hazardous materials are stored in proper areas and in a location where they cannot reach the land in case of accidental spillage. This includes storage facilities that are of hard impermeable surface, flame-proof, accessible to authorized personnel only, locked when not in use, and prevents incompatible materials from coming in contact with one another. • Maintain a register of all hazardous materials used and accompanying Material Safety Data Sheet (MSDS) must present at all times. Spilled material should be tracked and accounted for. • Incorporate dripping pans at machinery, equipment, and areas that are prone to contamination by leakage of hazardous materials (such as oil, fuel, etc.). • Regular maintenance of all equipment and machinery used onsite. Maintenance activities and other activities that pose a risk for hazardous material spillage (such as refuelling) must take place at a suitable location (hard surface) with appropriate measures for trapping spilled material. • Ensure that a minimum of 1,000 litres of general-purpose spill absorbent is available at hazardous material storage facility. Appropriate absorbents include elite, clay, peat and other products manufactured for this purpose. • If spillage on soil occurs, spill must be immediately contained, cleaned-up, and contaminated soil disposed as hazardous waste.			
		Impacts on Water Resources	• The anticipated impacts on the local water resources and utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operation phase. Such impacts are expected to be of low magnitude and of low sensitivity given the minimal water requirements of the Project. • The selected OEM/EPC Contractor should coordinate with the Akkar Water Directorate to secure the water requirements of the Project			
		Impacts on Wastewater Disposal Utilities	• The anticipated impacts on wastewater utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operation phase. Such impacts are expected to be of low magnitude given the minimal wastewater quantities generated, and of low sensitivity as they will be easily handled. • There are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must coordinate with the Akkar Water Directorate to obtain list of authorized contractors for disposal of wastewater.			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
		Impacts on Solid Waste Disposal Utilities	• The anticipated impacts on solid waste utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operations and maintenance phase. Such impacts are expected to be of low magnitude given the minimal solid waste quantities generated, and of low sensitivity as they will be easily handled by the landfill. • Given the above impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must: - Undertake discussions with the appropriate municipal landfills to determine where there is sufficient capacity to easily handle construction debris generated from the Project. - Coordinate with the appropriate municipality or hire a competent private contractor for the collection of construction waste from the site to the approved landfill. - Coordinate with the appropriate municipality or hire a competent private contractor for the collection of solid waste from the site to the approved landfill.			
		Impacts on Hazardous Waste Disposal Utilities	• The anticipated impacts on hazardous waste utilities are considered of short-term duration during the Project construction phase and of long-term duration during the operations and maintenance phase. Such impacts are expected to be of low magnitude given the minimal hazardous waste quantities generated, and of low sensitivity as they will be easily handled appropriately by the X Hazardous Waste Treatment Facility. • The impact is considered not significant. As such, there are no mitigation measures to be applied. However, the selected OEM/EPC Contractor must coordinate with the MOE to hire a competent private contractor for the collection of hazardous waste from the site and disposal at a hazardous waste treatment facility.			
Geophysical Ground and Seismicity	Construction, Operations and Maintenance	Landslide, Slope Stability, Earthquake	• Ground stability problems are not expected due to high resistance values and safe carrying power values evidenced by the seismic measurements. • During detailed design, the OEM/EPC Contractor will incorporate the recommendations of the seismic study for excavation at the platform foundation locations to a depth where stable soils are encountered.	Slight	Medium	**Negligible**
Air Quality	Construction and Decommissioning	Impact of Particulate Matter	• Use of wind screens or enclosures around dusty activities or the site boundary. Mojave Desert Air Quality Management District assumes that complete coverage by wind screens (on the windward side) will provide a control efficiency of 75 percent. • Water spray is also used to reduce fugitive dust as it increases the moisture content of the material. Therefore, and according to Mojave Desert too, Water spray (Application point) will ensure a control efficiency of 75%. This is very useful for exaction for example. • For unpaved roads, water flushing is the essential with 0.48 gallons per square yard twice per day to maintain a control efficiency above 50%. • For paved roads, water flushing with 0.48 gallons per square yard followed by sweeping is very effective and can reach 96%. If conducted directly before the passage of the turbines convoy or the morning and evening passages of the project vehicles to and from the site, a consequent decrease will occur. • A combination of the different above-mentioned measures will give a higher control efficiency that when applied individually.	Low	Medium	**Minor**
Transport and Traffic	Construction	Obstacle Removal	• An additional route survey will be undertaken once the OEM/EPC Contractor is selected. • The temporary removal of concrete bund, curb, electric pole and overhead cable, and demolition of the 45m of concrete wall be coordinated with the Port Authority.	Slight	Medium	**Negligible**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• Raising of pedestrian bridges, prohibition of car parking, removal of curbs, electric poles, trees, lamp posts, and fencing at ramps and roundabouts and ground leveling and compaction of significant curves will be coordinated with the Ministry of Transport. • Asphalt speed bumps will be replaced with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass. • Any modification required for the Al Abdeh roundabout will be discussed with the municipality as it is under their authority. • Such works will be coordinated and permitted by the Project Proponent and the Ministry of Transport and scheduled for time periods when traffic levels and/or pedestrian use are lowest.			
	Construction	New Road Development	• The construction of asphalt roads will occur for a period of 6 months and will be coordinated and permitted by Ministry of Transport and scheduled for time periods when traffic levels are lowest. • Construction of internal track will occur for a period of 3 months and will be coordinated with the Ministry of Transport and the Lebanese Army.	Low	Medium	**Minor**
	Construction	Transport of WTG Components, Construction Materials and Workers	• A communications protocol being developed for the transport of WTG components will be distributed to all Mayors two to three months prior to the start of transport. A final transport route map will be provided to all municipalities. • All three wind farms will use the same traffic access plan. • Announcements will be made to all villages along the WTG transport route from the Tripoli Port to the entrance of the Project site). • WTG components will be transported 2 days per week, a total of 22 trucks roundtrip per week. • Municipal police will provide an escort for the WTG transport convoy. • Transport will be timed before and after farmers take their crops to the Akkar Vegetable Market. • The road that passes through El Rweimeh Village is the main access of the trucks transporting rocks and gravel, and maintenance activities will be undertaken by the Project Proponent. • For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road. • For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic. • Once the EPC Contractor has been selected, and the number and location of construction numbers are known, measures will be put in place to maximize mitigation of traffic impacts through carpooling and group transport by van.	Low	Medium	**Minor**
Biodiversity	Construction, Operations and Maintenance, Decommissioning	Total Habitat Loss: • Approximately 67 ha out of 6,567 ha (1%). Karm Chbat Nature Reserve Loss: • 18 ha out of 473 ha within Karm Chbat.	Pre-Construction: • Completion of a pre-construction flora survey to identify habitats and key flora species as identified in the baseline section and prepare accurate habitat mapping. • Completion of pre-construction survey to identify all Cilician firs on site and subsequent micrositing of infrastructure to avoid or reduce their removal. Where this is not possible, appropriate offsetting of the loss of Cilician firs within those areas will be completed. The full range of potential measures from translocation of trees to creation of new areas of Cilician fir dominated woodland will be considered.			**Not Ecologically Significant**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
		Abies sp. Forest Loss: • 0.3 ha (≤3%) of the total area within the mid-zone. Endangered IPA Species: • 8 ha of the total area of Sparse Coniferous Forest; • 16ha of the total area of Shrubland. • 12ha of the total area of Rocky Land.	• Preparation of a Critical and Natural Habitat Assessment (CHA). An initial CHA has been prepared which identified the potential critical habitat on the Project site and surrounding area and outlined the requirement for further iteration(s) as further data were available. The CHA update is in preparation for inclusion with a future iteration of the ESIA. • Preparation of a BAP outlining the measures required to deliver a net gain for any areas of critical habitat. A draft BAP will be prepared following the completion of the CHA update. Construction: • Preparation and provision of workforce toolbox talks and monitoring to ensure all staff understand the importance of the biodiversity controls in place, exactly what they entail and are found to be following those controls. Particular key early tasks in workforce education will include implementation of a hunting ban on the Project site and prohibition of burning of vegetation for warmth or cooking. • Minimization of the project footprint within Karm Chbat Nature Reserve and total avoidance of the Upper Mountains of Akkar-Donnieh IBA. Footprint minimization will include measures such as adherence to strict working boundaries for all infrastructure construction. • If any key flora species are present, areas of habitat inhabited by the plants should be avoided. If it is not possible to avoid examples or areas of the species listed previously, every effort should be made to reduce the impact and further offsetting would be required. Implementation of rehabilitation measures to mitigate the loss of habitat, such as vegetation remediation, translocation or creation of new habitat areas. • Proper management of excavation materials. Separation and storage of top soil for use in restoration of all temporary project infrastructure and areas of temporary disturbance, e.g. track margins. Segregation of the topsoil of different habitat types will be required. • Soil management would also include observance of appropriate biosecurity controls to prevent the spread of invasive plants or floral diseases. This would involve washing vehicles and equipment to remove particles of vegetation and loose soil, with this done is specific “wash down” areas. Any invasive plants that are removed during vegetation clearance would need to be disposed of appropriately, in a safe way that does not allow it to spread. • A presumption for avoidance of all artificial light as far as possible. All lights should be cowled and downward facing and avoid light spill onto surrounding non-construction areas. • Removal of all vegetation to be felled or cleared outside of the bird breeding season (March-August) or removal during that period only after a check by an ornithologist to ensure that no nesting birds are present. • Burial of all on-site electrical cabling to avoid potential collision risk for birds. • Installation of guy rope markers on any new met-masts to reduce potential collision risk for birds. • Enclosed, segregated waste disposal to avoid attracting scavenging birds to the site. • Good construction environmental management on site based on best practice guidance to avoid spillage of fuels, other pollutants or excavated materials and provision of sufficient spill kits and similar to deal with any incidents. During Operations and Maintenance: • Monitoring of all habitat reinstatement, translocation, recreation, offsetting or enhancement as identified and implemented as required following pre-construction surveys.			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• If found to be present during pre-construction surveys, monitoring of populations of endangered reptiles as appropriate, including monitoring of any offsets or enhancements for those species. • Remove invasive plant species during routine vegetation maintenance. • Monitor power-line right-of-way vegetation to avoid fire risk. Remove blowdown and other high-hazard fuel accumulations. During Decommissioning • Typically, the same controls set out for construction would apply. • Minimization of activities within Karm Chbat Nature Reserve and total avoidance of the Upper Mountains of Akkar-Donnieh IBA. Footprint minimization will include measures such adherence to strict working boundaries for all infrastructure decommissioning. • Enclosed, segregated waste disposal to avoid attracting scavenging birds to the site. • Good construction environmental management on site based on best practice guidance to avoid spillage of fuels, other pollutants or excavated materials and provision of sufficient spill kits and similar to deal with any incidents. • Preparation and provision of workforce toolbox talks to ensure all staff understand the importance of the biodiversity controls in place and exactly what they entail.			
	Pre-Construction, Construction	Terrestrial Fauna: Loss or Disturbance of Resting Places	• Completion of pre-construction fauna walkover survey to identify potential habitat for key mammal and reptile species, followed by camera trapping to confirm species considered to be present/status of any dens found. • Completion of pre-construction bat survey to identify bat activity on the Project site. • Preparation and subsequent implementation of plan to identify and protect key bat roost caves in the area on and around the Project site from human persecution, such as identified elsewhere in the area. • Preparation of a final BMP setting out the measures required based upon the findings of the further surveys. A draft BMP is in preparation for inclusion with a future iteration of the ESIA.			
Bats	Construction, Decommissioning	Loss or Disturbance of Roosts and Foraging Habitat	• Assuming a likely worst-case scenario that the roost present is of national importance, the impact would be near certain to result in a significant ecological effect. Impacts associated with disturbance of a roost rather than loss of the roost would be similar but likely to be of moderate or low magnitude depending on the type of impact. A disturbance impact would occur as a result of construction noise, construction light or habitat alteration in the vicinity of the roost and could result in an ecologically significant effect. • Assuming a worst-case scenario that the population(s) of bats using the foraging habitat is (are) of national importance, the impact would result in a significant ecological effect. Impacts associated with temporary loss of a foraging area, e.g. temporary construction infrastructure upon areas of sparse herbaceous vegetation, rather than the permanent loss of the foraging area would be similar but likely to be of moderate or low magnitude. It is considered possible that it could result in an ecologically significant effect. • Development of an operational wind farm survey scope for bats. The level of activity of bats is unknown on the Project site, similarly it is unknown if, as seems likely, activity is lower in the highest parts of the Project site which are sparsely vegetated and provide limited opportunities for bat species.			**Moderate**
	Operations and	Collision Risk	• Whilst it is not possible to conclude that there will not be ecologically significant effects on any of the bat species likely to be present, based on the habitats and wind speeds across much of the			**Not Ecologically**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
	Maintenance		Project site, it is considered unlikely that bats would be present other only occasionally. • However, it is considered that the impact of collision risk is reversible, i.e. mitigation measures are possible which would avoid or reduce the impacts and ensure that even if any residual effects occur, they would not be significant. • Once the pre-construction survey results have been analyzed, it will be possible to develop an appropriately focused scope of operational period bat surveys. Surveys would cover up to three years' activity periods. • Monitoring of bat collision fatalities under and around each turbine following a standardized methodology potentially using trained dogs. Monitoring to be completed monthly and concurrently with bird collision monitoring. • Preparation and subsequent implementation of plan to identify and protect key bat roost caves in the area on and around the Project site from human persecution, such as identified elsewhere in the area.			**Significant**
Ornithology	Construction, Decommissioning	Designated Sites	• The IBA lists soaring birds and cranes (namely white stork, white pelican, Levant sparrowhawk and common crane) as another key feature. Those species have not been recorded on the Project site during field surveys, they pass through the area on migration. As such, potential construction impacts would be limited to disturbance such as noise and light, from construction activities. • Repetition of the migratory period VPs ensuring that the 36 hours per season standard is met. To be completed for three years after the start of operation and commence at the first migratory period after start of operation, regardless of whether it is the spring or autumn period. • Monitoring of bird collision fatalities under and around each turbine following a standardized methodology potentially using trained dogs. Monitoring to be completed monthly between November and February and in June and July, i.e. outside of the migration periods. Completed weekly during spring migration period of March to May and August to October. Project specific monitoring protocol to be prepared based on best practice guidance. • This study has not identified a need to shut down turbines on site during the bird migration seasons. However, if it were identified to be necessary based on the results of collision fatality monitoring or as a requirement of the as yet unpublished Lebanese Ministry of the Environment guidance on wind turbine shut down to avoid bird collisions, some or all turbines will be shut down as appropriate and proportionate to identified confirmed or potential impacts. • Related to the previous action, the project will consider the installation of bird monitoring radar to inform all shutdown related activities. • Strict enforcement of hunting ban on Project site. • Avoid artificial light where possible. White steady lights attract prey and their predators. Use red or white blinking or pulsing lights instead. • Enclosed, segregated waste disposal to avoid attracting birds to predictable food sources.			**Not Ecologically Significant**
		Habitat Loss	• Both temporary and permanent habitat loss are predicted as a result of the construction of the proposed development. Permanent loss would occur in the footprint of the infrastructure of the proposed development and from the construction of new permanent access tracks. Temporary, short-term habitat loss would occur at turbine bases, outside of the permanent hard-standing and from the construction of new temporary access tracks that would be reinstated after construction. • Mitigation for habitat loss is as presented above for Biodiversity.			
		Nest Destruction	• Vegetation removal outwith the breeding season.			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• Pre-clearance surveys to identify nesting locations if vegetation removal occurs during the breeding season.			
		Disturbance and Displacement	• Disturbance of small breeding birds found on site as a result of construction activities would be an adverse, low magnitude, short-term impact on a community of birds considered to have local importance.			
	Operations and Maintenance	Collision Risk to birds flying at collision risk height: • Common buzzard. • Eurasian sparrowhawk. • Honey buzzard. • Common kestrel. • Lesser Spotted Eagle. • Levant Sparrowhawk. • Short-toed snake eagle. • Steppe buzzard.	• None			
		Disturbance and Displacement: • Common kestrel • Short-toed snake eagle	• Both species could be displaced from the immediate zone during the operation of the proposed development. • Disturbance from the presence of construction workers and vehicles and from visual and noise disturbance from the turbines could cause both species to forage away from the site. • This would result in an adverse, low magnitude, long-term, impact on both species.			
		Barrier Effects	• The proposed development may result in a barrier effect on the movement of bird species with the vertical configuration of turbines creating an actual or perceived barrier which bird species may not cross or would need to habituate to crossing. • Such adverse impacts would be of low magnitude to the species inhabiting the immediate zone but potentially of moderate magnitude to any species that might use the area around the Project site for migration.			
Socioeconomic Conditions	Construction, Decommissioning	Positive Impacts: • The potential for the consistent provision of electricity to meet demand. • Economic benefits from the expected sourcing of construction materials from the Akkar region. • Economic benefits from the sourcing of Project personnel	• Landowners have agreed that the compensation provided is appropriate and fair, though the Project represents a loss of access to 137,004m^2 will be leased for the Project for 28 years, and 3,500m^2 will be acquired permanently. • Shepherds grazing near the Project will be advised of exclusion zones in advance, noting that other grazing areas are available. • Recreational hunters near the Project will be advised of exclusion zones in advance, noting that other tracks are available, and hunting is for recreational purposes, i.e. not subsistence. • Advance notification of transport schedule and health, safety and security measures (refer to **Community Health, Safety and Security**). • Additional measures to communicate the Project information to vulnerable groups including women, the elderly and informal settlements, including the provision of schedules, health, safety and security measures.	Low	Medium-High	**Minor**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
		from the northeastern part of Akkar. • Economic benefit from income that may be generated by nearby businesses including hotels and restaurants. • Land lease / acquisition for 28 years. Negative Impacts: • Land lease / acquisition for 28 years. • Temporary loss of access by shepherds to 0.40km^2 of grazing areas. • Temporary loss of access to tracks by recreational bird hunters. • Potential impacts to vulnerable groups, including women, the elderly and informal settlements. • The potential to overwhelm businesses in the Project area by the influx of workers.	• Establishment of the CRO Office in Jabal-Akroum Kfartoun. • Community development projects as agreed between Municipalities and the Developer.			
	Operations and Maintenance	• Reduced cost of provision of power to residents. • Boosting of the local economy. • Enhancing infrastructure such as roads and transportation.	• None.	No change.	Medium-High	**Positive**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
		• Cleaner environment. • Improved quality of life. • Economic growth.				
Community Health, Safety and Security	Construction, Decommissioning	Noise	• Limit the working hours from Monday to Friday 7 a.m. to 7 p.m., if possible. Some flexibility in working hours may be required during the delivery and erection of turbines and depending on weather conditions. • The final time schedule of the transport movements should be clarified with the authorities and communities. Only well-maintained equipment should be operated on-site.	Slight	Medium-High	**Negligible**
	Operations and Maintenance		• The distance of the WTGs to nearby receptors was increased by eliminating the originally planned WTGs 01-06; consequently, operating the turbines in a noise reduced mode is not required. • The WTGs will be maintained regularly to ensure that the turbines do not become louder over time. • If it would become necessary for any unknown reason to reduce the noise output of the wind farm, all turbine types under consideration offer the possibility to be operated in a noise-optimized mode. While the power output would be reduced, this measure would allow the reduction of the sound power levels once the wind farm is in operation.	Low	Medium-High	**Minor**
	Operations and Maintenance	Shadow Flicker	• The installation of shadow flicker shutdown modules in the turbines is a very common and an often-applied mitigation measure. Shutdown modules will eliminate the possibility for exceedances of annual and day limits. An automatic shadow-flicker shutdown system shuts down the WTG when the sun is shining (direct sunshine on a horizontal area > 120 W/m²). These systems shut down a turbine when one of two conditions are reached: - More than 30 minutes of shadow-flicker occur on one day at a receptor. - The maximum annual quota of shadow-flicker at a receptor is exceeded. • When shutdown systems feature a radiation sensor, the turbines only shut down when the sun is shining. If the shadow-flicker shutdown system does not include a radiation detector, the WTG will shut down at all times when the shadow-flicker assessment indicates shadow-flicker at a receptor (i.e. also in cases of overcast sky or fog when there is actually no shadow flicker). • The use of shadow flicker shutdown modules will have a (small) negative effect on the energy yield of the wind farm.	Slight	High	**Minor**
	Operations and Maintenance	Visual Amenity in Settlements	• Jouar El Hachich – no mitigation.	Small to Medium	Medium	**Slight to Moderate**
			• El Rweimeh Village – no mitigation.	Small to Medium	Medium	**Slight to Moderate**
			• Qobaiyat Village – no mitigation.	Small	Medium-High	**Slight to Moderate**
			• Akkar El-Atiqa'a Village – no mitigation.	Small	Medium-High	**Slight-Moderate**
			• Es Sayeh Village – no mitigation.	Small	Medium-High	**Slight-Moderate**
			• Fnaidek Village – no mitigation.	Medium	Medium-High	**Moderate-Substantial**
		Visual Amenity from Key Viewpoints	• Qobaiyat Metraniyye – no mitigation.	Small	Low	**Slight-Negligible**
			• Al-Saifa Fortress Akkar el-Atiqa'a – no mitigation.	None	High	**Negligible**
			• Qammouaah Plain – no mitigation.	Small	Medium-High	**Moderate**

<table>
<tr><th>Resource</th><th>Phase</th><th>Impact</th><th>Mitigation</th><th>Impact Significance</th><th>Sensitivity of Receptor</th><th>Residual Impact Significance</th></tr>
<tr><td rowspan="6"></td><td rowspan="6">Construction, Decommissioning</td><td>Transport and Traffic: Obstacle Removal</td><td>The temporary removal of concrete bund, curb, electric pole and overhead cable, and demolition of the 45m of concrete wall be coordinated with the Port Authority.
Raising of pedestrian bridges, prohibition of car parking, removal of curbs, electric poles, trees, lamp posts, and fencing at ramps and roundabouts and ground leveling and compaction of significant curves will be coordinated with the Ministry of Transport.
Asphalt speed bumps will be replaced with rubber ones, which we can easily be removed during the transportation of the WTG components and reinstalled immediately after the trucks pass.
Any modification required for the Al Abdeh roundabout will be discussed with the municipality as it is under their authority.
Such works will be coordinated and permitted by the Developer and the Ministry of Transport and scheduled for time periods when traffic levels and/or pedestrian use are lowest.</td><td>Low</td><td>Medium</td><td>Minor</td></tr>
<tr><td>Transport and Traffic: Construction of New Road Segments</td><td>The construction of asphalt and gravel roads will occur for a period of 6 months and will be coordinated and permitted by Ministry of Transport and scheduled for time periods when traffic levels are lowest. The construction would be performed under the supervision and conditions of the relevant municipality.
The improved road network will have a positive impact on the health and safety in the area by providing safer roads, minimizing impacts to city centers, providing greater buffer distances between houses and the road and eliminating dangerous curves/turns.</td><td>Low</td><td>Medium</td><td>Minor</td></tr>
<tr><td>Transport and Traffic: Construction of Internal Track</td><td>Construction of internal track will occur for a period of 3 months and will be coordinated with the Ministry of Transport and the Lebanese Army.
Occupational health and safety rules, codes and regulations will be followed during works.
The OEM/EPC Contractor will be supervised by and accountable to the Developer.</td><td>Slight</td><td>Medium</td><td>Negligible</td></tr>
<tr><td>Transport and Traffic: Transport of WTG Components</td><td rowspan="3">IN ADDITION, SOCIOECONOMIC DATA FOR VILLAGES ALONG THE TRANSPORT CORRIDOR, AS PROVIDED BY STATISTICS LEBANON, HAS NOT YET BEEN INCLUDED. THIS INFORMATION WILL BE USED TO FOCUS AND STREAMLINE THE BASELINE FINDINGS PRESENTED IN THIS SECTION, WHEN ADDED TO THE FINAL VERSION OF THE ESIA, TO SUPPORT OR DISPROVE THE ASSESSMENT OF IMPACTS.
The transport of WTG components will occur between 12am and 4am to avoid impacts to communities traveling to work and school.
Municipal police will provide end-to-end escort for the transport convoy.
Advance notification of the scheduled transport will be provided to all communities along the route.
The trucks will travel at a low speed to lessen the generation of noise, vibration and dust.
A communications protocol being developed for the transport of WTG components will be distributed to all Mayors two to three months prior to the start of transport. A final transport route map will be provided to all municipalities.
Transport will be timed before and after farmers take their crops to the Akkar Vegetable Market.
For Road Segments A, B, C and D, which are 4 lanes with a median, a conservative approach to traffic management will dedicate the northbound direction for transport and divert all other background traffic to the other direction making a two-lane road.
For Road Segment E, which is a two-lane road, the transport vehicles will have to utilize the road along with the background traffic.</td><td>Low</td><td>Medium</td><td>Minor</td></tr>
<tr><td>Transport and Traffic: Impacts to Communities Along the Transport Corridor</td><td>Low</td><td>Medium</td><td>Minor</td></tr>
<tr><td>Transport and Traffic: Impacts to Informal Settlements Along the Transport Corridor</td><td>Slight</td><td>Medium-High</td><td>Minor</td></tr>
</table>

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
		Transport and Traffic: Transport of Construction Materials	• The Developer will meet with Rweimeh Village residents of the houses located along the quarry tracks and existing asphalt roads to discuss the Project and nature and timing of the transport of construction materials. • Advance notification of the start of construction will be provided. • The trucks will travel at a low speed to lessen the generation of noise, vibration and dust. • Occupational health and safety rules, codes and regulations will be followed during works. • Negotiation of entry to quarry roads by resident vehicles will follow standard traffic safety/traffic control protocols, i.e. Stop/Go signage, flagman, etc. • The OEM/EPC Contractor will be supervised by and accountable to the Developer.	Medium	Medium-High	**Moderate**
	Operations	Transport of Workers	• None	Slight	Medium-High	**Negligible**
Landscape	Operations	Visual Impacts to Landscape	• Large, multi-MW turbines with large rotor diameters are considered. By using large, multi-MW turbines with large rotor diameters the number of turbines per generation capacity and the footprint of the Project will be reduced. In addition, large rotors have a reduced rotor speed compared to smaller turbines which will also reduce the visual impact of the Project. • The most northern turbines of the layout (WTGs 1-6) were eliminated to minimize landscape impacts. In addition, the distance to the wind energy project Sustainable Akkar was also increased so that cumulative impacts were reduced. • The wind farm layout was designed so that the array follows the existing landform of the mountain ridges. By considering the landform of the mountain ridges at the wind fam design, the wind farm layout follows the existing morphology of the mountain. Consequently, the typological appearance of the ridge remains largely recognizable. In addition, the overlapping of rotors of views from the east and the west are unlikely which can be perceived as visually restless. • Tracks will be designed to follow the existing tracks and fit with contours as far as possible. By following the existing tracks and fitting the location of the tracks with the contours lines the landscape impact of the tracks can be reduced. • The turbines and all the other aboveground structures will be removed at the end of the operational lifetime. By removing the turbines and all the other aboveground structures at the end of the operational lifetime, the landscape impact of the project will be entirely revisable and limited to the operation phase of the project. • The internal cabling should be underground cabling. By designing the internal cabling as underground cabling the landscape impact in the immediate surrounding was reduced.	Medium	Low-Medium	**Minor**
Archaeology and Cultural Heritage	Construction, Decommissioning	Buried Artifacts	Though the potential for impact is considered low, a Chance Finds Procedure has been developed (in accordance with guidance provided by the Ministry of Culture and the General Directorate of Antiquities) to appropriately respond to cultural resources encountered during construction, as follows: Where historical remains, antiquity or any other object of cultural or archaeological importance are unexpectedly discovered during construction in an area not previously known for its archaeological interest, the following procedures should be applied: 1. Stop construction activities. 2. Delineate the discovered site area. 3. Secure the site to prevent any damage or loss of removable objects. In case of removable antiquities or sensitive remains, a night guard should be present until the Responsible Authorities takes over.	Slight	High	**Minor**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			4. Notify the responsible foreman/archaeologist, who in turn shall notify the Responsible Authorities, the General Directorate of Antiquities and local authorities (within less than 24 hours). 5. The Responsible Authorities will be in control of protecting and preserving the site before deciding on the proper procedures to be carried out. 6. An evaluation of the finding will be performed by the General Directorate of Antiquities. The significance and importance of the findings will be assessed according to various criteria relevant to cultural heritage including aesthetic, historic, scientific or research, social and economic values. 7. The decision on how to handle the finding will be reached based on the above assessment and could include changes in the Project layout (in case of finding an irrevocable remain of cultural or archaeological importance), conservation, preservation, restoration or salvage. 8. The Responsible Authorities' decision concerning the management of the finding shall be implemented fully. 9. Construction work could resume only when permission is given from the Responsible Authorities after the decision concerning the safeguard of the heritage is fully executed. The Chance Finds Procedure has been included in the stand-alone ESMP.			
		Eco-Tourism at Karm Chbat Nature Reserve	• During the construction phase, access to certain portions of the 5.13M m^2 Karm Chbat Nature Reserve will be limited to ensure the health and safety of visitors.	Low	Medium	**Minor**
Occupational Health & Safety	Construction, Decommissioning	Impacts to Workers	*Air Quality* • Covering loads of dusty or excavated materials on a vehicle entering or leaving the construction site with impervious sheeting (such as nylon canvas). • Undertaking proper enclosure and guarding to limit public access to the site. • Drivers and workers in the vicinity of earth moving equipment would be supplied with ear mufflers, as well as goggles and nose masks, if necessary, in order to protect them from dust impacts. • Water spraying at the excavation sites prior to, during and after excavation to limit airborne particles. • Proper unloading of materials on-site to minimize dust. • Limiting the use of heavy equipment during periods of high winds. • Forbidding construction vehicles from keeping engines running (waiting to enter site or on-site). • Adopting weight limits for trucks and not exceeding vehicle loading capacity. • Ensuring adequate maintenance and repair of construction machinery. • Maintaining good housekeeping practices; and effective operational and waste management practices. • Implementing H&S measures (masks, work gloves, proper clothing, H&S rules) as needed. • Providing suitable rehabilitation and maintenance of road network surfaces to ease traffic flow. • Using environmentally friendly equipment with higher fuel efficiency or air pollution control. • Maintaining and operating equipment using appropriate fuel mixtures. • Enforcing speed limits for vehicles and maintaining normal traffic speed on-site and recommended traffic speed and driving time on the roads. • Applying dust suppression methods such as watering at access and internal roads. • Adopting good house-keeping measures to reduce dust build-up. • Maintaining stockpiles at minimum heights and forming long-term stockpiles into the optimum	Low	High	**Moderate**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			shape (i.e. stabilization) to reduce wind erosion. • Avoiding open burning of solid waste. • Enclosing the construction site with a dust mesh, as applicable. • Carrying out loading and unloading of material without scattering. • Covering access roads and internal roads with plant mix. • Washing construction vehicles leaving site to prevent transmission of soil. • Keeping drop height of materials that have potential to generate dust at a minimum. • Using well-maintained vehicles and ensuring regular maintenance of these vehicles. • Collecting and addressing complaints and suggestions through grievance mechanism. *Water and Soil Resources Protection* • Awareness on the efficient use of water. • Minimizing water and soil exposure. • Minimizing and if possible eliminating chemical usage (oil, lubricants and fuel) onsite. • Using as much as possible non-toxic and biodegradable chemicals to be stored on-site. • Reporting in case of spills from generator or disposed waste on-site in order to seek immediate remedial measures. • Routine inspection and maintenance of equipment to ensure that risk of leak/spill is minimized. • Promotion of good housekeeping during operation and maintenance. • Control and supervision of refueling at all times by appropriate personnel. • Development and implementation of training program for management of hazardous substances. • Temporarily store hazardous waste on-site in a designated and enclosed area. • Forbidding hazardous waste storage outside designated area. • Ensuring that oil changes, refueling, or lubrication of vehicles will be conducted offsite or in a dedicated area. • Equipping fuel storage tanks with drip trays and spill control equipment. • In case of spills, hazardous materials would be controlled via absorbents, and contaminated soil would be removed and disposed of in compliance with applicable legislation. *Topsoil Management* • Strip topsoil from project footprint (turbine bases and platform) at suitable depths and store separately at specialized areas. • Minimize topsoil losses via use of suitable equipment, procedures and construction work schedule -avoid soil disturbance during heavy windy and rainy periods. • Identify topsoil storage areas at relatively low slope areas. • Ensure that top soil stockpiles do not exceed 2m in height. • Ensure that only soil material will be stored at topsoil storage areas. • Maintain slope stability and a safe working environment for heavy construction vehicles. • Ensure that surface grading is done with appropriate vehicles to avoid soil compaction. • Enclose topsoil storage area(s) with fencing and place explanatory signboards • Ensure drainage of temporary topsoil site(s). • Within completed construction areas (turbine bases and platforms), reuse stored top soil for rehabilitation and landscaping.			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• Do not use vegetative soil or topsoil as fill material under any circumstances. • Ensure unnecessary soil stripping to minimize disturbance to vegetation, ecosystems and soils. *Noise and Vibration* • Choosing equipment with lower sound power levels when possible. • Using noise mufflers, and minimizing machinery or equipment idling conditions. • Optimizing internal-traffic routing to minimize vehicle reversing needs and maximize distances from closest sensitive receptors. • Keeping the main access road in well-maintained condition. • Ensuring mobile vehicles use only designated roads to reduce traffic through community areas • Proper site logistics and planning. • Performing proper maintenance on construction vehicles and equipment. • Limiting site working hours if possible. • Conducting construction activities closest to noise sensitive receptors during day time only. • Informing local municipalities and residents of the construction schedule and time of planned noisy activities. • Informing noise sensitive receptors about construction schedule in their proximity in advance. • Scheduling potentially noisier activities during daytime and/or less intrusive times. • Conducting noise monitoring during construction to verify compliance with regulatory limits. • Keeping equipment speed as low as feasibly possible without compromising performance. • Collecting and addressing complaints and suggestions through grievance mechanism. *Solid Waste Management* • Proper site clearing. • General cleanliness and organization of the site. • Use of excavated material as fill material, e.g. topsoil. • Segregation and proper disposal waste oils, paint barrels, lubricants, etc. from other wastes. *Traffic and Transport* • Planning, development and implementation of traffic management • Maintaining minimal traffic speed on-site and recommended traffic speed and driving time off-site • Implementing working hour limits for drivers and inform drivers periodically on working schedule • Implementing restrictions for night time driving • Adopting proper weight guidelines for trucks and not exceeding vehicle loading capacity • Providing alternate routing plans during all phases of construction • Restricting operation of heavy vehicles to those who are trained, competent and licensed • Providing traffic trainings to all relevant personnel and specialized trainings to personnel who will operate industrial, heavier or critical vehicles. • Including traffic issues in the scope of the trainings and instructions for site visitors. • Limiting visitor mobility in the construction area. • Installing and maintaining signage and other traffic visuals. • Implementing right of way practices. • Implementing proper vehicle maintenance at all times.			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• Conducting or enforcing periodic medical examinations for drivers. • Conducting awareness raising activities for affected communities through established mechanism. • Collecting and addressing complaints and suggestions through the grievance mechanism. *Health and Safety* • Restriction of access to project construction areas by patrolling and guarding. • Provision of training on the fundamentals of occupational Health and Safety procedures. • Developing an Emergency Response Plan and training personnel on the actions to be taken in risk situations. • Installation of warning signs at the entrance to the site to inform people about the Project and risks associated with entry. • Availability of personal protective equipment (PPE) such as protective clothing, goggles, gloves, boots, masks, rubber boots, brightly colored working overalls equipped with light reflecting stripes, safety helmets, rubber or plastic type of equipment (broom, shovel, other) for personnel as needed. • Covering excavated ground (e.g. anchorage pits for turbines before filling) to prevent fall-in accidents for people and animals alike. • Provision of on-site medical facility/first aid and medical insurance for the workers/construction site. • Installing retaining nets to hold falling debris during site clearing and construction. • Prevention of stagnation of exposed water volumes to hamper insect and vector breeding. • Implementation of speed limits for trucks entering and exiting the site. • Installing proper signage to avoid accidental injury. • Implementing good housekeeping practices. • Ensuring that the project elements (turbines, bases, offices, substation, etc.) are designed incompliance with applicable legislations related to natural hazards, especially seismic safety • Conducting regular maintenance of equipment.			
	Operations	Impacts to Workers	*Air Quality* For generators and other equipment: • Using good quality fuel (from reputable sources). • Performing regular and preventive routine maintenance according to manufacturer recommendations. • Looking out for and fixing potential leakage and spillage of any kind at an early stage. • Outfitting of the generators with an effluent filter for Particulate Matter (PM). Water and Soil Management • Collecting domestic wastewater from toilets and sinks and conveying to public sewer network. • Ensuring that no sanitary wastewater is discharged onto the land. • Identify high risk spill areas, e.g. fuel tanks and generator – and have impervious surfaces and capture facilities in place.	Low	Medium-High	**Minor**

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• Limit activities during adverse weather conditions to reduce potential wind and water erosion. Noise and Vibration • Adopting proper scheduling for noisy wind turbine / sub-station maintenance activities. • Selecting adequate noise muffling equipment and minimizing machinery idling. • Ensuring good maintenance and repair of equipment. • Optimizing turbine operation as per wind speed to minimize noise generation. • Keeping turbines in good working order throughout the operational life of the project via routine maintenance, inspection and operational diagnostics. • Limiting the cutting/clearing of vegetation. • Planting trees near sensitive receptors to act as a noise barrier. • Ensuring equipment that may be intermittent in use is shut down between work periods or throttled down to a minimum. • Implementing a rigorous inspection and maintenance program applicable to equipment on-site. • Providing adequate Personnel Protective Equipment (PPE) to workers at noisy activities/locations that exceed permissible occupational noise level limits. • Conducting noise monitoring (1st year of operation, continuous at local municipalities, and in case of complaints) to verify compliance with regulatory limits and take corrective action. Solid Waste Management • Storage of SW in a pre-determined area in covered drums for collection and disposal. • Keeping the site free of litter. Health and Safety • Restricting access to project elements (turbines, substation) by patrolling and guarding areas around the site – noting that local residents, shepherds/herders, herb gatherers, and land users, will not be subject to area access restrictions, but rather restrictions related to accessing Project elements. • Installation of warning signs at site entrances to warn people about the Project and associated risks. • Provision of appropriate monitoring instruments • Conducting regular maintenance of equipment. • Enforcing on-site transportation regulations. • Covering excavated ground (e.g. anchorage pits for turbines before filling) to prevent fall-in accidents for people and animals alike. • Prevention of stagnation of exposed water volumes to hamper insects and vector breeding. • If needed, employees should be provided with PPE such as hand gloves, helmets, safety shoes, goggles, aprons etc. and ear protecting devices like earplugs/earmuffs and breathing masks. • Prohibition of dirt accumulation, dampness, water, oil, and other substances which may adversely affect electrical safety within electrical areas or the sub-station. • Training of workers and staff for fire-fighting, work permit system, first aid, safe handling of chemicals and integrating safety during operation. • Provision of safety and warning signs where needed (displayed in Arabic and English).			

Resource	Phase	Impact	Mitigation	Impact Significance	Sensitivity of Receptor	Residual Impact Significance
			• An accident / incident reporting and information system for employees for good awareness levels. • Provision of first aid boxes at key points at the project facilities with prominent marking. • Regulations prohibiting smoking in potentially fire prone or sensitive areas and all indoor areas. • Provision of fire-fighting equipment and/or system if/where needed within site facilities; and regular testing of fire extinguishers. • Ensuring electrical switchboards are not accessible to the public and related cautionary signs are in place. • Ensuring access to turbine ladders is closed off and related cautionary signs are in place. • Grounding installed conducting objects, as applicable. • Ensuring maintenance schedule for turbines is strictly followed. Specific to hazards due to accidents and/or incidents and lifting objects to heights can be applicable during construction and operation: • Ensuring use of applicable PPEs and other protective means. • Installing guard rails and signs. • Ensuring sufficient overall illumination during working hours and special illumination on hazard areas during nighttime. • Conducting regular visual checks and clean-up of excavation debris. • Restricting operation of heavy machinery to those who are trained, competent and licensed • Providing regular H&S trainings. • Conducting labor audits to contractors' work force by an external third party. • Limiting manual lifting/handling needs by providing mechanical alternatives. • Ensuring personnel who conduct lifting operations receive special training. • Ensuring lifting operations are well planned and risks discussed in advance. • Ensuring lifting equipment is properly maintained and has sufficient capacity to support the weight. • Setting exclusion zones below any activities working at height, to account for falling objects. • Abiding by weather condition limits set by the lifting equipment manufacturer. • Implementing the worker internal occupational grievance mechanism. • Conducting regular labor audits to contractors' workforce (by independent third party auditors). Mitigation measures specific to blade and ice throw, and lightning applicable during operation: • Installing, maintaining and updating lightning protection systems for turbines and other elements. • Installing and maintaining vibration sensors that react to imbalance in rotor blades and shut down turbines. • Using de-icing mechanism, especially during fall and winter seasons. • Carrying out periodic blade inspections and repairing defects that could affect blade integrity. • Ensure heat control mechanism is maintained properly. • Ensure static and illuminated warning signs are used to inform/warn receptors.			

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