

FRV MASRIK  
Closed Joint Stock Company

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*Masrik 1*  
*Solar Power Plant*

Environmental and Social Impact  
Assessment report



FRV Masrik CJSC

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## ABBREVIATIONS AND ACRONYMS

CC	Construction Contractor
DC	Design Contractor
EMI	Environmental and Mining Inspectorate
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GoA	Government of Armenia
HSE	Health, Safety, Environment
IA	Implementation Agency
kV	kilovolt
kWh	kilowatt-hour
LSGB	Local Self Governance Body
MWh	Megawatt-hour
MEINR	Ministry of Energy Infrastructures and Natural Resources
MNP	Ministry of Nature Protection
MC	Ministry of Culture
MH	Ministry of Health
OC	Operation Contractor
OTL	Overhead Transmission Line
PAP	Project Affected Person
PCR	Physical Cultural Resources
PPE	Personal Protection Equipment
RA	Republic of Armenia
ROW	Right of Way
SNCO	State Non-commercial Organization

# CONTENT

<b>1. EXECUTIVE SUMMARY .....</b>	<b>6</b>
1.1. Introduction .....	6
1.2. Objectives and Methodology.....	6
1.3. Legal and Regulatory Framework.....	7
1.4. Institutional Framework.....	8
1.5. Baseline Conditions .....	8
1.6. Impact Assessment .....	9
1.7. Environmental and Social Management Plan .....	10
1.8. Information, Disclosure, Consultation .....	10
1.9. Grievance Redress Mechanism.....	10
<b>2. INTRODUCTION .....</b>	<b>12</b>
<b>3. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK.....</b>	<b>14</b>
3.1. National Legislation .....	14
3.2. Permits and consents required prior to commencement of construction works of the Solar Power Plant and the Transmission line connecting the Plant to the Grid.....	19
3.3. International Agreements.....	19
3.4. The World Bank Safeguard Policies .....	21
3.5. Codes and Standards .....	22
3.6. The comparative analyses of the RA and international norms.....	24
3.7. Administrative Framework .....	26
<b>4. PROJECT DESCRIPTION .....</b>	<b>29</b>
4.1. Masrik 1 PV Plant .....	29
4.1.1. <i>General Description</i> .....	29
4.1.2. <i>Generating System</i> .....	30
4.1.3. <i>Generation Medium voltage transformers</i> .....	30
4.1.4. <i>Grounding General Description</i> .....	30
4.1.5. <i>Auxiliary Services</i> .....	31
4.1.6. <i>Monitoring System</i> .....	31
4.2. <i>Overhead Power Line</i> .....	33
4.3. <i>Civil Works Description</i> .....	37
4.3.1. <i>Roads and Parking area</i> .....	37
4.3.2. <i>Buildings</i> .....	37
4.3.3. <i>Structure of photovoltaic modules</i> .....	38
4.3.4. <i>Foundations</i> .....	38
4.3.5. <i>Drainage</i> .....	38
4.3.6. <i>Perimeter fence</i> .....	38
<b>5. METHODOLOGY OF ESIA .....</b>	<b>41</b>
5.1. Scope and Objectives of the ESIA .....	41
5.2. Procedures and Methodology .....	41
<b>6. BASELINE DATA.....</b>	<b>43</b>
6.1. Location .....	43
6.2. Relief, Geomorphology, Geological Structure.....	44
6.3. Meteorological and Climate .....	45
6.3.1. <i>National Climatic Conditions</i> .....	45
6.3.2. <i>Local climatic conditions</i> .....	45

6.4.	Characteristics of seismic conditions .....	49
6.5.	Surface water quality characteristics .....	51
6.6.	Ambient air quality characteristics .....	53
6.7.	Noise and Vibration .....	54
6.8.	Soil quality characteristics .....	54
6.9.	Biodiversity .....	55
6.9.1.	<i>Flora</i> .....	56
6.9.2.	<i>Fauna</i> .....	60
6.9.3.	<i>Endangered ecosystems, specially protected nature areas</i> .....	62
6.10.	Historical and cultural environment .....	63
6.11.	Social environment of Project site .....	66
6.11.1.	<i>Sociodemographic picture and livelihood</i> .....	66
6.11.2.	<i>Vulnerable groups</i> .....	67
<b>7.</b>	<b>ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES .....</b>	<b>68</b>
7.1.	Environmental Impacts and their Mitigation during Construction .....	68
7.1.1.	<i>Landscape</i> .....	68
7.1.2.	<i>Flora and Fauna</i> .....	68
7.1.3.	<i>Soil Erosion</i> .....	69
7.1.4.	<i>Soil and Water Resources</i> .....	70
7.1.5.	<i>Solid and Liquid Wastes</i> .....	71
7.1.6.	<i>Noise</i> .....	72
7.1.7.	<i>Air Quality</i> .....	73
7.1.8.	<i>Historical and Cultural Sites</i> .....	73
7.1.9.	<i>Health and Safety</i> .....	74
7.1.10.	<i>Gender Aspects</i> .....	74
7.2.	Environmental Impacts and their Mitigation during Operation .....	75
7.2.1.	<i>Flora</i> .....	75
7.2.2.	<i>Fauna</i> .....	75
7.2.3.	<i>Water resources</i> .....	75
7.2.4.	<i>Noise</i> .....	76
7.2.5.	<i>Electric and Magnetic Fields</i> .....	76
7.3.	Social impact and mitigation measures .....	76
7.3.1.	<i>Survey Methodology</i> .....	76
7.3.2.	<i>Assessment of affected land</i> .....	77
7.3.3.	<i>Land losses</i> .....	78
<b>8.</b>	<b>ASSESSMENT OF POTENTIAL ECONOMIC DAMAGE .....</b>	<b>80</b>
<b>9.</b>	<b>ANALYSES OF ALTERNATIVES .....</b>	<b>81</b>
9.1.	The "No Action" Option .....	81
9.2.	Proposed Project of PV plants .....	81
9.2.1.	<i>Technology Assessment</i> .....	81
9.2.2.	<i>Mounting Systems</i> .....	83
9.2.3.	<i>Cost estimation</i> .....	84
9.2.4.	<i>Conclusions</i> .....	84
<b>10.</b>	<b>INFORMATION DISCLOSURE, CONSULTATIONS, AND PARTICIPATION .....</b>	<b>85</b>
10.1.	Background .....	85

10.2. Consultations with Main Stakeholders .....	85
<b>11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)</b>	<b>86</b>
11.1. Institutional Requirements.....	86
11.2. Capacity Development and Training .....	87
11.3. Mitigation Measures .....	88
11.4. Monitoring Measures.....	97
<b>12. GRIEVANCE REDRESS MECHANISM .....</b>	<b>102</b>
<b>13. REFERENCES.....</b>	<b>105</b>
<b>14. ANNEXES .....</b>	<b>105</b>
<b>ANNEX 1. Calculation of Emissions Occuring During the Construction of the Masrik 1 Solar Power Plant and Overhead Lines</b>	<b>105</b>
<b>ANNEX 2. Assessment of Economic Damage.....</b>	<b>105</b>

## 1. EXECUTIVE SUMMARY

### 1.1. Introduction

#### *General Information<sup>1</sup>*

Armenia has large solar energy potential (the average annual value of solar energy flow on 1m<sup>2</sup> horizontal surface is 1720 kWh/m<sup>2</sup>, and a quarter of the territory of the Republic possesses the solar energy reserves with 1850 kWh/m<sup>2</sup> intensity).

Solar thermal energy is rapidly developing in Armenia.

The private sector imports both separate parts of solar water heating systems for their future assembly and the complete systems. Presently, use of water heaters in Armenia not only results in energy efficiency but is also economically beneficial.

In Armenian communities without gas supply, the “Energy Efficient” loan project launched in August 2017, under which, as for October 2018, 1364 solar heaters and 41 photovoltaic systems were installed.

#### *Promoting the activities of a wide range of autonomous power producers*

To implement the activities of independent power producers, the parameters of 636 autonomous power producers (with about 8,5 MW total capacity) have been approved, of which 567 have already been connected to power system (with about 6,8 MW total capacity).

In the renewable energy sector, within the frames of implementing incentive measures aimed at popularization of autonomous energy producers, the RA National Assembly in December 21, 2017 adopted the Laws HO-262-N and HO-261-N. In the Law “On Energy” of RA, the limit of 150 kW has been revised setting it to be 500 kW for legal entities, as a result. The legislative framework has been developed for heavy users of electricity, in order for them to carry out the functions of autonomous power producers exclusively to meet the own needs. In the Law “On Energy Efficiency and Renewable Energy” of RA, the provision has been set on the volumes of non providing compensation against the energy supplied (delivered) in the frames of power exchange, and the exchange conducting regime timelines have been improved for the renewable energy resource users - autonomous energy producer and energy distributor license holder person.

According to the Article 59 of the Law “On Energy” of RA adopted on March 7, 2001, the entire power (capacity) produced by the use of small hydroelectric power stations, within fifteen years, and other renewable energy resources (wind, solar, geothermal and biomass), within twenty years, are subject to purchase in accordance with market rules.

The tariff is set and reviewed according to the method adopted by the Decision of the Committee number 88-N of April 22, 2015.

The purpose of this initiative is to build and operate the first industrial solar power plant in Armenia.

### 1.2. Objectives and Methodology

The proposed Masrik 1 PV plant and Overhead Transmission Lines (OTLs) will have several impacts on various environmental and social components. The main objectives of the ESIA are to identify, assess the magnitude of the expected impacts, furthermore, to provide measures for their mitigation commensurate in accordance with the national and international standards. The ESIA report provides

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<sup>1</sup> RA EINR official website: <http://www.minenergy.am/page/416>

useful data to the General Contractor on how PV modules and high voltage power lines should be designed and planned in order to avoid or mitigate negative impacts and to use more efficiently the anticipated environmental and social benefits.

After public disclosure of the draft ESIA report, stakeholder consultation will be carried out to receive feedback as well as hear concerns of the people affected by the planned works.

General overview on biophysical environment was carried out through a desktop study, and a field survey was conducted by the environmental and social experts. This implied walk-through along the proposed area and path of the OTLs, including hotspots like the crossing of valleys and villages affected by the Masrik 1 PV plant Project.

Additional information was gained through consultations with representatives of relevant governmental organizations and local communities. Intense consultations were conducted with the representatives of the Historical and Cultural Monument Protection Agency of the Ministry of Culture and with the representatives of the Ministry of Nature Protection.

### **1.3. Legal and Regulatory Framework**

The implementation of any activity in Armenia which may cause environmental impacts needs a positive conclusion outcome from an Environmental Impact Assessment (EIA) expertise.

Environmental impacts of a planned physical activity or a sectorial or regional development plan/program has to be assessed during the pre-implementation period. The Republic of Armenia (RA) Law on Environmental Assessment and Expertise of 2014 stipulates provisions regarding to environmental impact assessment, impacting the environment and conditions under which causing of such impact is allowed, thus, eventually it is the most important national law for EIA development.

According to this law, activities are classified into 3 categories: A, B and C. The activities related to solar power plant are included in category C if the power plant occupies 40 hectares or more as in the case of Masrik 1 Solar Plant, which occupies 128.3 ha.

EIA expertise shall also be conducted for construction of high voltage overhead power lines, which is according to the Law of the RA on EIA are the overhead power lines of 110 kV (category "B") or higher voltage.

*The PV Plant of Masrik 1 will occupy 97.5 ha area, and the voltage of the OTLs will be 110 kV, thus, according to this Law, Masrik 1 PV plant is subject to the environmental expertise under category B.*

According to World Bank OP 4.01, the Project falls into environmental Category B; therefore, it also requires EIA and environmental management planning.

GoA has ratified a number of international agreements and conventions related to the protection of the environment and biodiversity. In addition, an important environmentally relevant international agreement to which Armenia is a signatory is the Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters (signed 1998, ratified 2001).

The following safeguard policies of the WB are triggered for the proposed project:

- OP 4.01 - Environmental Assessment
- OP 4.04 - Natural Habitats
- OP 4.11 - Physical Cultural Resources
- OP 4.12 – Involuntary Resettlement

#### 1.4. Institutional Framework

Implementation Agency will be responsible for all operations under the Project, including its compliance with the national environmental, social legislation; IFC, the World Bank's and other institutions' safeguard policies. As part of the project implementation, IA can hire design, construction and operation contractors as well as other consultants.

Also, government agencies that are likely to be involved in the Project implementation according to their mandates include the Ministry of Energy and Natural Resources, the Ministry of Nature Protection and the Ministry of Culture.

#### 1.5. Baseline Conditions

The area requested for Masrik 1 PV Plant is situated in Vardenis sub region of Gegharkunik Marz, in Lake Sevan in-shore Masrik valley, in the territory of Mets Masrik community.

Vardenis sub region is situated in southeast of Sevan basin – between Sevan, Eastern Sevan and Vardenis mountain ranges. In general, the mountain surface prevails in the region. The dominant landscapes are the mountain steppe and mountain meadow.

The average temperature in January ranges from -6 °C to -14 °C, and in July –from 8°C to 16 °C, the annual precipitation is 350-650 mm and the active vegetation period is 40-130 days. Masrik, Babajan, Pambak, Dara, Karchaghbyur and other rivers run through the area. Masrik, Sotk, Gilli and other canals are functioning.

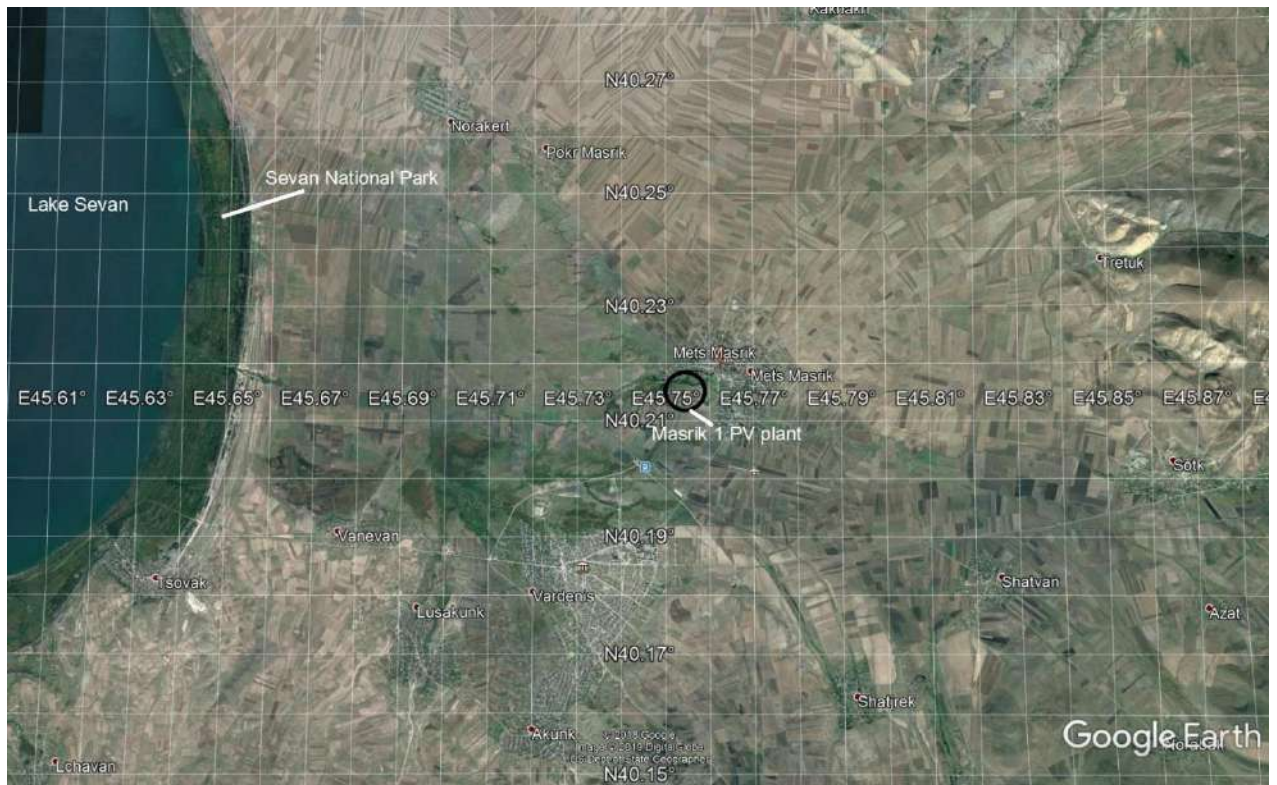


Figure 1.1: Site location (Source: Google Earth)

Masrik 1 PV Plant is located in the central part of Masrik field. Masrik field occupies the downstream basin of River Masrik. The altitude is 1900-2000 m a.s.l. The flat surface has steepness to the west and is covered by the strong alluvial sediments layer. To the west, at the location of the former Lake Gilli, there are turf resources.

The potato, cereal, tobacco, vegetables, etc. are cultivated here.



During the spring season, waters occurring in a result of precipitations and thaw are mainly being absorbed or partially form the small temporary ponds, which cause waterlogging of the soil. During summer, only traces of these waterloggings remain – the stripping's with depth of up to 0.5 meters covered by lush vegetation.

The main part of the land requested for Masrik 1 PV Plant is occupied by black soils, which is typical for damp valleys and plateaus at the higher altitudes. There are large numbers of wetlands, which, nevertheless, completely dry and harden during summer.

The area belongs to the floristic region of Sevan. It is situated in Masrik field, which is rich with alluvial sediments. The vegetation in the vicinity of Mets Masrik contains steppe and meadow elements.

During field works stage, it was revealed, that due to the yearly overgrazing of the area, its flora is very poor.

Nearest Mets Masrik is a rural community with an area of 36 km<sup>2</sup>. The population is 3,428. They are mainly engaged in agriculture.

### **1.6. Impact Assessment**

Main types of possible environmental impacts expected from construction of Masrik 1 PV plant comprise the following:

- During construction works, impacts to flora and fauna are unavoidable, including the OTLs corridor.
- New roads will be built, in the result of which the vegetation and habitats of some animals will be damaged.
- As the area has a thick layer of topsoil, during the construction works it will be necessary to cut and remove the topsoil from construction site, parking areas, which partly loses its properties during storage.
- Small amounts of construction waste will be generated.

Most important possible social impacts areas are as follows:

- Land acquisition, possible damages to pastures and cattle paths during construction of access roads, installation of towers, conductor stringing, and ROW maintenance.
- Nuisance to local communities due to movement of construction vehicles and machinery.
- Positive social impacts related to the services and infrastructures in the area, and the potential employment generation.
- There is no historical or cultural resource found at the project site and no impacts are expected, nevertheless OP 4.11 should be considered because non-recognized resources adjacent to the site can be found during the project implementation.

ESIA report shows that the proposed Project will have low to medium environmental and social impacts if the proposed ESMP is implemented and all proposed mitigation measures are applied. According to the ESIA, negative environmental and social impacts occur mainly during the construction phase. During the operational phase, the positive impacts are obvious and composed in a much more environmental friendly and reliable power supply.

### **1.7. Environmental and Social Management Plan**

The proposed Project of Masrik 1 PV plant will have impacts on various environmental and social receptors. The ESMP covers a set of measures that need to be taken in order to prevent, minimize, or compensate these impacts. Monitoring measures are deployed to ensure implementation of these mitigation measures.

#### Design Phase

Detailed design shall be developed in the way to minimizing needs for land take and physical relocation. Minimal need for the construction of new access roads shall also be targeted.

#### Construction Phase

During works required for construction of PV plant and installation of towers for OTLs, large amount of topsoil shall be stripped, stored separately and used for site restoration once the modules and towers are in place. Areas used for workers' camps will be rehabilitated after decommissioning of these camps.

Pollution of soil and water will be avoided by maintenance and re-fueling of construction equipment on sealed and enclosed areas, provision of spill-control materials, storage of liquid materials in adequate storage areas, provision of proper sanitation facilities, and training of workers.

Construction Contractor will discuss with the local municipalities how to arrange disposal of waste through the communal service providers. Although there are no standard sanitary landfills in this region, waste disposal through municipal service providers will at least ensure that there is no free dumping or open air burning of waste. Scrap metal may be sold for recycling purposes to specialized companies (e.g. METEXIM LLC), which should pick up the scrap metal directly at the dismantling sites.

Where the OTL corridor goes near villages or houses, the Construction Contractor has to control noise emissions from all equipment. For residents the noise levels may not exceed 55 dB (A). Workers will wear ear protection devices as part of their PPE if they are exposed to noise levels higher than 80 dB (A). Nuisance by construction noise will be minimized by different measures (e.g. truck movements only during daylight use of low sound power mechanical equipment etc.).

### **1.8. Information, Disclosure, Consultation**

ESIA process involved dialogue of the ESIA team with various agencies of the Government and specialists of the relevant fields with the purpose of sharing their experience and take advice. Consultant's environmental and social specialists held meetings with the representatives of Ministry of Nature Protection, Ministry of Culture, and conducted field trips to the proposed area of PV plant and corridor of OTL. The Ministry of Culture, Agency for Protection of Historical and Cultural Monuments was consulted on the procedures to protect historical and cultural sites.

The Final Draft version of the ESIA report, including the ESMP, will be disclosed to the public in English and Armenian versions to allow stakeholders to familiarize with it. The document will be posted on MNP's website and hard copies will be delivered to local administration offices. Printed copies will be also provided to representative civil society organizations.

### **1.9. Grievance Redress Mechanism**

In the course of the construction process, project affected people (PAP) may feel treated unjustly, for which case IA shall maintain a viable grievance redress mechanism. PAP is encouraged to proceed in the following way:

- a) Contact the contractor's designated grievance staff during periodical site visits in person or via designated telephone number or the community leader or NGO staff.
  - Lodge complaint and provide information on the case.
  - Agree with the contractor on mitigation measure or agree with the contractor on time limit for grievance settlement. (Grievances have to be settled within two weeks, or otherwise specified in scheduled agreement).
- b) Seek redress from the IA (In case of major grievances grievance committee will be called) if not satisfied with above mentioned procedure.
- c) Seek redress from court if all else fails.

Nevertheless, the above mentioned grievance mechanism does not limit the citizen's right to submit the case straight to the court of law just in the first stage of grievance process. The grievance mechanism is designed to avoid lengthy court procedures.

## 2. INTRODUCTION

Armenia has a high potential of solar power. Figure 2.1 below presents the Global Horizontal Irradiation based on the data collected from the period 2000-2015. Highest values of GHI are obtained at eastern strip, Aragats mount and south part of the country, of around 5.5-6 kWh/m<sup>2</sup>/day (~2000-2200 kWh/m<sup>2</sup>/year), reaching minimum values of 3 kWh/m<sup>2</sup>/day (~1100 kWh/m<sup>2</sup>/year) at north east region, Araks and Debet valleys. (Source: Solar Resource Mapping and Site Selection for Solar PV Plants in Armenia). For comparison, the average annual value in Europe is 1000 kWh/m<sup>2</sup>.

Nevertheless, Armenia considerably lags behind the European countries in sphere of solar power. Though in Armenia the solar thermal collectors (water heaters) with 1.38-4.12 m<sup>2</sup> standard size are made, and the 2.75 m<sup>2</sup> size water heater produces 120-160l hot water daily, its use is not widespread.

The solar power electrical converters are rarely used. To date, the small capacity demonstrative photovoltaic (PV) modules have been installed in Armenia. In Armenian American Wellness Centre in Yerevan (Institute of Mammography), the polymer photovoltaic converters, produced by the technologies of Germany and USA, are installed on the roof and their total surface is 200 m<sup>2</sup> and the capacity - 9.8 kW.

Solar is not yet cost competitive under purely commercial financing assumptions, but the combination of several factors could make it more so in the near future. The factors include: (i) new, higher-cost thermal plants being built to serve demand in Armenia; (ii) lower solar installation costs that will result as a domestic industry develops around it; (iii) lower financing costs as lenders become more comfortable with the technology, and (iv) potential further reductions in the global costs of PV panels.

Financial and technical support can help Armenia nurture its solar industry so that, as these factors converge, Armenia can look to utility-scale solar as a commercially viable alternative to some thermal power generation.



Figure 2.1: Global Horizontal Irradiation (Source: Solar Resource Mapping and Site Selection for Solar PV Plants in Armenia)

### 3. POLICY, LEGAL, AND ADMINISTRATIVE FRAMEWORK

This chapter provides an overview of the national policy within which the Utility-Scale Solar Power Project is being developed. This chapter discusses the overall policy and legal framework in the Republic of Armenia with specific sectorial laws on environment, land use and health and safety.

#### 3.1. National Legislation

##### Constitution

In accordance with article 12 of the Constitution of the Republic of Armenia (adopted in 1995 and amended in 2005 and 2015) “The State stimulates protection, improvement and restoration of the environment and reasonable use of the natural resources based on the principle of steady development and taking into account the responsibility to the future generation. Everybody is obliged to take care of environmental protection”. Article 85 of the constitution provides that “Everyone has, in accordance with the law, the right of health protection”.

Since 1991 more than 25 codes and laws as well as numerous by-laws and regulations have been adopted to protect the environment.

##### Land Code (2001)

The preamble of the Land Code stipulates that the possession, disposition and use of lands shall not cause damage to the environment, defensibility and security of the country shall not violate the rights and lawful interests of citizens and other persons. The Land Code defines the main directions for use and disposition of the state lands, included those allocated for various purposes, such as agriculture, urban construction, industry and mining, energy production, transmission and communication lines, transport and other purposes.

The Code also defines the lands under the specially protected areas as well as forest, water and reserved lands. It also establishes the measures aimed to the lands protection, as well as the rights of state bodies, local authorities and citizens towards the land.

The Government of the Republic of Armenia directly or by means of the authorized bodies implements the State management of the land resources of the RA.

Following the requirements of this Code, the decree on the establishment of technical regulations for general requirements for protection of lands from pollution, list of substances polluting the lands, and assessment of level of land pollution (24.08.2006 N1277-N) was adopted by the Government of the Republic of Armenia. The RA Government Decrees “On Approval of the Technical Regulations for Definition of the Norms for Topsoil Removal and for Removed Topsoil Maintenance and Use” number 1026-N of July 20, 2016 and “On Recognizing Void the RA Government Decree number 1026-N of July 20, 2006” (02.1.2017 number 1404-N).

“Calculation and Indexing Procedure of Reclamation Activities Estimated Values” was adopted by the Order of the RA Minister of Nature Protection number 365-N of 24.12.2012.

*Masrik 1 PV plant’s and OTL’s land allocation will be carried out according to the provisions of this Code.*

##### Water Code (2002)

The main purpose of the Water Code is to provide the legal basis for the protection of the country’s water resources, the satisfaction of water needs of citizens and economic sectors through effective

management of water resources, and safeguarding the protection of water resources for future generations. The Water Code addresses the following key issues: responsibilities of state/local authorities and public, development of the National Water Policy (2005) and National Water Program (2006), water cadastre and monitoring system, public access to the relevant information, water use and water system use permitting systems, trans-boundary water resources use, water quality standards, hydraulic structures operation safety issues, protection of water resources and state supervision.

*A PV plant does not use water to generate electricity. Only minimum quantities of water are used during construction works, apart from the drinking water needs for workers.*

#### *Code on subsoil (2011)*

The code defines principles and rules of mining in the RA, the relations related to preservation and use of the deposits, conditions and requirements of efficient use, complex use and preservation of deposits, security of mining and protecting the environment from its negative impacts, as well as protection of rights of the state, citizens and users of deposits. According to the Code, natural deposits are under the exclusive ownership of the state. They may be given out for use for a certain period of time, and cannot be privatized. The law also determines conditions, requirements and peculiarities of the natural resources and deposits. It also establishes payment principles, compensation, monitoring, and limitation for mining activities.

*If due to the construction works it will be more appropriate to carry out the inert materials' (sand, gravel) supply from their own mine, all registrations will be done according to the requirements of this Code.*

#### *Labour Code*

The Labour Code of the RA, adopted on 9 November, 2004, protects the rights and interests of employees and employers in collective and individual employment relationships, establishes state guarantees for labour rights and freedoms, and promotes the creation of favorable conditions of work.

The labour relations between the employee and employer are originated on the basis of labour contract concluded in a procedure established by the Labour Code and other normative legal acts containing norms on labour Code.

*Activities and operations of the project shall be implemented in accordance with the mentioned Code in order to assure the protection of the rights and interests of the employees.*

#### *Law on Environmental Impact Assessment and Expertise (2014)*

The Law on environmental impact assessment and expertise was adopted on July 2014. The Law provides legal basis undertaking state environmental expertise of planned activities and concepts and presents standard steps of EIA process. The Law establishes general legal, economic, and organizational principles for conducting mandatory State EIA of various types of projects and concepts of sectorial development.

According to this law, activities are classified into 3 categories: A, B and C. The categories are defined on the basis of the volume of the activity, characteristics and the level of impact on environment.

The state expertise procedure consists of 2 stages. During the first stage lasting 1 month the Ministry of Nature Protection and the public are notified on the project (short summary), and the first round of public hearings is held. The Ministry of Nature Protection undertakes classification of a project and recommends TOR for the EIA, if the EIA is required according to the classification outcome.

At the second stage, an EIA report is submitted to the Ministry of Nature Protection and the Ministry undertakes its review during 60 days for a category “A” project or 40 days for a category “B” project. Two public consultation meetings are required at this stage. The Ministry may extend the review deadline for up to 30 days after which it issues a positive or a negative conclusion of the expert review. The length and the complexity of the procedure depend on the categorization of the planned activity.

The activities related to solar power plant are included in category C, in case if the power plant occupies 40 hectares and more. Assessment and expertise are implemented prior to the implementation of planned activity. Also, for the activities of category C only the initial stage is exercised. Following the examination of the application at initial stage, the authorized body makes a decision on the issuance of an EIA conclusion for activities under category C.

EIA expertise shall also be conducted for construction of high voltage overhead power lines, which, according to the Law of the RA on EIA and, are the overhead power lines of 110 kV and more voltage. Pursuant to article 14 of the Law, installation of OTLs is classified as activity of category B. For planned activities of category B EIA expertise shall consist of both initial and main stages.

*The PV Plant of Masrik 1 will occupy 128.3 ha area, and the voltage of the OTLs will be 110 kV, thus, the design of the entire Plant, respectively, will be subject to environmental expertise as a higher Category “B”.*

*Law on Ensuring Sanitary-epidemiological Security of the RA Population (1992)*

The Law On Ensuring Sanitary-Epidemiological Security of the RA Population was adopted in 1992, which sets legal, economic and institutional bases for ensured sanitary and epidemiological safety of the population, as well as other guaranties provided for by the State to exclude influence of adverse and hazardous factors on human organism and ensure favorable conditions for vital capacity of the present and future generations.

*Sanitary-epidemiological conditions of the staff must comply with the terms of this law.*

*Law on Provision of Medical Care and Services to the Population (1996)*

The Armenian Law on Medical Care and Services to the population establishes the legal, economic and financial guidelines for medical care and service delivery, which ensures the realization of people’s constitutional right to preserve their health.

*Activities and operations of the project shall be implemented in accordance with the mentioned laws in order to insure health and safety of the employees as well as of the surrounding population.*

*Law on the Protection and Use of Fixed Cultural and Historic Monuments and Historic Environment (1998)*

The Law on the Protection and Use of Fixed Cultural and Historic Monuments and Historic Environment was adopted by the National Assembly on November 11, 1998. It provides the legal and policy basis for the protection and use of such monuments in Armenia and regulates the relations between protection and use activities. Article 15 of the Law describes procedures for, among other things, the discovery and state registration of monuments, the assessment of protection zones around them, and the creation of historic-cultural reserves. Article 22 requires approval of the authorized body (Department of Historic and Cultural Monuments Preservation) before land can be allocated for construction, agricultural and other types of activities in areas containing monuments.

*The issues regarding to the cultural and historical monuments in Masrik 1 PV plant’s and OTL’s sites will be regulated by this law, as well as the World Bank policy. Although no historical values exist on the site,*



the LAW should be considered because non-recognized resources can be found during the project implementation.

#### *Law on Flora (1999)*

The law defines RA state policy in the field of maintenance, protection, usage and regeneration of flora. The law defines objectives of flora examination, state monitoring, state inventory, requirements and approaches of red book preparation on flora, conditions, peculiarities, limitations of allocation of flora objects for purposeful usage, basis of termination of the right to use, provisions on flora maintenance, and economic encouragement of usage and implementation of supervision. The law also defines the rights and obligations of the state governance and local governmental bodies in the field of flora maintenance, protection, reproduction and usage, mechanisms of state inventory, principles of deciding their indicator.

*In Masrik 1 PV plant's and OTL's sites, the natural flora's protection norms are regulated by the law above.*

#### *Law on Fauna (2000)*

The law defines RA state policy in the field of maintenance, protection, usage and regeneration of fauna. The law defines the objectives of survey of the fauna, state monitoring, state inventory, requirements and approaches of red book preparation on fauna, conditions, peculiarities, limitations of allocation of fauna objects for purposeful usage, basis of termination of the right to use, provisions on fauna maintenance, and economic encouragement of usage and implementation of supervision. The law also defines the rights and obligations of the state governance and local governmental bodies in the field of flora maintenance, protection, reproduction and usage.

*In Masrik 1 PV plant's and OTL's sites, the wildlife protection measures are regulated by this law.*

To ensure compliance with the requirements of this Law, the RA Government approved the Red Book of Animals of the Republic of Armenia with its Decree number 71-N of 29.01.2010 and the Red Book of Plants of the Republic of Armenia - with its Decree number 72-N of 29.01.2010.

#### *Law on Wastes (2004)*

The law regulates legal and economic relations connected to the collection, transfer, maintenance, development, reduction of volumes, prevention of negative impact on human health and environment. The law defines the main principles and directions of state policy, the principles of state standardization, inventory, and introduction of statistical data, the implementation of their requirements and mechanisms, the principles of wastes processing, the requirements for presenting wastes for the state monitoring, activities to decrease the amount of the wastes, including nature utilization payments, as well as the compensation for the damages caused to the human health and environment by the legal entities and individuals, using the wastes, as well as requirements for state monitoring and legal violations. The law defines the rights and obligations of the state governmental and local governmental bodies, as legal entities and individuals.

*Constructional and daily waste management occurred during the construction and operation of PV plant must comply with this law.*

#### *Law on Environmental Oversight (2005)*

The Law regulates the issues of organization and enforcement of oversight over the implementation of environmental legislation of the Republic of Armenia, and defines the legal and economic bases

underlying the specifics of oversight, the relevant procedures, conditions and relations, as well as environmental oversight in the Republic of Armenia. The existing legal framework governing the use of natural resources and environmental protection includes a large variety of legal documents.

Governmental resolutions are the main legal instruments for implementing the environmental laws. Environmental field is also regulated by presidential orders, Prime-Minister's resolutions and ministerial decrees.

*The compliance with the environmental legislation during construction and operation of the Masrik 1 Power Plant will be controlled by the Environmental Protection and Mining Inspectorate as per the provisions of this Law.*

*Law on Specially Protected Natural Areas (2006)*

The law defines legal basis and relations of state policy for development, restoration, maintenance, reproduction and use of natural complex and separate objects, as well as ecosystems of specially protected natural areas of the Republic. According to the law, specially protected natural areas are divided into four categories, National parks, State Reserves, Natural museums and the fourth category is divided into three separate types: areas of international, republican and local importance. Law defines concepts, regimes of maintenance, principles of preparation of specially protected natural areas management plans, monitoring, calculation and state registrar, as well as the requirements of usage, limitations and principles, rights and obligations of state governmental and local governmental bodies, maintenance bodies of the protected areas, the rights public to get an information on protected areas, financial sources of protected areas, requirement of supervision and responsibility for violating the Law on Specially Protected Natural Areas.

*Masrik 1 PV plant's territory is located in "Sevan" National Park's buffer zone.*

*RA Health Minister's N 01-N order as of January 25, 2010, «On approving sanitary rules and norms of soil quality hygiene requirements N 2.1.7.003-10».*

The sanitary rules and hygienic norms determine the hygienic requirements of soil quality, such as the hygienic evaluation of land sanitary condition, soil quality monitoring, assessment of main indicators of the sanitary condition of the soil, depending on their functional significance, as well the degree of soil pollution on land use proposals.

*RA Health Minister's N 533-N order as of May 17, 2006, «On approving HN N 2.2.4-009-06 vibration hygiene norms at workplaces, residential and public buildings».*

The hygienic norms determine the vibration classification, regulation standards, the maximum permissible level of vibration at workplaces, as well as the permissible levels of vibration at residential and public buildings.

*Protocol Decree N 54-13 of the Government of the RA, dated 10 December 2015 On Approval of the Program "Ways of long-term (up to 2036) development of the energy system of the Republic of Armenia".*

The program of strategic development of the energy system titled as "Ways of long-term (up to 2036) development of the energy system of the Republic of Armenia" was developed and adopted by the Government of Armenia in 2015.

The document is based on the Armenia Least Cost Energy Development Plan prepared under the USAID Project "Low Emissions Strategies and Clean Energy Development in E&E" and USAID grant "Support to National and Regional Energy Planning and Capacity Building at the Scientific Research Institute of

Energy”. At the same time, the World Bank, which is financing diverse energy system infrastructure development projects, initiated the analysis of Armenian energy system and presented a number of proposals.

*Energy Security Concept of the Republic of Armenia” (adopted by the President of RA, 2013)*

Energy Security Concept of the Republic of Armenia is aimed to ensure the energy security of the Republic of Armenia in conformity with the provisions of the national security strategy. According to this concept energy security is a complex of political, economic, legal, organizational and other measures which aim to provide reliable and high-quality power supply on daily basis, as well as in emergency situations and in times of war.

The implementation of this document is motivated by the rapidly developing social-economic and political situation in the region, the global economic crisis, as well as by need to ensure RA’s energetic independence and security in times of possible emergencies and war. The document also has an objective to ensure RA’s proper engagement in regional programs organized by international organizations, the European Union, the Russian Federation and the United States of America and finally by the importance of creating long term strategic supply (stock) of fuel and energy resources.

**3.2. Permits and consents required prior to commencement of construction works of the Solar Power Plant and the Transmission line connecting the Plant to the Grid.**

- Positive conclusion for construction of the Solar Plant and the Transmission line connecting the Plant to the Grid issued by the State Environmental Expertise SNCO of the Ministry of Nature Protection. Such conclusion is required in accordance with the Law on Environmental Impact Assessment and Expertise.
- Construction license in the area of the capital construction, including development of documents for urban development, engineering research and expertise to be held by the design company.
- Construction license in the area of capital construction to be held by the construction company providing works.
- Construction permit to be issued by the Head of Community.
- Technical expertise of PV plant design.
- Consent from the relevant local/regional authorities (usually community administration) for disposal of excavated materials and construction wastes in the approved dump site shall be obtained by Construction Contractor prior to transportation and disposal of construction concrete rubbles, debris and spoils as well as excessive excavation materials in such dump sites.
- Power Generation license to be issued by the RA Public Services Regulatory Commission.

**3.3. International Agreements**

In addition to the above presented list of laws, numerous strategies, concept frameworks, and national programs related to the nature protection have been developed, as well as a number of international agreements and conventions have been signed and ratified by the Republic of Armenia.

The table below shows the list of relevant International Conventions and Protocols as well as their status with respect to signing and ratification by the Republic of Armenia.

Table 3.1: International Conventions and Protocols signed and ratified by the RA

NN	Convention or Protocol, Name and Place	In Force	Signed	Ratified	Comment
1	Convention on Biological Diversity, (Rio-De-Janeiro, 1992)	1993	1992	1993	Re-registered in UN 1993
2	UN Framework Convention on Climate Change, (New-York, 1992)	1994	1992	1993	Re-registered in UN in 1993
3	Kyoto Protocol, (Kyoto, 1997)	2005		2002	
4	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)	1975	Acceded as assignee by the request of MFA RA 1993		
5	Convention on Long-range Transboundary Air Pollution, (Geneva, 1979)	1983		1996	Re-registered in UN in 1997
	Protocol on Persistent Organic Pollutants, (Aarhus, 1998)		1998		
	Protocol to Abate Acidification, Eutrophication and Ground-level Ozone, (Gothenburg, 1999)		1999		
6	Convention on Environmental Impact Assessment in a Trans-boundary Context, (Espoo, 1991)	1997		1996	Re-registered in UN in 1997
	Protocol on Strategic Environmental Assessment, (Kiev, 2003)		2003		
7	UN Convention to Combat Desertification, (Paris, 1994)	1996	1994	1997	Re-registered in UN in 1997
8	Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, (Basel, 1989)	1992		1999	Re-registered in UN in 1999
9	Convention for the Protection of the Ozone Layer, (Vienna, 1985.)	1988		1999	Re-registered in UN in 1999
	Montreal Protocol on Substances that Deplete the Ozone Layer, (Montreal, 1987)	1989		1999	Re-registered in UN in 1999
10	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, (Aarhus, 1998)	2001	1998	2001	
11	Convention on Protection and Use of Trans-boundary Watercourses and International Lakes, (Helsinki, 1992)	1996	1999		
	Protocol on Water and Health, (London, 1999)		1999		

### 3.4. The World Bank Safeguard Policies

The World Bank OP/BP 4.01 Environmental Assessment is considered to be the umbrella policy for the Bank's environmental safeguard policies. These policies are critical for ensuring that potentially adverse environmental and social consequences are identified, minimized, and properly mitigated. The safeguard policies, the triggers for each policy, as well as status of their relevancy for the proposed project are presented in the table below:

Table 3.2: WB safeguards policies

Operational Policy	Triggers	Status
Environmental Assessment (OP 4.01)	If a project is likely to have (adverse) environmental risks and impacts in its area of influence.	Yes
Forests (OP 4.36)	Forest sector activities and other Bank sponsored interventions which have potential to impact significantly upon forested areas.	No
Involuntary Resettlement (OP 4.12)	Physical relocation and land loss resulting in: (i) relocation or loss of shelter; (ii) loss of assets or access to assets; (iii) Land acquisition, loss of income sources or means of livelihood, whether or not the affected people must move to another location.	Yes
Indigenous Peoples (OP 4.10)	If there are indigenous peoples in the project area, and potential adverse impacts on indigenous peoples are anticipated, and indigenous peoples are among the intended beneficiaries.	No
Safety of Dams (OP 4.37)	If a project involves construction of a large dam (15 m or higher) or a high hazard dam; If a project is dependent upon an existing dam, or dam under construction.	No
Pest Management (OP 4.09)	If procurement of pesticides is envisaged; If the project may affect pest management in the way that harm could be done, even though the project is not envisaged to procure pesticides. This includes projects that may (i) lead to substantially increased pesticide use and subsequent increase in health and environmental risk, (ii) maintain or expand present pest management practices that are unsustainable, not based on an IPM approach, pose significant health or environmental risks.	No
Physical Cultural Resources (OP 4.11)	The policy is triggered by projects which, prima facie, entail the risk of damaging cultural property (e.g. any project that includes large scale excavations, movement of earth, surface environmental changes or demolition).	No
Natural Habitats (OP 4.04)	The policy is triggered by any project with the potential to cause significant conversion (loss) or degradation of natural habitats whether directly (through construction) or indirectly (through human activities induced by the project).	Yes
Projects in Disputed Areas (OP 7.60)	The policy is triggered if the proposed project will be in a "disputed area".	No

Operational Policy	Triggers	Status
Projects on International Waterways (OP 7.50)	If the project is on international waterway such as: any river, canal, lake, or similar body of water that forms a boundary between, or any river or body of surface water that flows through, two or more states ( or any tributary or other body of surface water that is a component of this waterway); any bay, gulf, strait, or channel bounded by two or more states or, if within one state, recognized as a necessary channel of communication between the open sea and other states-and any river flowing into such waters.	No

The project is classified as the Environmental Category “B” in accordance with the World Bank OP/BP 4.01.

### 3.5. Codes and Standards

It must comply with applicable Armenian laws and regulations, national, regional or local level, and the regulations or directives of the International Electrotechnical Commission in force at the time of order placement.

Armenian requirements:

- The RA PSRC Resolution No. 314-N, 2007, “Procedures for Connection of Power Plants to the Power System”.
- The RA PSRC Resolution No. 358-N, 2006, “Rules of power supply and use”.
- The RA PSRC Resolution No. 176-N, 2004, “Rules and procedures to ensure safety and reliability of the Power System of Armenia”.
- Standard defining general requirements and procedures for connection of up to 5 MW solar photoelectric power plants to the common electric grid of the power supplying company of the Power System.
- The RA PSRC Resolution Decree N 374-N, 2013 on Approval of licensing procedures for activity in the power sector and to annul the number of resolutions”.
- The RA Government Decree N 1605-N dated December 27, 2007, Technical Regulations on operation of the electric power plants and networks.
- The RA Government Decree N 1033-N, 2008, Technical Regulations “Requirements to the electric distribution devices and the equipment of substations”.
- The RA Government Decree N 42-N, 2008, Technical Regulations “Requirements to power plants relay protection and automation devices”.
- The RA Government Decree N 1933-N dated November 23, 2006, Technical Regulations “Safety rules for operation of the electric installations”.
- The RA Government Decree N 1033-N dated September 4, 2008, Technical Regulations “Requirements to the electric distribution devices and the equipment of substations”.
- The RA Government Decree N 1943-N dated December 21, 2006, Technical Regulations “General Requirements to the equipment of electric installations”.

- The RA Government Decree N 1922-N dated November 23, 2006, Technical Regulations “Safety Requirements to the electric devices converting voltage of 1000V and higher”.
- The RA Government Decree N 961-N dated July 12, 2007, Technical Regulations on transmission and distribution of electric energy.
- The RA Government Decree N 1918-N, 2011, on Approval of procedure for development of temporary schemes for land use and to annul the GoA Resolution N30 dated January 17, 2001.
- The RA Government Decree N 777-N of 2009 on Approval of licensing procedure for construction works in the area of civil construction (excluding the works not requiring construction permit).
- The RA Government Decree N 739-N of 2005, on Approval of procedure for issuing conclusion on commissioning of newly constructed and rehabilitated power installations with voltage of 6kV and higher.
- The RA Government Decree N 1920-N of 2011, on Approval of procedure on development, expertise, agreement, approval and amending of General Plan for communities (settlements) of Republic of Armenia and to annul the GoA Resolution N 609-N dated May 2, 2003 and N 208-N dated March 4, 2010.
- The RA Government Decree N596-N of 2015 on Approval of procedure for obtaining permits and other documents on the development in the RA and consider void of some of the Government Decrees of RA.
- The RA Government N510-N of 2011 on Approval of licensing procedure and form on development and expertise of the urban development documents (except of activities not required construction permit) and to annul the Government Decrees of Republic of Armenia N 778-N and N 779-N, dated July 2, 2009.

#### International standards:

- IEC 60904-1: Photovoltaic devices
- IEC 61683: Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
- IEC 61727: Photovoltaic (PV) systems - Characteristics of the utility interface
- IEC 61730: Photovoltaic (PV) module safety qualification
- IEC 62093: Balance-of-system components for photovoltaic systems - Design qualification natural environments
- IEC 62124: Photovoltaic (PV) standalone systems - Design verification
- IEC 61557-1: Electrical safety in low voltage distribution systems up to 1000 Vac and 1500 Vdc
- IEC 61558: Specification for safety of power transformers, power supply units and similar apparatus
- IEC 61173: Over-voltage protection for photovoltaic (PV) power generating systems
- IEC 61194: Characteristic parameters of stand-alone photovoltaic (PV) systems

- IEC 61724: Photovoltaic system performance monitoring - Guidelines for measurement, data exchange and analysis
- IEC 62446: Grid connected photovoltaic systems - Minimum requirements for system documentation, commissioning tests and inspection
- ISO 9355-1: Ergonomic requirements for the design of displays and control actuators Applicable editions of these standards will be the last published, including corrections, at the time of order placement.

### 3.6. The comparative analyses of the RA and international norms

The WB, ADB and RA comparative analysis of the environmental and social regulatory requirements is provided in the tables 3.3 and 3.4 below:

Table 3.3: Environmental Impact Assessment

RA Legislation	WB
The Law of the RA On Environmental Impact Assessment and Expertise (the “Law”) limits the concept of “area of influence” to “affected community”, which, according to the Law is the population of the community(ies) of the possible impact zone, including individuals and legal entities.	The area likely to be affected by the project, including all its ancillary aspects, such as power transmission corridors, pipelines, canals, tunnels, relocation and access roads, borrow and disposal areas, and construction camps, as well as unplanned developments induced by the project.
The Law provides for less vague rules for environmental categorization of the planned activity. The planned activities are classified into category A, B and C, based on descending impact scale. According to the Law, PV plants occupying an area of 40 hectare and more are listed as category C, and high voltage lines of 110kV and more are classified as Category B.	A proposed project is classified as Category B if its potential adverse environmental impacts on human populations or environmentally important areas, including wetlands, forests, grasslands, and other natural habitats are less adverse than those of Category A projects. These impacts are site-specific.
Environmental monitoring during project implementation provides information about key environmental aspects of the project, particularly the environmental impacts of the project and the effectiveness of mitigation measures. Such information enables the borrower and WB to evaluate the success of mitigation as part of project needed.	The EMP shall: (a) describe monitoring measures with technical details, including parameters to be measured, methods to be used, sampling locations, frequency of measurements, detection limits and definition of thresholds that will signal the need for corrective actions; and (b) describe monitoring and reporting procedures to ensure early detection of conditions that necessitate particular mitigation measures and document the progress and results of mitigation.

Table 3.4: Social Impact Assessment

RA Legislation	WB SPS
Land compensation only for titled landowners.	Persons who have no recognizable legal right are provided compensation or resettlement assistance, as specified in the RPF.



RA Legislation	WB SPS
All affected houses/buildings are compensated for buildings damages/demolition caused by a Project, with the exception of unregistered commercial structures.	WB Policy includes compensation for loss of structures for those without title to land or permits (Undepreciated value of building in cash +Right to salvage materials+ costs of shifting + job placement, skills training).
Crop losses compensation provided only to registered landowners.	Crop losses compensation provided to all PAPs.
Land valuation based on current market value plus 15% of the assessed value.	The methodology to be used in valuing losses is based on replacement cost.
Information on impacts quantification/costing, entitlements, and amounts of compensation and financial assistance are to be disclosed to the PAPs prior to appraisal	The same
No provision for income/livelihood rehabilitation measure, allowances for severely affected PAPs and vulnerable groups, or resettlement expenses.	The WB policy requires to assist PAPs in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels.
RA law does not have a specific project level GRM, but RA legislation envisages mechanisms for the PAP's to submit applications, complaints, objections and suggestions to the acquirer and to the relevant authorities as well as filing a complaint to the court, during every stage of the acquisition process. Regardless the requirement of the "RA Law on Alienation of Property for Public and State Purposes", every person has a right to an effective remedy before courts and before state authorities according to the RA Constitution. Public consultations with PAPs are not envisaged by RA legislation. However, the RA legislation defines the requirements and conditions for notification of PAPs on their actions and rights during different stages of alienation process, particularly:	An appropriate and accessible grievance mechanism should be established and specified. PAPs and community should be meaningfully consulted and provided opportunities to participate in planning and implementing resettlement programs. They have to be Informed about their options and rights pertaining to resettlement. Full information regarding the GRM process is available in the RPF.
after the government decree on recognition of property as exclusive prevailing public interest comes into force, a copy of the description protocol of the property to be acquired, draft contract of the property to be acquired is sent to the property owner and persons possessing property rights. The property acquirer shall provide information on transferring the compensation into the court or notary deposit account. If the acquirer is conducting a preliminary survey on the property to be acquired, adequate information shall be provided to the property owner, the possessor and user on the nature and matter, legal consequences of those proceedings prior to its initiation.	

In case of conflict between standards, the most stringent requirements will prevail.

### 3.7. Administrative Framework

This section identifies all major parties to be involved in the project implementation and summarizes their roles and responsibilities primarily, but not exclusively from an environmental perspective. More details including capacity development and training needs are provided in Section 10 of this report.

#### *Implementation Agency (IA)*

FVR Masrik CJSC will be an implementation agency of the.

Particularly in the ESIA framework, IA will be responsible for overall project implementation monitoring and reporting to WB, including but not limited to:

- i. Guarantee that all relevant requirements of Environmental Management Plan (including nature protection designing and mitigation measures) are properly included in the project tender documents.
- ii. Ensure that all necessary permissions and/or agreement required from the relevant government institutions are received by Developer prior to any construction works under the Project.
- iii. Ensure that Developers (contractors) understood their obligations on mitigation of the problems of environmental protection connected with construction and training of their personnel in implementation of EMP.
- iv. Monitoring of EMP implementation by the Developer according to the plan of environment monitoring.

#### *Ministry of Nature Protection*

The Ministry of Nature Protection (MNP) is responsible for protection, sustainable use, and regeneration of natural resources as well as the improvement of the environment in the Republic of Armenia. In those areas, the MNP's authority includes overseeing national policy development, developing environmental standards and guidelines, and enforcement. The MNP implements those functions through the following structural departments:

- Department of Environmental Protection Policy
- Department on Monitoring of Environmental Strategic Program
- Legal Department
- Information and Public Relation Department
- Financial-economic Department
- Department of Underground Resources and Land Protection Policy
- Department of International Cooperation

The MNP also undertakes several functions through the following key detached divisions and subordinate bodies:

- *Water Resources Management Agency*

WRMA is the key institution responsible for the water resources management: development of National Water Policy and National Water Plan; classification of water resources by their purpose of usage; participation in water standards development and supervise their application, issue water use permits, etc. Prior to operation of the PV Plant, it is necessary to receive the Water System Use Permit from this Agency.

- *Environmental Impact Expertise Center SNCO* (conduct environmental assessments, issue expertise conclusions). Masrik 1 PV Plant is subject to the environmental expertise to be implemented by this Center.
- *Environmental Impact Monitoring Center* (collects water quality data from 131 sampling points), including from River Masrik, which is adjacent to the PV Plant's area.

#### *Ministry of Energy Infrastructures and Natural Resources*

The MEINR is a state body of executive authority, which elaborates and implements the policies of the Republic of Armenia Government in the energy and natural resources management sector. The MEINR implements the functions related to natural resources management through the following structural departments:

- *Subsoil Concession Agency*
- *Mineral Resources Agency*
- *State Energy Inspectorate – the inspectorate issues startup conclusion for the power plants.*
- *State Committee of Water Economy*

#### *Public Services Regulatory Commission*

- Construction and operation of the solar power plants are regulated by the Power Generation License issued to the IE. According to the local legislation, the RA Public Services Regulatory Commission issues Power Generation License to the legal entity in accordance with the PSRC Resolution N374 dated November 1, 2013.

#### *Ministry of Health*

The Ministry of Health is a state body of executive authority, which elaborates and implements the policies of the Republic of Armenia Government in the healthcare sector. The MH implements the functions related to development and organization of implementation of healthcare management policy and state projects, development and approval and sanitary norms and rules, drafting as well as oversight over implementation of laws and regulations related to healthcare sector.

The MH has the following separate divisions and state agencies:

- Medical Aid Policy Department
- Maternal and Child Healthcare Department
- Legal Department
- Medication and Medical Technology Policy Department
- Licensing Agency
- National Healthcare Inspectorate

*This Inspectorate implements the supervision of the population and employees health. During construction and operation of the PV plant, meeting the obligations related to employees' health will be supervised by the Inspectorate.*

#### *RA Environmental Protection and Mining Inspectorate*

The RA Environmental Protection and Mining Inspection Body established according to the requirements of the Law of the Republic of Armenia “On Inspection Bodies”, on the basis of the RA Ministry of Nature Protection Staff Nature Protection State Inspection and the RA Ministry of Energy Infrastructures and Natural Resources Staff State Mining Inspection. The RA Environmental Protection and Mining Inspection Body implements control and (or) other functions provided by the law, as well as applies sanctions in spheres of environmental protection, use, reproduction of natural resources and mining industry, on behalf of the Republic of Armenia.

Table 3.5: Key Stakeholders Matrix:

No.	Stakeholder	Role / Responsibility
1	Implementation Agency	IA is responsible for overall project implementation monitoring and reporting to WB.
2	Head of Local Community	Issues Construction permit
3	Public Services Regulatory Commission	Issues Power Generation License
4	Ministry of Nature Protection / Environmental Inspectorate/Environmental Impact Assessment Expertise Centre	Environmental impact assessment expertise;  Supervision of the compliance with the effective environmental legislation
5	Ministry of Energy Infrastructures and Natural Resources/ State energy inspectorate	<i>Issues Startup conclusion for the power plants.</i>
6	Ministry of Health/ National Healthcare Inspectorate	<i>Supervision of the population and employees health</i>
7	Ministry of Culture / Agency for Protection of Historical and Cultural Monuments	Accompany design team to ensure that cultural heritage sites are bypassed or over-spanned

## 4. PROJECT DESCRIPTION

### 4.1. Masrik 1 PV Plant

#### 4.1.1. General Description

AC power: 55.0 MWn

Peak Power: 62.013 MWp

Fenced Area: 128.3 ha

These production units (hereafter ITC “Inverter Transformer Center”) are formed by several parallel and series associations of photovoltaic modules, which in turn are mounted on fixed structures with horizontal PV module assembly.

- ITC contains following MV switchgears:
  - 1 Incoming switchgear.
  - 1 Outgoing switchgear.
  - 1 Protection switchgear.

Each ITC will be equipped with an auxiliary power transformer which will supply energy to necessary auxiliary services for proper operating of PV plant.

The interconnection of the production units that composed the PV Plant will be by 2 circuits of 6 ITCs and 2 circuits of 4 ITCs each through medium voltage cables (35kV). These aluminum medium voltage cables will be preferably installed under duct through several trenches converge in the Connection Center (CC).

In the CC will be interconnected the internal medium voltage power lines (35kV) with 110kV PV electrical substation through two lines (one line for each power transformer) connecting the PV plant with PV Electrical Substation redundantly.

Connection Center contains following MV switchgears:

- 4 Line switchgears, that correspond with the 4 connection circuits.
- 1 PV production measurement/coupling switchgear.
- 2 Evacuation switchgear.
- 1 Auxiliary Services Protection Switchgear.

The CC will be equipped with certified and homologated measurement system connected to the MV switchgears to get a measurement of the net energy.

From the CC an auxiliary power transformer will supply the necessary energy to devices (Aux. Services, lighting, power suppliers, etc.) of the Control Center used to control the operation of PV plant and Warehouse used to store maintenance elements. The consumption of the auxiliary services of the photovoltaic plant will be upstream of the general PV production to discriminate incoming and outgoing power.

Generally fixed tilted systems are employed on sites with high wind or snow loads. However, some tracker

#### *4.1.2. Generating System*

The generating system consists of a group of PV modules connected in series and in parallel with each other to achieve an optimal level of output voltage and current ranges compatible with the input of inverter model selected.

The parallel connection of the PV modules series will take place in direct current combiner boxes distributed by the solar field. In this combiner box, will be installed protection (fuses and surge arrester) and switch of series that will allow maintenance and switching operations.

The number of trackers and piles the numbers are:

- Number of trackers 2,953,
- Number of piles per tracker 5,
- Number of PV modules per tracker 56,

The direct current received from solar panels will be transformed into alternating current through a number of inverters that in turn will be connected to the average voltage transformers forming a medium voltage network. A medium voltage network will be connected to the substation located in the territory of the plant, where the voltage will rise to 110 kV in order to be connected to the Electric Networks of Armenia (ENA).

It is planned to construct a 33/110 kV voltage substation in the territory of the Solar Power Plant.

#### *4.1.3. Generation Medium voltage transformers*

In PV plant will be installed 12 Medium voltage transformers

- 6 Transformer station 5MVA (x42/43 inverters SUN2000-105KTL-H1)
- 6 Transformer station 5.1 MVA (x44 inverters SUN2000-105KTL-H1)

The transformers will be employed to step up the low voltage output from inverters (two inverters by ITC) to the internal medium voltage of the plant. These transformers will have double secondary windings to optimize the interconnection with the two inverters. The transformers will be with very low losses (1%).

#### *4.1.4. Grounding General Description*

A grounding system should be installed in a manner that will limit the effect of ground potential gradients to such voltage and current levels that will not endanger the safety of people or equipment under normal and fault conditions. The system should also ensure continuity of service.

The system of ground electrodes will have the form of a grid of horizontally buried conductors, supplemented by a number of vertical ground rods connected to the grid. Horizontal (grid) conductors are most effective in reducing the danger of high step and touch voltages on the earth's surface

Rods penetrating the lower resistivity soil are far more effective in dissipating fault currents whenever a two-layer or multilayer soil will be encountered and the upper soil layer has higher resistivity than the lower layers.

Grounding conductors shall be stranded soft drawn annealed copper material or equivalent.

Ground rods shall be Copperweld material or equivalent.

As a general conception grounding system shall be such that when connected to other on site grounding networks, the electrical resistance between networks shall be 0.5Ω or less.

#### 4.1.5. Auxiliary Services

The general auxiliary services of the PV plant will be feed from auxiliary medium voltage power transformer located inside of Connection Centre. This auxiliary transformer will step down medium voltage of the grid connection to low voltage and it will be interconnected with the auxiliary low voltage panel board which will supply the auxiliary services of Control Centre and Warehouse.

The general auxiliary services will be the following:

- Lighting
- Sockets
- Fire protections
- Security
- CCTV
- Control system
- Warehouse electrical consumption

On the other hand, the ITCs will have electrical consumption which will be feed from an auxiliary low voltage power transformer located inside of each ITC and it will step down the output voltage of inverters to low voltage of following auxiliary services:

- Inverter power supply
- Cooling fans power supply
- Lighting
- Sockets
- Smoke detectors

#### 4.1.6. Monitoring System

It shall be designed in order to achieve a global and detailed view of the operation of the plant and a failure or deviation detection tool.

The data acquisition levels are:

- Junction boxes: measuring voltage and intensity in photovoltaic generators
- Inverters: input and output process variables at the inverter
- Meteorological station
- Measuring counters at the battery limit of the PV plant, in order to know the energy delivered to the electric company.

All these data are sent, by means of a fiber optic net, to the Control Centre, where a SCADA application is installed. This SCADA will be continuously evaluating inverter values in order to supervise which are producing with poor performance and to allow corrective actuations.

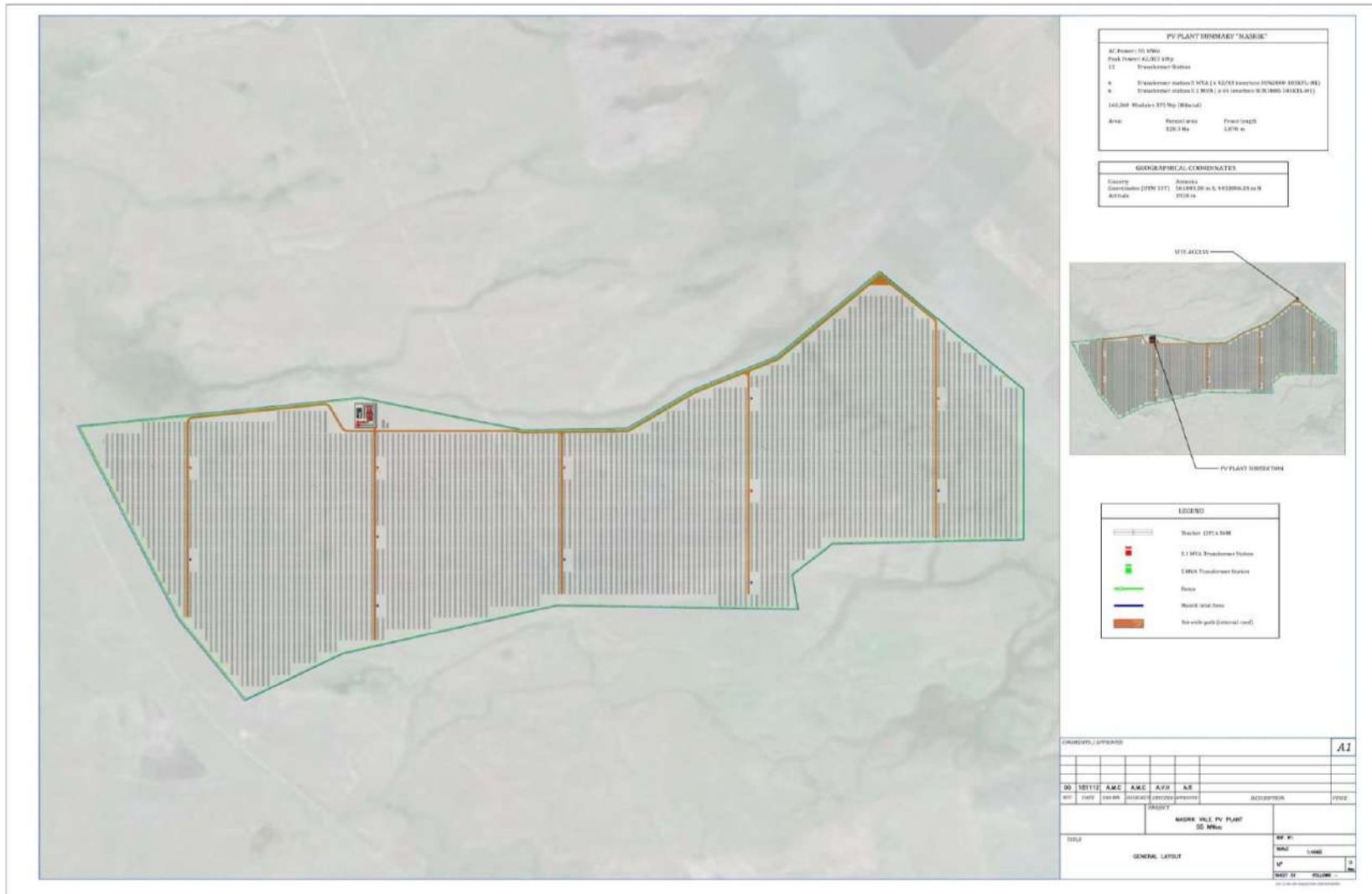


Fig. 4.1. PV plant area and infrastructure



## 4.2.Overhead Power Line

The PV Electrical Substation will be connected to the energy system at the nearest tension towers of 110kV “Kaputak” and “Akunk” overhead lines by constructing 9.2 km overhead branch lines (T-off lines).

Masrik-1 110kV double circuit overhead power transmission line is intended to connect existing two single line overhead power transmission line Kaputak N452 tower and Akunq N86 tower. The selected trajectory is coordinated by all stakeholders.

The trajectory is in the third climatic zone where the ice cover thickness is 20mm, and the maximum wind speed is 36mps, the maximum air temperature is +35°C, and the minimum is -26°C.

In the trajectory will be placed 41 towers, 13 of them will be deviation towers.

The lightning protection will be performed with OPGW-50 optical lightning conductor.

The selection of the foundation was based on the forces acting on them based on the physical and technical properties of the ground.

There are three types of foundations, which will be used for the project. For tangent tower will use F2-2 foundation. For deviation tower will use F2-Y and F4-Y foundations.

Under foundations it is planned 100mm crushed stone. After the foundations installation need to do ground backfill with compaction. The grounding system of each foundation is separate.

As the conductor will be used aluminum steel conductor AS150/24. As vibration damper will use GVH-3-17. For suspension string of insulation will use 10 PS70-E insulators, and for supporting insulation string will use 9 PS70-E insulators.

In the part of lightning protection optical conductor, which is tension are isolated and the supporting fasteners are not insulated.

Connection of aluminum steel conductors in plume is foreseen PA-4-1 hinges clamp, and for each connection provide two hinges clamp.

For connecting aluminum steel conductors in flights foreseen SOAS-150-3 clamps, and for connection lightning protection optical conductor SBS-50-3 clamps.

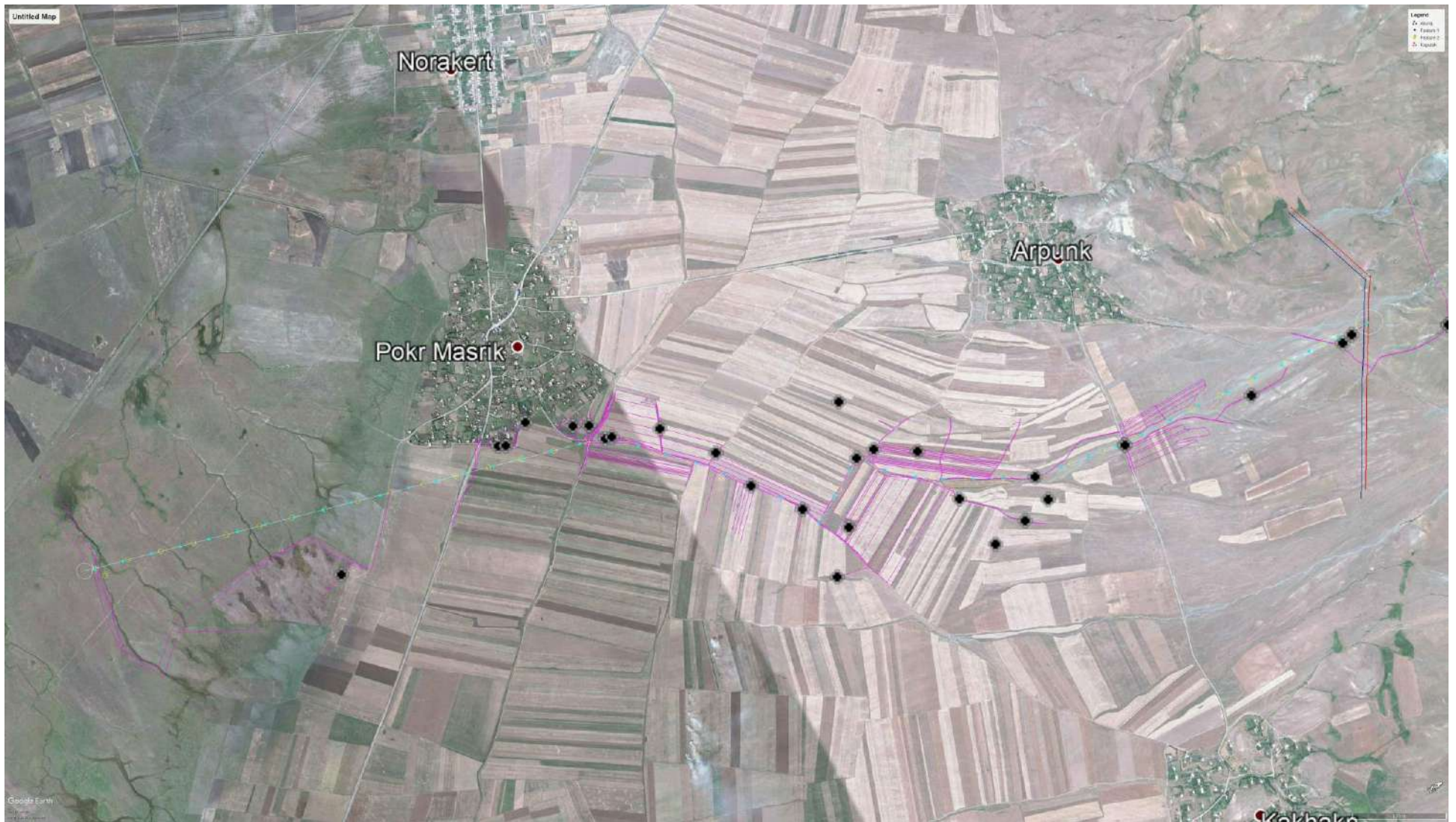


Fig. 4.2. Transmisión line area

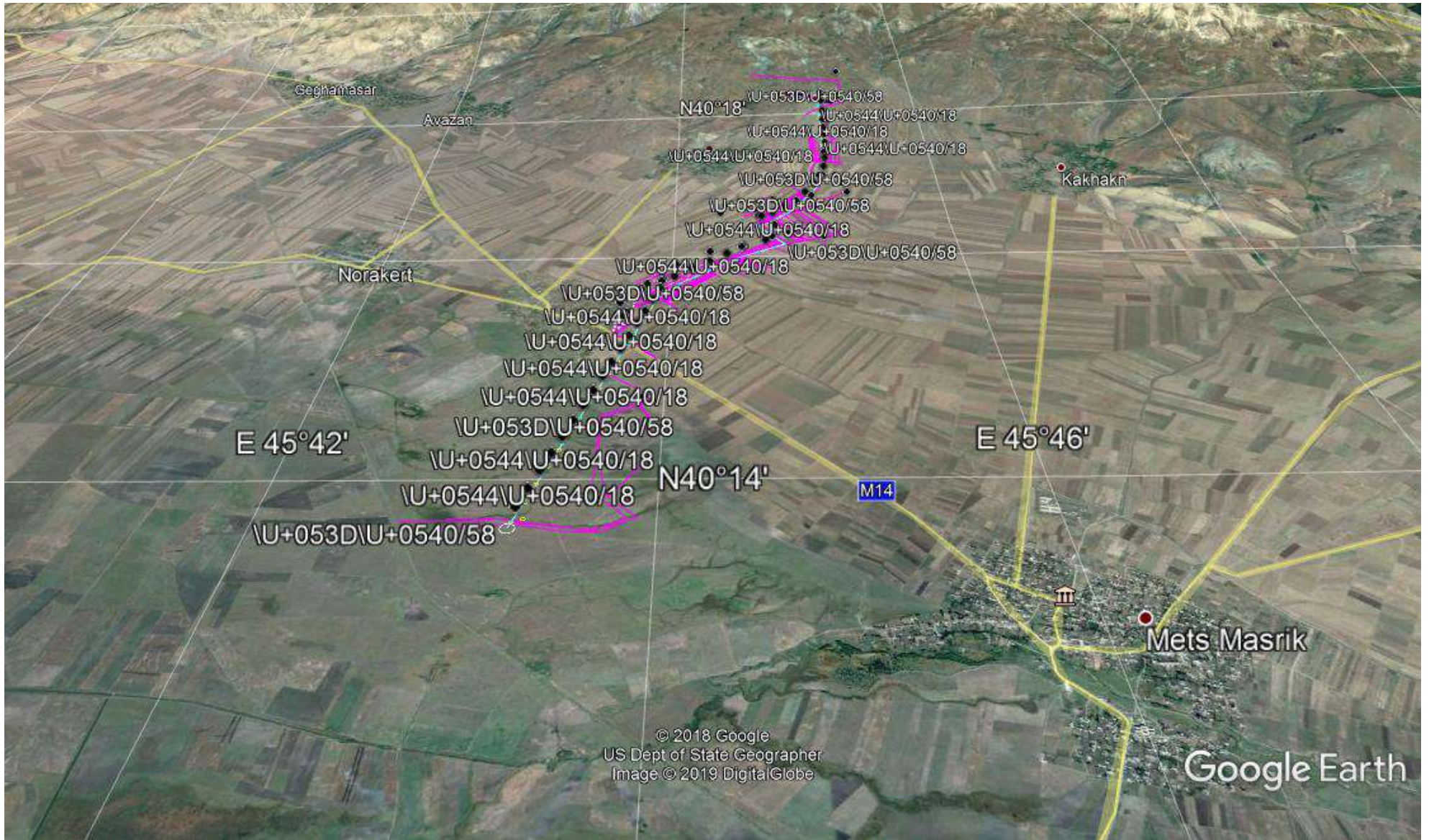


Fig. 4.3. OTL Towers



### **4.3. Civil Works Description**

#### *4.3.1. Roads and Parking area*

##### *Perimeter road*

A perimeter road will be implemented joining the internal roads in the outline of the General Blocks to improve the mobility.

##### *Internal road*

The purpose of the internal roads is to allow access to various facilities in the solar plant, during construction, operation and maintenance on a safe way. There will all interior roads needed to allow access to each ITC.

Considering the hydrology study and drainage system designed in the plant will assess the design of the roads drainage.

The roads will have the appropriate transversal slope for drainage to reduce pending and infiltration of water into the pavement and sub-grade materials. The construction of perimeter swales, edge drains, curbs and gutters, or combination of these drainage devices is recommended to reduce the adverse effects of surface water runoff. The design of the alignment of each road will be carried out adequately to let the vehicles to pass over these roads under safety and comfortable conditions.

The sizing of the type section will be done taking into account the heavy traffic category (number of vehicles per day) and types of soils of the embankment, ensuring the correct transmission of loads during the useful life of the plant.

A parking with capacity of at least 15 vehicles will be necessary. This parking is available in the vicinity Control Centre.

#### *4.3.2. Buildings*

The following buildings are considered:

- Control Centre

Prefabricated galvanized steel building (container blocks-type). It will contain a control room, toilet and dressing room, kitchenette and electrical room. It will be available in the vicinity a parking.

- Warehouse

Prefabricated galvanized steel building (container blocks-type).

Inverter transformer centre (ITC)

Prefabricated galvanized steel building (container-type) with two inverters, one medium power transformer, one auxiliary power transformer, and all auxiliary elements to lighting, auxiliary power supply, ventilation, security and fire protection.

- Connection centre (CC)

There will be a prefabricated concrete with auxiliary medium voltage power transformer, medium voltage switchgears and all auxiliary elements to lighting, auxiliary power supply, ventilation, security and fire protection.

#### *4.3.3. Structure of photovoltaic modules*

According to photovoltaic structures providers the supporting structure (columns, tubes, bars and levers) of photovoltaic modules normally is hot-dip galvanized steel (according to EN ISO 1461). All the elements will be bolted. Welding, drilling or cutting is not necessary on site.

Main structure will be formed by foundation posts and rails, both produced by hot-dip galvanized steel profiles. Two foundation posts will form one support unit. This allows wider support distances and bigger module areas. The PV modules will be horizontally assembly on the rails with the appropriate fastening system to withstand the loads due to the weight of the PV panels and to those generated by weather conditions.

#### *4.3.4. Foundations*

The foundations depend on the structure itself, the wind requirements, the terrain characteristics, and the good durability strategy. For this reason there is not a general optimal solution and it always depends on the combination of the mentioned factors.

In later stages of the project, the choice of the type, shape and size will be handled as well as the structure type for supports and the loads transmitted to the foundation, taking into account the existing conditions the geological and geotechnical study of the location.

#### *4.3.5. Drainage*

A philosophy of drainage will be previously evaluated according to the site conditions that allow deciding the need of protection of the plant against floods, avoiding damage to people and facilities during the phases of construction, operation and maintenance.

#### *4.3.6. Perimeter fence*

Perimeter enclosure will be erected a perimeter fence 2 m height with strands of barbed wire for security, with steel posts separated adequately and steel post reinforcement each 15 m and in each direction change. A galvanized steel wire mesh of simple twist at least, will be placed between the steel posts. Steel posts must be adequately installed on the ground for proper working of the fence. It will be taken into account the location of the accesses for the vehicles and pedestrians.

The total length of the perimeter fence will be 5870 m.

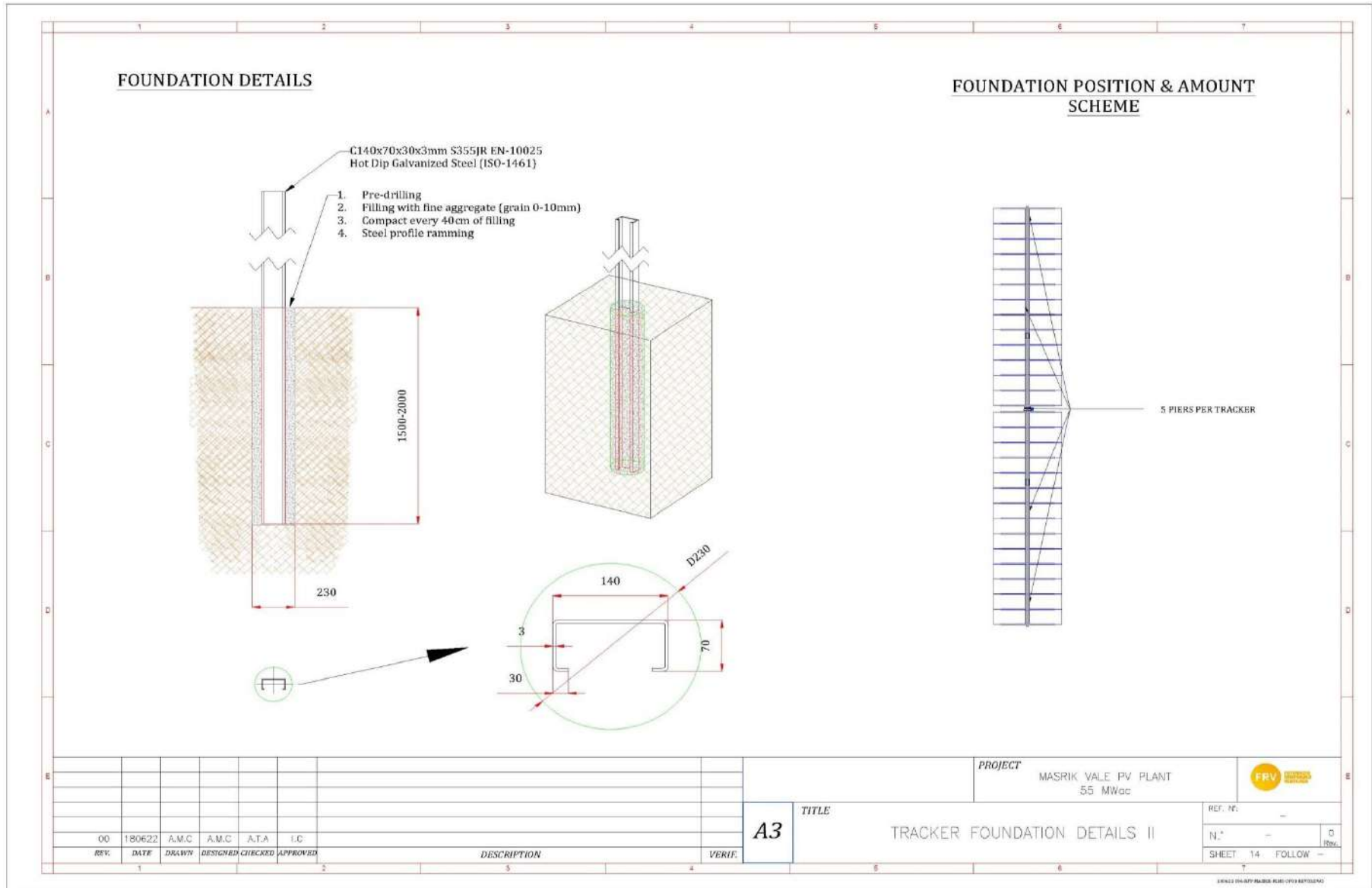


Fig.4.5. Foundation Position

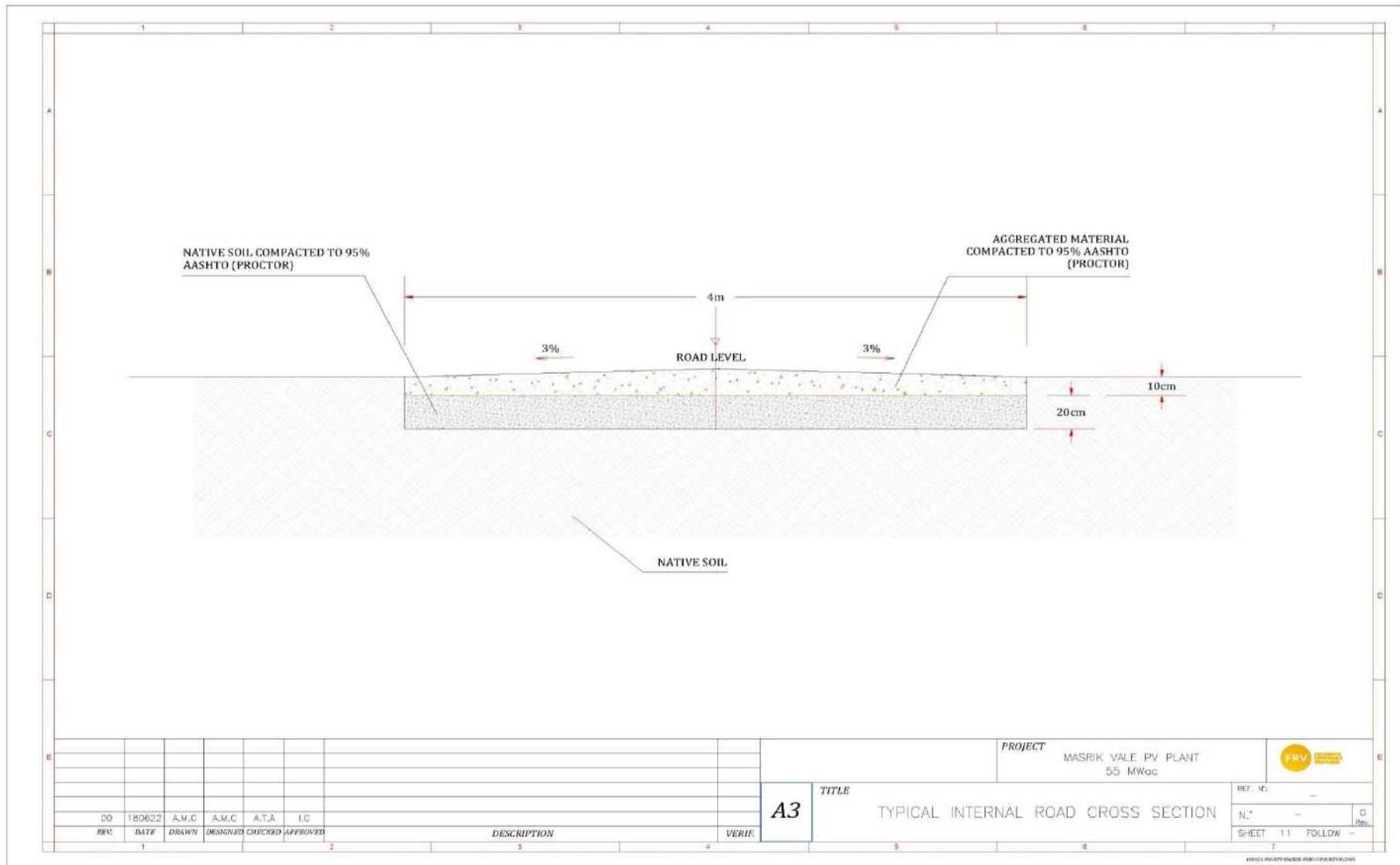


Fig. 4.6. Internal Roads



## 5. METHODOLOGY OF ESIA

### 5.1. Scope and Objectives of the ESIA

Within the scope of this Environmental and Social Impact Assessment, the environmental and social impacts of the construction of Masrik 1 PV plant and OTLs are investigated.

The proposed construction of Masrik 1 PV plant will have several impacts on different environmental and social components. The main objective of the ESIA was to ensure that requisite environmental and social mitigation measures, commensurate with the national and international standards, are recommended and implemented. The ESIA provides useful information to IE and to the general constructor on how the PV plant shall be designed and planned, to avoid or mitigate negative impacts as well as to better capture anticipated environmental and social benefits.

On the basis of the existing environmental situation, the environmental and social impacts during construction and operation of the proposed PV plant are determined and evaluated. In a second step, appropriate mitigation measures and monitoring measures were considered to reduce possible adverse impacts.

During the investigation of OTL routing, main focus was stressed on finding a line routing that is feasible from an economic and technical point of view avoiding:

- a) environmental impacts to the possible extent,
- b) the need of resettlement actions or any other adverse social impacts to the greatest possible extent,
- c) avoid interaction with cultural and historical sites as much as possible.

After public disclosure of the ESIA, including the ESMP, public consultations will be executed in order to seek feedback and concerns of people affected by the Project.

### 5.2. Procedures and Methodology

General overview about biophysical settings has been done as desktop study, and a field survey was conducted by the environmental and social experts in July-September 2016. No rare, endangered, endemic, or other species of concern were found during the survey.

The additional field surveys, including surveys along the alignment of the overhead lines, were carried out in October, 2018. In a result of surveys, no species registered in the Red Book of Animals and Plants of the Republic of Armenia, were detected.

Additional information was gained by consultations of representatives of governmental organizations and local communities. Intense consultations have also been conducted with members of the Historical and Cultural Monument Protection Agency of the Ministry of Culture.

To ensure the expressiveness of the assessments, in addition to the calculation method required by the RA legislation, the matrix method is also applied. This method is largely applied by many international companies.

On the basis of a point scale, the severity of the particular environmental impact together with its general trend is described. The evaluation scale applied is as follows:

Extent of impact:

???	=	high
??	=	medium
?	=	low
?	=	no impact

For judgment: international standards like standards from the EU, World Bank, ADB are used supported by national Armenian standards.

With the presented method it can be clarified which environmental impacts are most important and for which impacts mitigation measures must be applied, in order to reduce negative effects on the environment.

## 6. BASELINE DATA

### 6.1. Location

The area requested for Masrik 1 PV Plant is situated in Vardenis sub region of Gegharkunik Marz, in Lake Sevan in-shore Masrik valley, in the territory of Mets Masrik community. The distance from the nearby settlements is as follows: 4.2 km from Mets Masrik, 3.35 km from Pokr Masrik, 4.5 km from Norakert, 6.95 km from Arpunk, 5.2 km from Vardenis, and 7.2 km from Lake Sevan shore. Geographical coordinates and altitude:

- Latitude: 40° 13.564'N
- Longitude: 45° 43.565'E
- Altitude: 1930 m above sea level

In the west, through the midfield road, it borders upon Ararat-Sotk railroad, in the south and west there are arable lands of Mets Masrik community, and in the north, there are similar uncultivated and flat land areas, used as pastures.

Vardenis sub region is situated in southeast of Sevan basin – between Sevan, Eastern Sevan and Vardenis mountain ranges. In general, the mountain surface prevails in the region. The dominant landscapes are the mountain steppe and mountain meadow.

The slopes of Vardenis mountain range facing the Lake Sevan are relatively of mild steepness; here the stream of lava erupted by numerous volcanic cones of those mountains, in addition to the volcanic slopes, created also plateaus and moraines. It is precisely in these parts – in the territories between Vardenis mountain range and Lake Sevan, where there are significant flat areas, very convenient for farming. It is specifically the valley of River Masrik and the relatively extensive Masrik field. Those flat areas are at the altitude of 1900-2200m above sea level. The eastern, southern and western riparian flat areas of Lake Sevan are characterized by mountain steppe fertile black soils, with the relatively upland parts being characterized by mountain meadow soils. Among the plant species, prevail mountain steppe, subalpine and alpine plant species serving as summer pastures and highlands. In Gegharkunik Marz, there is scarce forest vegetation; there are sparse shrub parks of oak, juniper and some other tree species in northeastern slopes, with the artificial forest layers grown in the areas formed in a result of lake level drawdown. The holly parks occupy significant areas here. The fauna is not rich; the birds and fish species had significantly decreased in a result of lake level drawdown.

The average temperature in January ranges from -6 °C to -14 °C, and in July –from 8°C to 16 °C, the annual precipitation is 350-650 mm and the active vegetation period is 40-130 days. Masrik, Babajan, Pambak, Dara, Karchaghbyur and other rivers run through the area. Masrik, Sotk, Gilli and other canals are functioning.



Figure 6.1: The panorama of the area requested for Masrik 1 PV Plant

## 6.2. Relief, Geomorphology, Geological Structure

Masrik 1 PV Plant is located in the central part of Masrik field. Masrik field occupies the downstream basin of River Masrik. The altitude is 1900-2000 m a.s.l. The flat surface has steepness to the west and is covered by the strong alluvial sediments layer. To the west, at the location of the former Lake Gilli, there are turf resources.

The potato, cereal, tobacco, vegetables, etc. are cultivated here. The area requested for the PV Plant has the valley relief. During the spring season, waters occurring in a result of precipitations and thaw, are mainly being absorbed or partially form the small temporary ponds, which cause waterlogging of the soil. During summer, only traces of these waterloggings remain – the stripping's with depth of up to 0.5 meters covered by lush vegetation.

Masrik valley to the west (to Lake Sevan) is the concavity of mild steepness surrounded by the mountain ranges of Sevan (from northeast), Eastern Sevan (from southeast) and Vardenis (from south).

Eastern Sevan Kongur mountain range is situated in the confine of the RA Gegharkunik Marz and Artsakh. It encompasses the Lake Sevan by length of 40 km in the southeast. It serves as water division between River Tartar and Lake Sevan. The average altitude of the mountain range is 2700 m. The highest zone is the northern part, where the *Mets Tsarasar* peak (3441 m) is. Of the high peaks there are also *Pokr Tsarasar* - 3427 m, *Gomk* - 3052 m, *Mokhrasar* - 3037 m, *Katarajayr* - 3008 m and *Tsrasar* - 2869 m. Sotkr mountain pass is in Eastern Sevan mountain range (2366 m). In Mets Tsarasar area, steepness of slopes reaches the maximum (above 30°C). In many areas, scattered stones are spread. In the mid parts of Eastern Sevan, the altitudes decrease and the asymmetry of mountain range increases.

Sevan mountain range is extending along the eastern part of Sevan concavity, gradually increasing from the northwest to the southeast, with the highest point being Kochasar (Satanakhach) mountain (3319 m) in the

territory of Azerbaijan, and Perezak Mountain (3290) – in the territory of the Republic of Armenia. The slopes differ from each other by both vegetation cover and steepness. The north-eastern slopes are forest covered and south-western slopes - covered with steppe vegetation. The rivers running down to Lake Sevan are active for 3-4 months in a year. There are temporary active streams on these slopes, which periodically turn into mudflows. The flat alluvial cones can occur on the slopes, and they result from the raised mountain range, at the one hand, and vibrations of Lake, on the other hand.

Vardenis mountain range demarcates the Gegharkunik and Vayots dzor Marzes of Armenia and Artsakh. It extends from Gndasar Peak of Geghama Mountains to Mets Tsarasar mountain loop. The length is 60 km with Vardenis Mountain (3552 m) being the maximum height. Of mountain peaks there are Sandukhtasar (3454 m) and Porak mountain (3047 m), which is a young volcano with the lava flows reaching Vardenis city.

The mountain ranges surrounding Masrik field are composed of the chalk, Paleogene and Miocene rocks and are with folded-fragmental structure. They consist of volcanic, partially – sedimentary (limestone) rocks. These rocks are leached to Lake Sevan and make the alluvial rocks of Masrik field base.

The steepness of Masrik field increases towards the mountain slopes. In the area requested for the solar plant, the area has an insignificant steepness towards Lake Sevan. In the lowland zones of Masrik field prevail the black soils, and in the upland zones – mountain meadow soils.

### **6.3. Meteorological and Climate**

#### **6.3.1. National Climatic Conditions**

The landlocked location and in-country mountain ranges produce climatic conditions within the RA generally dry and continental, although significant variation does occur within the different regions. The RA is categorized as “Dfb” in the Köppen-Geiger climate classification groups. This indicates that RA has a Warm Summer Continental climate. In this designation, the D represents the Continental/Micro thermal climate group, which has an average temperature over 10°C in the warmest months with a coldest month averaging below -3°C. This climatic type usually occurs in the interiors of continents or on their east coasts, and north of 40°N in latitude. The f indicates that there is significant rainfall throughout all seasons and the b indicates that the warmest month averages below 22°C; however at least four months average above 10°C.

Regional climate variation across the RA is noticeable, with lower altitudes having longer and hotter summers, averaging around 25°C with winter temperatures in the foothills falling to around -5°C rather than -12°C which can be recorded in the mountains.

Annual rainfall variations occur across the RA and are influenced by topography. The Lesser Caucasus Mountains prevent humid air masses from reaching the inner areas of the country. Elevations between 1400 m and 2000 m above sea level tend to receive around 800 mm of rainfall per year, with the inland plains only receiving 200 mm to 400 mm.

#### **6.3.2. Local climatic conditions**

For description of climatic conditions of the area requested for the construction of Masrik 1 PV Plant “Construction Climatology” RACN 11-7.01-2011 document was used, which is approved by the RA Minister of Urban Development order No 167-N of September 26, 2011. The document sets up the climatic parameters applied during design of buildings and constructions, heating, ventilation, air improvement, water supply systems, as well as during planning and construction of urban and rural settlements. Climate indicators are mainly calculated for those settlements of the Republic of Armenia where there are meteorological stations with rather long series of observations (of not less than 30 years). The indicators are proofread taking into account the data for the last decade (2009 inclusive). For calculation of certain parameters of precipitations,

also the data of meteorological stations with short series of observations have been used. To characterize the climatic conditions of Mets Masrik climate, the results of long-term observations of Masrik meteorological station located in the vicinity were taken as a basis. As per the data of the meteorological stations, the climate of Mets Masrik should be characterized as cold, mountainous; Winter – very cold, windy, humid, with the average temperature in January ranging from minus 5°C to minus 12°C, relative humidity (at 15 hours) is 70% and above, the average wind speed - 5.0-7.0 m/s. For the winter season, the steady snow cover with the duration of almost three months is typical. The average annual amount of precipitations is 432 mm, though the showers are also possible that will add up to 72 mm daily. The hottest and driest month of the year is August (maximum temperature - 34 °C, the minimum relative air humidity - 47 %).

The wind rose study shows that the east-west wind direction prevails. Moreover, the picture worsens particularly during the hot seasons of the year, and probably depends on the location of the requested area in relevance to Lake Sevan. Nevertheless, the requested area with fewer storms can be characterized as secure.

Table 6.1: Average ambient temperature

	Altitude above sea level, m	Average temperature as per months, °C												Average annual	Absolute minimum	Absolute maximum
		1	2	3	4	5	6	7	8	9	10	11	12			
M. Masrik	1940	-8.5	-7.9	-3.1	4.2	9.4	12.9	16.2	16.0	12.5	6.7	0.6	-5.9	4.4	-38.4	34

Table 6.2: Average humidity

	Altitude above sea level, m	Relative air humidity as per months, %												Average annual	Average monthly at 15:00	
															in January	in August
		1	2	3	4	5	6	7	8	9	10	11	12			
Mets Masrik	1940	76	77	75	69	68	69	67	68	66	70	74	76	71	66	47

Table 6.3: Atmospheric precipitations

Name of settlement	Amount of precipitations average monthly / maximum daily, mm													Snow cover, mm		
	As per months												Annual	Maximum ten days snow cover	Snow cover days of the year	Maximum quantity of water in the snow
	1	2	3	4	5	6	7	8	9	10	11	12				
Mets Masrik	19	19	27	37	62	65	43	35	29	43	31	22	432	73	107	154
	23	29	32	30	44	48	54	72	36	40	35	18	72			

Table 6.4 Wind parameters in Mets Masrik

Name of settlement, meteorological station	Average annual atmospheric pressure, kPa	Month	Repeatability, %								Repeatability of calm, %	Average monthly speed m/s	Average annual speed m/s	Number of days with strong (speed>5 m/s)	Estimated speed possible once during "n" years, m/s	
			Average speed, m/s												50	100
			Northern (N)	North-eastern (NE)	Eastern (E)	South eastern (SE)	Southern (S)	South western (SW)	Western (W)	North western (NW)						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	17	18
Mets Masrik	834.9	Jan	3	3	57	3	7	6	19	2	55	2.3	3.1	84	30	32
			2.2	2.6	3.0	3.4	5.0	4.6	5.2	3.5						
		April	3	2	43	3	8	6	32	3	64	3.0				
			3.5	3.0	4.2	4.3	6.1	4.4	46	3.6						
		July	3	2	84	2	1	1	6	1	77	5.0				
			2.9	4.6	6.4	5.1	3.6	3.0	3.3	3.1						
		October	2.	2	53	3	4	4	29	3.	59	2.4				
			2.1	2.9	3.9	3.8	4.6	4.2	4.2	3.5						



#### 6.4. Characteristics of seismic conditions

The Republic of Armenia is situated in the active earthquake zone with the following seismic zones differentiated from north to south: Near-Kura, Somkheta-Karabakh, Near-Sevan, Kapan-Gogoran, Tsaghkunyats-Zangezur, Yerevan-Orbudar and Urts-Vayk. The deep crustal faults mainly pass through the borders of the mentioned zones, with the largest of them being Sevan-Akera, Shirak-Zangezur and Mid-Arax (Yerevan) faults. These fault zones penetrate into the 40-50 meter depths of earth crust, and on the earth crust surface they are expressed by 5-10 km width zones, for which the altered ophiolitic rock associations are typical.

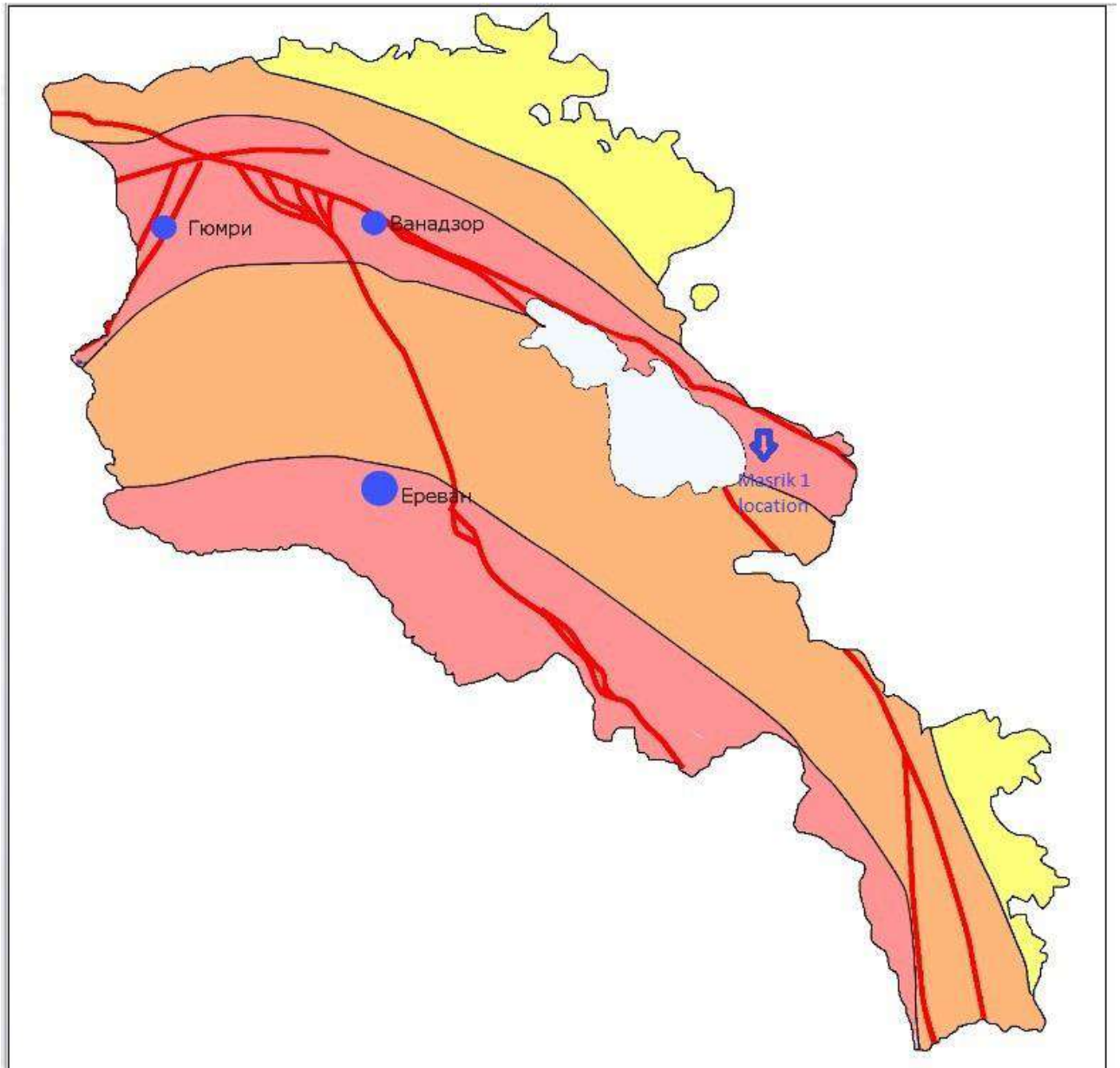


Figure 6.2: Main deep faults of earth's crust



Minister of Emergency Situations Order No 100-N of 12.02.2013, defines the provisions of organization and implementation of seismic risk assessment works, according to which the seismic risk assessment maps are being prepared, serving as a basis for the marzes and communities development programs, as well as for preparing urban development documents, that are applied for the planning of seismic vulnerability reduction measures for buildings and constructions, for the management of emergency situations and reduction of their consequences.

For construction of the solar plant at the requested area, the compliance with the requirements of the RA Law “On Seismic Protection” and the above mentioned legal documents should be ensured. This consideration will be assumed in the technical specifications in relation with the corresponding load calculations design.

## 6.5. Surface water quality characteristics

The main hydrographic units of the region are River Masrik and Lake Sevan. The area requested for the PV Plant, up to the mid 20th century, was adjacent to the Lake Gilli, which disappeared as a result of Lake Sevan level drawdown.

### River Masrik

River Masrik originates in the southwestern slopes of Eastern Sevan mountains and flows into Lake Sevan in north from Tsovak village. (Presently, the estuary of the River is largely displaced). The length is 45 km, and the catchment basin - 685 km<sup>2</sup>. It is composed of the tributaries originating from Eastern Sevan mountain range. It is a mountain valley river. In Masrik field, the river flow slows down and creates ornaments and a waterlogged valley. Presently, at a distance of 2 km from Mets Masrik village, passing the railway bridge, the river is incorporated into the artificial river bed. 2.5 km up the river from Mets Masrik village, part of Masrik waters, through the Masrik canal, flows to the west and irrigates fields of several communities. The river is predominantly fed with snows/rains, including groundwaters. It rises in spring. The water is used for irrigation purposes. The average annual water consumption is 3.01 m<sup>3</sup>/s (Torfavan observation station), the flow is 94.8 mln m<sup>3</sup>. In winter, River Masrik is partially frozen.

The RA Government Decree “On adopting the norms providing the water quality for each water basin management area, depending on the peculiarities of the area” (RA Government Decree No 75-N of January 27, 2011) establishes the surface water quality assessment system in the RA for each chemical water quality indicator. The Decree defines five status classes - excellent (1st class), good (2nd class), average (3rd class), insufficient (4th class) and bad (5th class). The general assessment of chemical quality is formed by the worst quality indicator class. The surface water quality monitoring in the RA is implemented by ArmEcoMonitoring SNCO. The data on the Masrik and Sotk rivers pollution as per the Armeconomonitoring Summary Report for 2017, are provided in the Table 6.5.

*Table 6.5. Water Quality in the Local Rivers*

<b>Water resource</b>	<b>Observation Post Location (number)</b>	<b>Water Quality Indicator</b>	<b>Water Quality Indicator Class</b>	<b>General Water Quality Class</b>
Masrik	0,5 km above Verin Shorzha village (62)	Σ	2 <sup>nd</sup>	2 <sup>nd</sup>
Masrik	Estuary (63)	Phosphate Ion, Cobalt	2 <sup>nd</sup>	

		Vanadium	5 <sup>nd</sup>	5 <sup>nd</sup>
Sotq	0,5 km above mine (64)	Σ	2 <sup>nd</sup>	2 <sup>nd</sup>
Sotq	Estuary (63)	Nitrate, Vanadium, Aluminum, Suspended Solids	3 <sup>rd</sup>	3 <sup>rd</sup>

### Lake Sevan

Lake Sevan is situated at the altitude of 1900 meter above sea level. It is the second freshwater high-altitude lake in the world. In ancient times, it has been referred to as Geghama tsov and Gegharkunyats tsov.

The length is 70 km, the maximum width is 55 km. It is the largest by its surface area in South Caucasus Region - 1260 km<sup>2</sup>. The average depth is 26.8 m, and the deepest part is 83 m (Small Sevan). The water volume is 32.92 billion m<sup>3</sup>. Lake Sevan is divided by Shorja underwater dam into 2 parts: Mets Sevan (37.7 m average depth) and Pokr Sevan (50.9 m). Lake Sevan is an open lake with freshwater. 28 large and small rivers and streams run into the Lake with only one – Hrazdan, originating from it. Due to the latter, the annual water leakage is 0.7 km<sup>3</sup>.

According to one of the genealogical hypothesis of the Lake, it originated in the Quaternary. It emerged in a result of the volcanic action – due to glacial and snow melting waters filling the intermountain tectonic rift valley. It is particularly surrounded from four sides by Areguni, Sevan, Vardenis and Geghama mountains.

During the years of Soviet Governing, the level of the lake has decreased significantly (18 m), which resulted in the ecological problem for the region. In 1978, the Sevan National Park was established. To restore the water level, Arpa-Sevan (48.3 km, 1963-1981) and then also Vorotan – Arpa (21.6 km, 2004) derivation tunnels were constructed.

Lake Gilli is the former wetland lake in southeastern part of Lake Sevan, near Norakert village in Gegharkunik Marz. Before the drawdown of Lake Sevan water level, it had the surface area of about 1000 ha and average depth of 2 m. It had been fed by the waters of River Masrik and of mountain streams. It had the unique biodiversity of birds and fishes. In the swampy part of the basin, out of the nesting birds, there were herons, ibises, gray geese, ducks, cranes, turganes, Eurasian spoonbills and Great crested grebes. On the global migration path of birds, there were a number of birds' resting places, as well as wintering places with favorable weather conditions for certain species. It served as a spawning site for fishes of Sevan. In the area of the Lake, a rare aquatic plant – Marsh clover, could occur.

After the launch of the Sevan Water Level Lowering Project, the water level of Gilli has also decreased, and in 1953 – it was completely dried up. The area of the former lake is used as a peat mine and agricultural lands.

In 2000, the RA Ministry of Nature Protection developed the “Rehabilitation of Lake Gilli” Project, which, nevertheless, was not implemented. As per the experts, the restoration of the lake's water level to the Pre-Soviet period level of Lake Sevan, would impact the swamping process of Lake Sevan.

There are no rivers, streams, lakes and other water bodies running through the area requested for Masrik 1 PV Solar Plant. Presently, the area is used as waterless pasture. Therefore, the construction of the area does not disturb the water balance of the region. In the requested area and in adjacent territories there are a number of sites, which are at the risk of swamping and flooding during the spring season of the year. No permanent spring exits were detected in the requested area. There are traces of a number of shallow springs

with temporary, and not permanent, exits, along the northwestern border of the requested area. The waters of their exits flow to the south-west through the stripping with 30-50 cm depth, accumulating before they reach the railroad poster – creating the small sites of wetlands and marshy lands.

#### Surface and groundwater quality characteristics

The area requested for Masrik 1 PV Plant is a valley situated on the strong alluvial rocks layers. Those rocks are soaked with water. The level of groundwater depends on the season of the year and on the level of River Masrik watercourse. It is supposed, that it is situated within 3 – 10 meters range from the ground level. The flow of groundwater is directed to Lake Sevan, situated on the lower elevation.

In the lowlands near the area, there are a number of deep pits, the waters of which are used to irrigate the surrounding valleys. In Mets Masrik and other affected communities, the groundwater is not used for household purposes. The groundwater quality indicators meet the requirements for irrigation water established by the Annex 1 to the RA Government Decree No 75-N of January 27, 2011. The high level of the groundwater shall be taken into account when designing of the sewerage and drainage system of the PV Plant.

#### **6.6. Ambient air quality characteristics**

The area requested for Masrik 1 PV Plant is situated at a distance of 4-5 km from the settlements the largest of which is Vardenis city (with population of 12500 people as per data of 2015). In the PV Plant's nearby settlements, there are no functioning industrial enterprises, which could be the potential sources of ambient air pollution. At a distance of about 1 kilometer from the area, there is Vardenis - Mets Masrik – Shorja asphalt road (M14) with not an intensive traffic (approximately a vehicle per minute). The border of the area is crossing the Sevan-Sotk railroad. Thus, it can be mentioned that in the area requested for the Masrik 1 plant and in its vicinity, there are no active objects polluting the ambient air. Considering the predominant eastwest direction of wind rose, it can be stated that the pollution of the ambient air of the requested area can be identified with the pollution of Mets Masrik ambient air.

The background atmospheric pollution in the RA territory is controlled by the RA Ministry of Nature Protection “Environmental Impact Monitoring Centre” SNCO (“ArmEcoMonitoring”).

Nevertheless, in Mets Masrik and in nearby villages, there are no permanent (stationary) observation stations or passive samplers installed, and in “ArmEcoMonitoring” there are no data on ambient air pollution.

It is possible to get some idea on the pollution of the atmospheric air of the settlements by method of calculation. For that purpose, “ArmEcoMonitoring” offers relevant manual-guideline<sup>2</sup>. As per that guideline, for the settlements with population of up to 10 thousand people, such as Mets Masrik, the background atmospheric pollution indicators<sup>3</sup> are as follows:

- Dust - 0.2 mg/m<sup>3</sup>
- Sulfur dioxide - 0.02 mg/m<sup>3</sup>
- Nitrogen dioxide - 0.008 mg/m<sup>3</sup>
- Carbon monoxide - 0.4 mg/m<sup>3</sup>

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<sup>2</sup> RA Ministry of Nature Protection “Environmental Impact Monitoring Center” SNCO: “The ambient air pollutants' background concentrations in the RA settlements” Manual-Guideline. Yerevan-2011

<sup>3</sup> EIMC N 15-1/14 On Results of the Ecological Monitoring of the RA Environment: Reference, Atmosphere, Page 22.

Taking into account, that the site chosen for the solar plant is far from the industrial companies and large settlements, and the practically null pollution generated for the PV plant under operation, the level of air basin pollution can be assessed as low.

## 6.7. Noise and Vibration

Maximum allowable noise levels are prescribed within the Sanitary Norms N2-III-11.3 “Noise at workplaces, residential and public buildings, and urban areas” approved by the RA Ministry of Health (Order No 138 dated 6 March 2002).

These maximum allowable noise levels are shown in Table 6.6.

Table 6.6: Maximum allowable noise levels in RA

RECEPTOR	HOURS	Maximum allowable noise levels	
		dBL <sub>AEQ</sub>	dBL <sub>AMAX</sub>
Near residential dwellings and public buildings	06:00-22:00	55	70
	22:00-06:00	45	60

Source : Sanitary Norms N2-III-11.3 “Noise at workplaces, residential and public buildings, and urban areas”.

In the area the source of noise may be the vehicles, air conditioning system and compressor station supplying compressed air at high pressure, explosions, loading and unloading operations. In initial conditions noise level is low, practically noise sources are not anthropogenic (they are natural sounds). Underground explosions can be source of the earth’s crust shaking (vibration).

## 6.8. Soil quality characteristics

Mountain meadow soils are most typical for Vardenis region. Here, the low temperature and strong humidity promoted the development of dwarf, heavy sod making cereal miscellaneous plants and legume plant associations. The vegetation cover of the main part of mountain meadow soils is used mostly for livestock farming – as pastures. The humus content of the mountain meadow soils is 13-20%; they have light mechanical composition and fragile structure, with cation exchange capacity below average (15-20 mg/meq) and acidity reaction (pH=4.8-5.5), and with favorable water physical properties.

The main part of the land requested for Masrik 1 PV Plant is occupied by meadow black soils, which is typical for damp valleys and plateaus at the higher altitudes. There are a large number of wetlands, which, nevertheless, completely dry and harden during summer.

The meadow black soils, as azonal type of soil, were formed in the areas of alpine plains, occurring separately, and not by large areas, in Ashotsk, Lori, Shirak, Aparan and Sevan basin. Development of those soils proceeds under the permanent influence of underground freshwaters on the depth of 11.5-3.0m. The meadow black soils are typically non-calcareous and with coriander-grainy structure, with high humus content – up to 15%, low acidity reaction, high cation exchange absorption capacity (up to 54 mg/meq), and with heavy sandy clay and clayey mechanical composition. They are used as arable lands and meadowlands.

The fertile soil layer capacity of the area requested for Masrik 1 PV plant is high – sometimes exceeding one meter. In the requested area, twenty measurements of fertile soil layer capacity have been carried out in two places – in lowland and upland sites of the area, the average capacity of fertile soil layer has been calculated

(about 80 cm), soil sampling was taken; two representative samples were made from soil samples for two typical areas and their analysis/ results are presented in Annex 5.

According to the requirements of the RA Government Decree number 1404-N of 02.01.2017 “On Approval of the Technical Regulations for Definition of the Norms for Topsoil Removal and for Removed Topsoil Maintenance and Use and on Recognizing Void the RA Government Decree number 1026-N of July 20, 2006” the topsoil is extracted and stored before the construction.

During earthworks, the fertile soil layer shall be extracted separately from the rocks. The fertile soil layer is excavated during warm and dry period of the year. Before excavation of fertile layer, the preparatory works of cleaning the soil surface from stumps, bushes and large stones are carried out. The calculation results of the volumes of fertile soil, extracted from various sites of Masrik 1 PV plant, are presented in Annex 5.

The requirements for the extracted fertile soil layer conservation, in accordance with the RA Government Decree No 1026 of 20.06.2006, are as follows:

- a) During earthworks, the excavated fertile layer of the unused soil, shall immediately be piled up.
- b) The height and form of the piles shall exclude development of soil leaching processes.
- c) If the excavated fertile soil layer is envisaged to be kept for the period exceeding 2 years, then, in order to prevent rinsing and leaching, the surface area and slopes of the piles shall be fixed with grass sowing or other methods. It is allowed to make the sowing on slopes of the piles via hydro methods.
- d) The excavated fertile soil layer in piles can be kept for up to 20 years.
- e) The piles are installed on sites unfit for agricultural works or in lands with low productivity; water-logging, salinization of the piles, as well as their contamination with industrial wastes, hard objects, stones, gravel, pebbles and construction waste, shall be excluded.
- f) The fertile soil layer, before its extraction, shall not be contaminated or littered by industrial or domestic wastes, hard objects, stones, gravel and construction waste, and shall meet the sanitary requirements.

As the capacity of fertile soil layer subject to extraction is high – 70 cm in average, there is a large volume of extracted fertile soil, the storage and conservation of which requires large surface areas. Besides, the surfaces of soils disturbed for the construction of the solar plant, mainly remain under construction, thus, the core bulk of the extracted fertile soil is not used on site for recultivation purposes. In order to avoid expenses for the storage of extracted fertile soil and for the conservation of the stored fertile soil, the measures are to be developed in advance to address the issues of use of the extracted fertile soil. One of the solutions may be not to extract the soil remaining under solar panels, except for the fertile soil remaining under the fundamentals of the panel bearing structures. Nevertheless, it is necessary to verify the compliance of such a solution with the requirements of laws and normative documents.

The owner of the area requested for Masrik 1 PV Plant is Mets Masrik community. The area has the land fund of agricultural purpose and pastures of operational purpose.

## **6.9. Biodiversity**

For the survey of the flora and fauna of the area requested for Masrik 1 PV Plant and its nearby areas, in the first stage, the research of the requested area biodiversity was carried out, based on literature and published materials (see Annex 4). Then, the research was complimented by the field surveys. There were tours in the

area and its vicinities, observation of fauna representatives through optical devices and photographing done, the traps installed and the results of vital activity of the fauna representatives surveyed (nests, excrements, etc.). The observations, photographing, sampling and herbarization of the flora representatives were made. Then, the collected herbarium material was examined in the laboratory conditions. When determining the plant species, the book of research "Flora of Armenia" (Volumes 1-11, 1954-2010) and other literature sources were used. In the field survey stage, the List of flora and fauna representatives potentially occurring/or highly probable to occur, prepared during the office survey, was verified. In the List of flora and fauna representatives, prepared during the office survey stage, the presence of a part of them was not proved, nevertheless, other animals and plant species, not included in the List, were detected.

The survey of the area requested for Masrik 1 Plant showed that:

- a) the area is not situated in the specially protected areas and/or in forest areas, within the boundaries of the historical and cultural monuments or in green areas of common use;
- b) the area is situated in the protection zone of Sevan National Park; there are no plant or animal species, which may become extinct or are endangered. In the Charter of the National Park, the role of the protection zone is presented as an area, where those types of activities, which can impact the protected species in the area, are restricted. The Solar Stations are not included in the List of restricted types;
- c) it is used as pasture and is practically overgrazed every year;
- d) there are wetlands in the area, that should have served as habitats of water related plants and animals (waterfowls, amphibians, of invertebrates – the snails, dragonflies, etc.). As a result of field surveys and information received from local residents, it had been found out that those lands are boggy during April – May, not creating the stable swampy environment.

#### **6.9.1. Flora**

The area belongs to the floristic region of Sevan. It is situated in Masrik field, which is rich with alluvial sediments. The vegetation in the vicinity of Mets Masrik contains steppe and meadow elements. Separately, in wetlands and on the shores of River Masrik, the hydrophilous vegetation can occur. In stage of office works, the presence of Astragal Xerophytic /*Astragalus xerophylus*/ plant species was considered possible in the requested area. Nevertheless, during field works stage, no plant species registered in the Red Book of Armenia were detected in the requested area. The prevailing forms of the surveyed area vegetation are mountain steppes and meadows. Nevertheless, in this area there is a significant depression, sparse and impoverished species composition of the vegetation due to overgrazing (Image 1).





Figure 6.4: Image 1: The area in the North-West from Mets Masrik, scenery

Thus, for example, the Safflower (*Carthamus* sp., Image 2), growing in other areas of Armenia – in rocky or grassy slopes, reaches 1 m height. Here it has “dwarf” looks and gives rise to flowers directly in the land-attached leaf-plugs.



Figure 6.5:Image 2. *Carthamus* sp

The Bird's-foot Trefoil (*Lotus corniculatus* L., Image 3), typical for meadows and riversides in Armenia, also occurs here. Usually, this plant has 15-40 cm height. Here it also grows attached to the land.



Figure 6.6: Image 3. *Lotus corniculatus* L.

Occasionally, the Swollen Clover (*Trifolium tumens* Stev. ex M. Bieb., Image 4) – the plant species typical for forest, meadow or marshy vegetation, also grows in the area.



Figure 6.7: Image 4. *Trifolium tumens* Stev. ex M. Bieb

As it can be seen in the below provided photos, in a result of overgrazing, the soil almost lacks vegetation cover in many parts of this area (Image 5).



Figure 6.8: Image 5: Soil degradation due to overgrazing

In the third section of the surveyed area, the prevailing form of vegetation is the steppe mountain (Image 6). There are also many elements typical for steppes. The overgrazing phenomenon is marked here, though, in lesser degree as compared with previous section.



Figure 6.9: Image 6: Panorama of the third section of the area requested for Masrik 1 PV Plant The Thistle (*Cousinia sp.*, Image 7) is one of the common plants here.



Figure 6.10: Image 7 Cousinia sp

As separate “islands”, the Austrian Wormwood is growing.

African Sage (*Salvia aethiopsis* L., Image 8), typical for arid areas, is quite common in the area. Of meadow elements, there is Neilrechi's Yarrow (*Achillea neilrechii* A. Kerner, Image 9). There are also Felty Germander (*Teucrium polium* L., Image. 10) and Longleaf Spinach (*Falcaria vulgaris* L., Image 11), etc.

There are also many cereals plants growing in the area – various species of Sheep's Fescue (*Festuca* sp.), Ryegrass (*Lolium* sp.) and Bluegrass (*Poa* sp.) (Image 12).



Image 8. *Salvia aethiopsis* L. Image 9. *Achillea neilrechii* A. Kerner Image 10. *Teucrium polium* L.



Image 11. *Falcaria vulgaris* L.

Image 12. *Poa* sp.

### 6.9.2. Fauna

The area requested for Masrik 1 PV Plant is close to the “Gilli” preserve of “Sevan National Park” (6.3 km distance by the straight line), and during the stage of the office works, the potential presence of many animal species, especially, of birds, was considered possible in the area. During field works stage, it was revealed, that due to the yearly overgrazing of the area, its flora is very poor. The area’s landscape is flat and monotonous; there are no suitable nesting areas and adequate habitats for the abovementioned animal species. During the field works, no animal species registered in the Red Book of Armenia were detected in the area requested for Masrik 1 Solar Power Station. It is likely, that the requested area includes the habitats of certain birds registered in the Red Book of Armenia; nevertheless, there are no nesting site conditions for those birds in surveyed area. The construction of the requested area cannot have a significant impact on the number and habitats of those birds.

The surveyed area is adjacent to River Masrik, on the shores of which, of the amphibians, typical for the region - the Long-legged Wood Frog and Marsh Frog, were detected. It is possible, that those animals shall pass their breeding season in the wetlands of the surveyed area, which, nevertheless, completely dry up during the summer. 5 types of lizards, small rodents and birds were detected in the area. Of the insects, certain types of straight-winged (Othoptera), membrane-winged (Hymenoptera) and scale-winged (Lepidopteran), were detected. Below is presented the Table of the animal species detected during the field works.

Table 6.7: Detected animal species

Class	Order	Family	Genus	Species	Name
Amphibians	Anura	Ranidae	Rana	ridibunda	Marsh Frog
Amphibians	Anura	Ranidae	Rana	macrocnemis	Long-legged Wood Frog
Reptilia	Squamata	Lacertidae	Darevskia	raddei	Radde's Lizard
Reptilia	Squamata	Lacertidae	Darevskia	unisexualis	White-Bellied Lizard
Reptilia	Squamata	Lacertidae	Lacerta	agilis	Sand Lizard
Reptilia	Squamata	Lacertidae	Lacerta	media	(Medium Lizard)
Reptilia	Squamata	Lacertidae	Lacerta	strigata	Striated Lizard
Aves	Galliformes	Phasianidae	Coturnix	coturnix	Common Quail
Aves	Passeriformes	Corvidae	Pica	pica	Eurasian Magpie
Aves	Passeriformes	Turdidae	Turdus	torquatus	Ring Ouzel
Aves	Cuculiformes	Cuculidae	Cuculus	conorus	Common Cuckoo
Aves	Passeriformes	Corvidae	Corvus	monedula	Eurasian Jackdaw
Aves	Passeriformes	Passeridae	Passer	domesticus	House Sparrow
Aves	Accipitriformes	Accipitridae	Buteo	buteo	Common Buzzard
Aves	Apodiformes	Apodidae	Apus	apus	Common Swift
Mammalia	Rodentia	Cricetidae	Microtus	arvalis	Common Vole



Image 13 Marsh Frog

Image 14 Radde's Lizard

Image 15. Eurasian Magpie



Image 16. Straight-winged (Othoptera); Image 176 Membrane-winged (Hymenoptera); Image 18. Anthills in the surveyed area

### **6.9.3. Endangered ecosystems, specially protected nature areas**

#### *Sevan National Park*

Near the area requested for Masrik 1 PV Plant is the Sevan National Park. It occupies the entire mirror of Lake Sevan and its riparian areas. The total area of the Park, together with the mirror of Lake Sevan, is 147,343 ha, and without the mirror of the Lake – 22,585 ha. The area of the protective zone is 342,920 ha.

The Park is under the jurisdiction of the RA Ministry of Nature Protection. It was established on March 14, 1978, by joint Decree No 125 of the Central Committee of Communist Party of Armenia and Council of Ministers of Armenian Republic.

“Sevan National Park” State Non-Commercial Organization provides the scientific research, preservation, protection, restoration, recreation, inventory, observation of the natural ecosystems, landscape, biodiversity and nature heritage of the area of the park, as well as sustainable use of natural resources of the park. It is a non-profit environmental, scientific research, scientific and cognitive organization with a status of legal entity, functioning on the basis of the RA Constitution, the RA Laws “On Specially Protected Nature Areas” and “On State Non-Commercial Organizations”, as well as of the SNCO Charter and other legal acts. According to the RA Law “On Lake of Sevan” (May 15, 2001), the whole area of the national park was included in the Sevan Ecosystem Central Zone, being determined as the specially regulated object of urban development activity.

The area of Sevan National Park is divided into 4 territorial-functional zones – nature reserves, preserves, recreational and economic. There are 4 natural reserves in the territory of the park: “Norashen”, “Lichk-Argich”, “Gilli” and “Artanish”, the total area of which is 7,464ha, of which land area – 4,289ha, and water area – 3,175ha; there are 2 preserves – “Gavaraget” and “Gihikaghnut relict”, the total area of which is 2,652ha, of which land area –2,359 ha, and water area - 293 ha, recreational zone with total area of 4,753ha total and economic zone with total area of 11,266ha.

Preservation “Gilli” is the closest to the initiative. Preservation “Gilli” is situated in the southeastern part of the national park – in the estuaries of Gilli canal, Masrik and Geghamasar rivers, and occupies the area of 1,810ha, of which land area is 1,325ha, and water area – 485ha. The area of the preservation extends with about 10.4 km length and 1.8 km width. The objective of the preservation is to provide protection of estuaries of Masrik and Geghamasar rivers for the valuable and rare fish species spawn and development, as well as to protect adjacent marshlands – as birds nesting locations.

The area requested for Masrik 1 PV Plant is by the straight line 6.3 km far from “Gilli” preservation and is separated from the preservation by arable lands and pastures.

### *Wetlands*

The status of wetlands, their vulnerability degree and preservation procedures are regulated by the *Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, 1971)*. There are three areas presented in Armenia’s page of the Convention’s official website.

- ❖ Lake Sevan.06/07/93; Gegharquniq Province; 490,231 ha; 40°24'N 045°17'E. National Park, Ornithological Preserve, State Sanctuary. One of the largest freshwater, alpine wetlands in the world, Sevan lies at 1,900m asl and is surrounded by mountains. The Ramsar Site incorporates the entire hydrological system of the lake including its watershed, tributaries and outflow. About 1,600 plant species have been recorded, including rare and endemic species. The site is important for numerous species of nesting and staging waterbirds, several of which are endangered in Armenia.
- ❖ Khor Virap Marsh.25/01/07; Ararat Province; 50 ha; 39°53'16"N 044°34'18"E. State Sanctuary. Located in the ancient Arax riverbed in the central part of the country, close to the capital city of Yerevan, this freshwater marsh of semi-artificial origin consists mainly of reed beds fed by an irrigation canal and surrounded by drainage channels.
- ❖ Lake Arpi.06/07/93; Shirak Province; 3,230 ha; 41°03'N 043°37'E. National Park, IBA, State Sanctuary (Government approval pending). Lake Arpi is a freshwater lake high in the Ashotzk Mountains, fed by small rivers, springs and melt-water and fringed by marshy areas giving way to meadows and meadow-steppe. The Ramsar site consists of four sub-sites including Lake Arpi, the human-made wetlands of Alvar Sanctuary as well as the ephemeral wetlands of Ardenis Sanctuary consisting of Ardenis pond and the wet meadows of Aghvorik.

*Masrik 1 Solar Power Plant is situated in the Sevan National Park protection zone, and though the protection zone is included in the Ramsar area, there are no wetlands and it does not have immediate impact on wetlands.*

In the area requested for Masrik 1 PV Plant and in the adjacent areas there are no natural monuments, approved by the RA Government Decree No 967-N of 14.08.2008 “On Approving List of Natural Monuments of Armenia”.

### **6.10. Historical and cultural environment**

The Gegharkunik Marz, as well as Vardenis region, are rich with historical and cultural monuments. Those monuments represent all types of monuments with secular and spiritual functions, known in the region. Those are ancient habitations, Stone Age houses, medieval village territories, protective, spiritual, economic structures, cemeteries, obelisks and khachkars (cross stones), etc. Chronologically, they include the period from 15th millenium B.C., i.e. from Stone Age, to our times. Particularly Mets Masrik, out of affected communities, has rich heritage of monuments of history and culture. There are five historical cemeteries in the territory of the village, of which the most famous is the family cemetery of the local ruling dynasty of 15th-17th centuries – Melik – Shahnazaryans, and the upland khachkar dated Year 881 (the second oldest dated khachkar). The Table provides the List of Monuments of Mets Masrik village approved by the RA Government Decree No 80 of 09.01.2003 “On Approving State List of Immovable Monuments of History and Culture of Gegharkunik Marz”.

Table 6.8: List of Immovable Monuments of History and Culture of Masrik Community

Name of monument	Date	Location	Comment
Cemetery	9 <sup>th</sup> -17 <sup>th</sup> centuries	In the NE part	
Khachkar	Year 881		
Khachkar	9 <sup>th</sup> -10 <sup>th</sup> centuries		The upper part is broken
Khachkar	10 <sup>th</sup> -11 <sup>th</sup> centuries		The upper part is broken
Khachkar	11 <sup>th</sup> century		On the pedestal
Khachkar	11 <sup>th</sup> century		On the unprocessed pedestal
Khachkar	11 <sup>th</sup> century		On the unprocessed pedestal
Khachkar	12 <sup>th</sup> century		Set up on the ground
Khachkar	13 <sup>th</sup> -14 <sup>th</sup> centuries		On the unprocessed pedestal, with inscriptions
Khachkar	14 <sup>th</sup> century		Set up on the ground
Khachkar	14 <sup>th</sup> -15 <sup>th</sup> centuries		The lower part is broken
Khachkar – of Yeghisabet	15 <sup>th</sup> -16 <sup>th</sup> centuries		On the pedestal, the upper part is not saved
Khachkar – of Ani and Shahum	Year 1568		Set up on the ground
Khachkar – of Movses and Gulum	Year 1571		On the pedestal
Khachkar – of Abraham	Year 1576		The upper right corner is broken
Khachkar – of Chanpasha and Stepanos	16 <sup>th</sup> century		On the unprocessed pedestal
Tombstone – of Hayrapet	Year 1568		
Tombstone – of Tahir	Year 1581		
Tombstone – of Sargis	16 <sup>th</sup> century		
Tombstone – of Hovhannes	16 <sup>th</sup> -17 <sup>th</sup> centuries		
Tombstone	16 <sup>th</sup> -17 <sup>th</sup> centuries		There are fissures on the sides
Tombstone	16 <sup>th</sup> -17 <sup>th</sup> centuries		NE corner is broken



Name of monument	Date	Location	Comment
Tombstone – of Melikdjan	Year 1638		
Tombstone – of Pap, Melikbek, Atichan	Year 1683		
Tombstone	Year 1685		The upper left part is broken
Tombstone – of Atarbek	Year 1685		
Tombstone – of Djanibek	Year 1692		
Cemetery	9 <sup>th</sup> -17 <sup>th</sup> centuries	In the E part	On the right shore of River Masrik, in the territory of functioning cemetery
Khachkar	11 <sup>th</sup> century	In the N part	Set up on the ground
Khachkar	11 <sup>th</sup> century	In the N part	Set up on the ground
Khachkar	12 <sup>th</sup> -13 <sup>th</sup> centuries	In the N part	Lying on the ground
Khachkar	14 <sup>th</sup> century	In the N part	Set up horizontally as a tombstone
Khachkar	14 <sup>th</sup> -15 <sup>th</sup> centuries	In the N part	Set up horizontally as a tombstone
Khachkar	Year 1600	In the N part	Set up on the ground, with inscriptions
Cemetery - Novaghin	Year 1620	In the N part	Lying on the ground
Cemetery	10 <sup>th</sup> -17 <sup>th</sup> centuries	In the centre	Im Mariam Kurdyan's homestead area
Cemetery	12 <sup>th</sup> -19 <sup>th</sup> centuries	In the S part	Near the school, in Rafik Poghosyan's homestead area
Khachkar	12 <sup>th</sup> -13 <sup>th</sup> centuries		Lying on the ground
Cemetery: the family mausoleum of Melik-Shahnazaryans	16 <sup>th</sup> -17 <sup>th</sup> centuries	In the centre	
Khachkar	15 <sup>th</sup> -16 <sup>th</sup> centuries		Set up on the ground
Khachkar	16 <sup>th</sup> century		The upper part is broken
Khachkar	Year 1571		The upper half is not saved, dated
Khachkar – of Melik bek	Year 1578		On the two-level pedestal
Khachkar – of Abas bek	Year 1641		On the unprocessed pedestal
Khachkar – of Yavri bek and Gulasar	Year 1656		On the pedestal

Name of monument	Date	Location	Comment
Khachkar – of Mirza	Year 1698		On the pedestal, the upper part is not saved
Tombstone – of Babajan	16 <sup>th</sup> -17 <sup>th</sup> centuries		
Tombstone	16 <sup>th</sup> -17 <sup>th</sup> centuries		
Tombstone	16 <sup>th</sup> –17 <sup>th</sup> centuries		Horse-shaped
Tombstone – of Marian	Year 1670		
Tombstone	Year 1682		
Tombstone	Year 1685		
Tombstone – of Papam	Year 1713		
Village territory “SRKHANA”	10 <sup>th</sup> -17 <sup>th</sup> centuries	2 km to the W	
Mausoleum	1 <sup>st</sup> millennium B.C.	In the S part	In the S outskirts of the village, to the left from the road entering the village
S. Astvatsatsin Church	13 <sup>th</sup> -14 <sup>th</sup> centuries	In the S part	On the hill of the right shore of River Masrik
Khachkar	Year 1539		Fits in the W wall, with
			inscriptions
Khachkar – of Emkar	Year 1551		To the S from church, lying on the ground
Khachkar – of ter Sargis, Dovlat and others	Year 1552		
Tombstone – of Tirun	Year 1541		On the W wall
Tombstone	16 <sup>th</sup> -17 <sup>th</sup> centuries		On the W wall
Khachkar	Year 1551	In the E part	On the E outskirts, lying on the ground, dated, has transverse fracture
Khachkar	Year 1580	m.h.	On the edge of the road, in the S from historical cemetery of the village

### 6.11. Social environment of Project site

The information for the baseline data draws primarily on the following sources:

- National Statistical Service of the Republic of Armenia
- Official website of the Government of the Republic of Armenia
- The analysis of Socio-Economic condition of Gegharkunik marz in 2015 (National Statistical Service)

#### 6.11.1. Sociodemographic picture and livelihood

This Location is situated in the Gegharkunik marz. It is located at the eastern part of Armenia, bordering Azerbaijan and the Shahumyan Marz of Nagorno-Karabakh Republic. With an area of 5,348 km<sup>2</sup>, Gegharkunik

is the largest marz in Armenia. However, approximately 1,278 km<sup>2</sup> of its territory is covered by Lake Sevan, the largest lake in the Caucasus and a major tourist attraction of the marz.

According to the date of official census conducted in 2011, Gegharkunik has a population of 235,075 (119,180 men and 115,895 women), forming around 7.8% of the entire population of Armenia. The urban population is 71,423 (30.4%) and the rural is 163,652 (69.6%). The marz has 5 urban and 87 rural communities. The largest urban community is the regional centre of Gavar, with a population of 20,765. The other urban centres are Sevan, Martuni, Vardenis and Chambarak. With a population of 9,880, the village of Vardenik is the largest rural municipality of Gegharkunik and is also the largest rural community in Armenia.

The economy of Gegharkunik has a predominantly agricultural orientation, including farming and cattle-breeding. It has a share of 18% in the annual total agricultural product of Armenia. Around 65% (3,487 km<sup>2</sup>) of the total area of the marz are arable lands. Around 60,000 farms in Gegharkunik are operated by the private sector. The main crops are potato and grains. Fishing and fish farming is also dominant in the marz. Recently, beekeeping has significantly developed.

Mets Masrik is a rural community in Gegharkunik marz with an area of 36 km<sup>2</sup>. The community has a school, a primary school, two kindergartens, medical clinic and a flour mill, hotel, gas stations, ten shopping centres, tower, meteorological station, a post station, irrigation system. The population according to the data of RoA government is 3,428. They are mainly engaged in agriculture.

#### **6.11.2. Vulnerable groups**

In the study area the following vulnerable groups have been identified:

- *Poor households* - based on the information disclosed in official website of the regional administration (marzpetaran) of Gegharkunik for August, 100 households are registered in the evaluation system of vulnerability of families (ESVF) in Mets Masrik. They receive a family allowance in average 34,250.00 AMD (minimum is 24,000.00 AMD, maximum is 63,000.00) in case when the minimum salary of RA is amounted to 55,000.00 AMD. Taking into account that 3,428 people is about 857 households (4 persons per AH), 11.6% of the total households are poor in Mets Masrik. Besides the family allowance, 21 households receive additional social allowance amounts to 18,000.00 AMD, out of which the head of 14 households are women and head of 6 households are men respectively.
- *Women and elderly headed households* - Single and divorced women headed households and elderly headed households in the area are among the most vulnerable people. If resettlement issues arise, they will receive support as a vulnerable group.

Sometimes, the vulnerable people can have some limitation do not raise their grievances/complaints in public and often do not seek legal support even if they perceive a situation to be unjust. It is suggested that during all of the stage of the Project a social specialists investigate potential grievances individually with the affected households. Otherwise, many justified complaints will never be made and therefore impossible to address, preventing full livelihood restoration and thereby violating safeguard principles.

In case, if vulnerable households lose their livelihood caused by the Project (loss of land or other losses), a special livelihood support program shall be implemented as specified by the project RPF and safeguard policies. As suggested in OP 4.12 for the full livelihood restoration the vulnerable households, additionally to cash compensation, will receive the support/allowance to build up a future livelihood.

## 7. ANTICIPATED ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION MEASURES

### 7.1. Environmental Impacts and their Mitigation during Construction

#### 7.1.1. Landscape

The land envisaged for Masrik 1 PV Plant is located in the central part of Masrik field. The altitude is 1900-2000 m a.s.l. The flat surface has steepness to the west and is covered by the strong alluvial sediments layer.

In the west, through the midfield road, it borders upon Ararat-Sotk railroad, in the south and west there are arable lands of Mets Masrik community.

When preparing for construction, certain leveling works, insignificantly changing the landscape, will be made. After the preparation of the area, the modules will be installed. The change of a scene will be visible from Mets Masrik and Vardenis villages, however for the vicinity it will be not a relevant visual impact.

The OTL corridor will mainly pass through the unused areas or pastures.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Landscape	■	■	Long term impacts	Direct by the physical presence of the PV plant

#### 7.1.2. Flora and Fauna

During the construction stage of Masrik 1 PV Plant, the biodiversity of the requested area will be affected by soil disturbance, change of quality of the ambient air, man-made noise, etc. Certain fauna representatives will leave the area.

The survey conducted by the specialists in the area requested for Masrik 1 PV Plant showed, that the biodiversity of the area is much poorer than that presented in a result of the office survey of the same areas. The main reason for this is the overgrazing of the mentioned areas by small hooved domestic animals for years long.

In a result of Project implementation, in the section of modules within the areas envisaged for the PV Plant, the microenvironment will be created, which will result in change of biodiversity.

As a result of construction of the PV Plant, a part of the area will be covered by the solar modules and a part of the soil will be shadowed. According to the schematic image (Feasibility Study: ARIES INGENIERÍA Y SISTEMAS), it has been calculated, that 30 - 35 percent of the occupied area will be in the shade of the Solar Power Station. The remaining area will be shadowed partially, moreover, at sunrise and sunset it will be fully lit up – being situated under the direct sunlight. The essential part of the area remaining directly under the panels will be under the diffuse light. It is expected that in these partially lit up areas, the new plant assemblage will be formed, having in its composition both the native sciophyte plants, as well as new plants, which have not been growing in those areas before, but which are growing in the lower layer of the forests growing in the similar climatic conditions, e.g. the representatives of the nearby “Gilli” reserve’s forest layer sciophyte vegetation. The new ecosystem formed is going to be affected to some extent by the new soil humidity regime resulting from the distribution of the humidity occurring from atmospheric precipitations.

The precipitations of the area covered with solar modules, running downstream from the lower edge of the modules, are distributed in a new way, however, it is expected that the change will be insignificant.

The new scheme of air masses movement, resulting from the resistance of modules to the air movement (wind) and the upward movement of the air in a result of panels' heating, is also going to have certain impact. The orientation of the solar module lines is the East-West with the prevalent wind rose direction being the same. It is expected, that in the area occupied by the solar modules the new ecosystem will be formed, which will be gradually stabilized over time. The most important role here belongs to the man-made factor, which may be expressed, for example, in regular mowing of the partially lit up areas grasslands.

No construction is envisaged for a part of the area requested for Masrik 1 PV Plant (4 meter wide belt between the fence and the perimeter road, the inner edges of roads, etc.). In these areas the flora will be restored fully with the fauna being restored partially.

At the same time, it shall be noted, that though the area of Masrik 1 PV Plant will be situated in the protection zone of Sevan National Park, there are no endangered plant and animal species, and the nature of activities and the distance from the Park (6.3 km far from "Gilli" reserve and is separated from the reserve by arable lands and pastures), allows to conclude, that the construction and operation of the PV Plant will not impact the National Park.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Flora and Fauna	■	■	Long term	Direct

### **7.1.3. Soil Erosion**

Loss of vegetation and soil compaction increases the soils' vulnerability to erosion. It can be difficult for vegetation to recolonize bare and compacted areas of ground. Once vegetation is lost and not restored, the areas affected by erosion often tend to spread through the effects of wind and rain.

Erosion of exposed soil and the resulting sediment produced can occur from the project development, causing air (form dust). Earthmoving activities such as grading and grubbing for the site preparation and heavy equipment hauling over unpaved ground, may loosen soils and cause fugitive dust and particulate matter to become airborne. The potential risk for erosion is increased by placing project components in areas with steep slopes; on unstable soils such as alluvial soils; and on clays, which are fine-grained and susceptible to dust and erosion in dry conditions.

Damage to soils also has further effects on land-use. When soil is compacted, it cannot support native grasses or other vegetation. This in turn reduces the pasturage that can be used by the livestock of local herders or that is available for other creatures. The loss of grass affects biodiversity, since grass is a food source for small mammals, which in turn provide food for predators.

Removal of topsoil will be only in construction site, roads and around towers feet. But the amount of topsoil will be large.

The volumes of the removed topsoil for the foundations of the solar panels bearers are calculated as per number of the bases and the required volumes of holes for each foundation, which is 1.4m x 0.7m x 0.7m = 0.686 m<sup>3</sup>.

- Under the bearers of the foundations: 2953 bearers x 5 bases/bearer x 0.686 m<sup>3</sup> = 6950 m<sup>3</sup>.

The approximate length of the newly operated roads will be 2km, their width will be 4 km, and the volumes of the extracted soil – 2000m x 4m = 8000 m<sup>3</sup>.

The topsoil under the bearers and roads will be 14950 m<sup>3</sup>, and will be stored in the outskirts of the Solar Power Plant area, in the specially furnished warehouse, in accordance with the requirements of the RA Government Decree number 1404-N of 02.01.2017 “On Approval of the Technical Regulations for Definition of the Norms for Topsoil Removal and for Removed Topsoil Maintenance and Use”.

The topsoil under the foundations of the overhead line towers will also be cut and removed, placed near the towers for the short while, and immediately used for the improvement of tower platforms after construction of the foundations.

The removed topsoil will be stored in special conditions and used for the area improvement in future, particularly will be brought back after construction and soil will be replanted when towers are erected in steeper slopes. Access roads that are not needed anymore after construction will be rehabilitated and replanted.

At the same time, changes in site conditions will result in the increased soil moisture content, which in turn will reduce the risk of erosion.

Additional to the mitigation measures given in Section 10.1, preparation and implementation of specific erosion control plans is recommended, once the final technical design of the PV plant and OTLs is available.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Soil Erosion	■ ■	■ ■	Long term	Direct

#### **7.1.4. Soil and Water Resources**

There is a risk of pollution of soil and groundwater by fuel and lubricants from the construction vehicles and machinery, which can be avoided by proper maintenance. Additionally, oil, fuel, paint, chemicals, soil run-off during construction could pollute surface waters. Measures to prevent pollution of soil and water resources by oil and chemical spills have to be implemented during construction phase.

The PV modules will not present a hazard with respect to soil contamination unless paint or other coating is used. The leaching potential for modules from plant structures is extremely low. If soil will be contaminated by drips and spills it will be cleaned up and removed for safe disposal.

The roads will have the appropriate transversal slope for drainage to reduce pending and infiltration of water into the sub-grade materials. The construction of perimeter swales, edge drains, curbs and gutters, or combination of these drainage devices is recommended to reduce Operation of work camps - namely functioning of sanitation and catering facilities, storage and servicing of equipment, stockpiling of construction materials and waste - can lead to sewage and garbage pollution and spills from construction equipment operation and servicing. Construction camp must be equipped with toilets according to IFC/ADB Guidances - separately for men and women - and waste bins to accommodate the entire labor force during construction period. The measures preventing pollution of surface and ground water and soil with chemical products must be applied at the construction site. Dismantlement of construction camps and harmonization of the area with the landscape shall be implemented after completion of construction works.

#### *Water supply and sanitation*

Sanitary water demands in the plant during the construction phase will be satisfied through tanker trucks, and drinking water will be supply with individual bottles. Sanitary water will be stored in the water reservoir on the site.

It is estimated that the amount of water utilized by 1 person is 3 litres.

Chemical toilets will be enabled at the beginning of the construction phase. After this phase, modular wastewater treatment plants will be constructed.

*Water treatment*

Basically wastewater generated during the construction phase is the wastewater from chemical toilets, staff and general facilities services and wastewater for concrete mixer and the cleaning of equipment.

The wastewater from chemical toilets will be managed through authorized management agent, in order to avoid any risk of spillage. This solution will be provisional until the plants wastewater treatment modular, consisting of modules, independent wastewater treatment are built.

It is usual to install general facilities services for the workers, providing them a place to relax and personal care.

Table 7.1: Water usage quantity

Water usage	Quantity (consumed volume)
Workers - personal care	130 persons x 15 l/person/day
Wetting of access roads	12 m <sup>3</sup> /km
Watering for dust control	1 l/module
Contingency	6300 m <sup>3</sup> /year

The activities for wetting the access roads will be twice per day during the dry period of the year. The service will be provided troughs tanker trucks.

The cleaning of the modules will be at the end of the construction phase, in order to commence with the commissioning tests. This process only uses water, without any chemical additives.

Impact of/ on	Sensitivity	Extent of Impact on /by	Duration of Impact	Direct/ Indirect
<u>Soil</u>	■ ■	■ ■	Short term during construction	Direct
<u>Water Resources a)</u>				
Groundwater	■	■		
b) Surface Water	■	■		

**7.1.5. Solid and Liquid Wastes**

The sensitivity of the PV plant area and OTL corridors for solid and liquid wastes is assessed to be medium. The generation of wastes will be minimized by a proper waste management, implemented by the construction contractor. Small amounts of hazardous waste like residual oil, fuel, paint or spill contaminated soil will be stored at PV plant site, which should contains adequate space and roofed, concreted and bonded

facilities for storing of hazardous waste. The hazardous waste will be provided to the relevant licensed organizations to transport it for the future processing or placement.

*Fuel usage*

Fuel will be requested as combustible, for machines and trucks base on the construction activities demand.

The consumption related to trucks and machine use can vary, depending on machine type, fluctuating between 40-80 l/h.

Specific area for the fuel storage will be determined. This area will have a concrete platform and a spillage manage system. The fuel tank volume is provided 100l.

The Construction Contractor will agree with municipal authorities regarding to the using services of communal service providers for waste disposal purposes. Construction wastes include small amounts of packaging material, remaining metal parts, ceramics etc. While there are no standard sanitary landfills in the region, disposal of waste through official communal service providers. It will ensure that at least no free dumping and no open air burning of waste occurs.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Solid Waste (generated by construction activities and by workers)	■ ■	■	Short term during construction	Indirect

**7.1.6. Noise**

Workers will wear ear protection devices as part of their PPE if they are exposed to noise levels higher than 80 dB (A).

Wherever the line corridor is near to villages or houses, the construction contractor has to control noise emissions from all equipment. For residents the noise levels may not exceed 55 dB (A) daytime or result in a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site. In order to keep nuisance from construction noise low, construction works near villages or houses shall be done between 9 am and 5 pm. However, due to the limited time of the construction period and the sparsely populated area, nuisance caused by noise during construction activities will be generally low.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Noise	■	■	Short term during construction	Direct



### 7.1.7. Air Quality

During construction of PV and installation of the OTLs, certain substance of emissions will occur. Particularly, there will be dust emissions during the soil digging, loading and transportation works. During operation of the construction machinery, in a result of fuel burning, the oxides of nitrogen, carbon and sulfur, as well as solid particles (soot), will be produced.

The calculations of the quantities of materials generated during the construction works are presented in the Annexes.

Due to the limited time of the construction period the impacts on ambient air quality by construction activities will be low. Machines and vehicles will be checked regularly to minimize exhausted pollutants. Dust generated by construction activities will be suppressed by spraying water, where necessary.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Air Quality	■	■	Short term during construction	Direct

### 7.1.8. Historical and Cultural Sites

According to the RA Ministry of Culture Agency for Protection of Historical and Cultural Monuments, there are no historical or cultural sites located in the proposed PV plant site and OTL corridor.

#### Chance Finding Procedure

In case of unexpected encounter of Cultural and Historical Sites a Chance Finding Procedure has to be implemented. In case of any chance findings, the construction has to be stopped immediately and the Agency for Protection of Historical and Cultural Monuments, Ministry of Culture has to be informed to agree on further steps (according to the Armenian Law). The Chance Finding Procedure will include:

- Stop the construction activities immediately in the area of the finding.
- Notify the responsible local authorities and the Ministry of Culture.
- Evaluation of the findings to be performed by the archaeologists of the Agency for Protection of Historical and Cultural Monuments and Ministry of Culture.
- Decision on how to handle the find to be taken by the responsible authorities and implementation of the decision concerning the management of the finding.
- Construction works can be resumed only after written permission is given from the responsible local authorities and the Ministry of Culture concerning safeguard of the heritage.

For implementing the Chance Finding Procedure no costs will arise for the Construction Contractor and the related excavation and conservation costs will be paid from the Government budget. The Construction Contractor will not be entitled for compensation for idle time while Chance Finds are dealt with it, because due to linear nature of the infrastructure, Contractor will be able to continue works on other sections of the OTLs.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Historical and Cultural Sites	■ ■	■	Short term during construction	Direct

### 7.1.9. Health and Safety

Direct impacts on Health and Safety during construction of the planned PV plant and transmission lines may result from various factors as electrocution during construction, sanitary situation during construction, e.g. contamination of water, sexually transmitted diseases (STD) due to contact of workers and population etc.

A potential impact for the health and safety of workers could be further related to work accidents during construction of the PV plant and OTLs or due to contaminated drinking water or food.

Workers' camps have to meet the requirements of IFC/ADB guidances on worker accommodations, including e.g. provision of an adequate number of sanitation facilities, medical facilities, dormitory facilities etc.

The Construction Contractor will develop an appropriate Health, Safety and Environment Management Plan for the construction phase and implement a Health, Safety and Environment Management System (HSEMS) during construction. An H&S manager of the CC shall be on duty all the time during construction period.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Health and Safety	■ ■	■	Short term during construction	Direct

### 7.1.10. Gender Aspects

The construction of the PV plant and lines may increase existing gender disparities, as benefits from construction work will be earned mostly by men, therefore, access and control over compensation payments are likely to be at the disposal of men and not of women, which increases the probability that the family will benefit less. There are a considerable percentage of single women headed households in the area, who are among the most vulnerable people.

Special vulnerability allowance will be provided to affected women-headed households and holding targeted consultations with women who will be affected by construction works.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Gender Aspects	■ ■	■ if any	Short term	Indirect

## 7.2. Environmental Impacts and their Mitigation during Operation

### 7.2.1. Flora

The vegetation under PV plant, towers and roads, tracks will partly be destroyed permanently. Thus, the impact of the proposed Project on the flora during operation is assessed to be low, as the main impact already occurs during the construction phase.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Flora	■	■	Long term	Direct

### 7.2.2. Fauna

Birds are the animal group which may be most affected by OTLs in operation, mainly because of the risk of electrocution and risk of collision. Different bird species may also use the towers for perching, thus risking electrocution.

Concerning habitat alteration and habitat loss the main impacts (if any) already occur during the construction phase even though the results are of permanent nature.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Fauna	■	■	Long term	Direct

### 7.2.3. Water resources

#### *Water supply and sanitation*

Sanitary water demands in the plant during the operation phase will be satisfied through tanker trucks, unless a suitable installation of water pipes from a reservoir is possible. If not, sanitary water will be stored in the water tanks on the site.

Drinking water will be supply with individual bottles. It is estimated 3 l/day per person for drinking water.

#### *Water treatment*

Basically, wastewater generated during the operation phase is the wastewater from staff and general facilities services. These facilities will be connected to a septic tank.

A septic system is a natural sewage and disposal system that relies on bacteria to digest and clean the waste water.

Table 7.2: Water usage quantity

Water usage	Quantity (consumed volume)
Workers - personal care	8 persons x 15 l/person/day
Watering for dust control	1 l/module

The cleaning of the modules will be no more than twice per year. This periodicity will depend on the intensity of the fouling process.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Water basin	■ ■	■	Long term	Direct

#### 7.2.4. Noise

The impacts on the villages through noise resulting from the operation of the PV plant and OTL are assessed to be low. Noise emitted by substation will be minimal. Specific mitigation measures are not necessary.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
Noise	■ ■	■	Long term	Indirect

#### 7.2.5. Electric and Magnetic Fields

The substation and OTLs will be designed the way to conform with the national and the ICNIRP's standards - whichever is more stringent - and, therefore, people residing in the vicinity of the OTLs will be protected from the negative impacts of exposure to the electric and magnetic fields. In order to provide the equal conditions for women, it is envisaged, prior to commencing of the works, to receive from Local Self Governance Body's (LSGB) Office the number of women capable of working and to organize targeted consultations with the women willing to work.

Impact of/ on	Sensitivity	Extent of Impact on/ by	Duration of Impact	Direct/ Indirect
<u>Electric and Magnetic Fields</u>				
• for the public	■	■	Long term	Indirect
• at the workplaces	■	■		

### 7.3. Social impact and mitigation measures

#### 7.3.1. Survey Methodology

The methodology adopted for the social impact assessment part of the study aims to describe and assess the magnitude of the social impact to the extent sufficient to assist the assessment of the feasibility of the studied design and alignments and to plan in advance the appropriate mitigation measures.

In order to assess the extent of the social impacts caused by construction of PV Plant and OTL, the following steps were undertaken for them based on the technical and current possibilities:

- *Obtaining of common references* - to describe the characteristics of the land plots based on the official information provided by the Cadaster: the lot-code, total surface, legal status, name of registered legal entity, target position, registered right to the buildings and structures, if any, limitation of property rights and other property relative information.
- *Cadastral maps analysis* - to measure the total surface and prepare individual maps for each affected land plot.
- *Study of the local standards and norms required for the construction of pylon and transmission of the high voltage lines* - to identify and measure the required surface area of affected land plots based on the technical characteristics of the Project.
- *Inventory of losses based on data from cadastral maps, field visit and meetings with head of the affected community* - to identify the characteristics of the land plots to be acquired.
- *Collection and review of general socio-economic data (deskwork)*: to describe the current socioeconomic condition of the Project location.

The scope of the social survey and assets inventory includes identification, classification and measurement of the land plots as the main asset have been impacted by the Project taking into account the particularity of the Project to construct the solar PV plants and high voltage line far from the buildings, structures and trees.

### **7.3.2. Assessment of affected land**

Determination of affected surface area of the land plot needed for construction of the panel PV plant is based on the Preliminary Design. The common reference has been requested from the Cadaster based on which the state registration of the right was not done. The updated cadastral map for affected location has been acquired non-officially. The measurement specialist has calculated the total and affected surface area, quantities (cadastral lot-code quantities) of the affected land plots by their targeted position based on the relevant cadastral map. The MWp for the plant is shown in the table below

Table 7.3: Determination of affected land plot for panel PV plant

Location	MWp	Affected area (ha)
Masrik 1	55.0	128.3

As the alignment of the high voltage lines is subject for the further modification and finalization, identification of the affected surface area and number of affected land plots has been done taking into account the technical requirements for construction of the pylons and transmission of the lines.

- *Identification of the number of affected land plots*- the number of affected land plots is related to the number of constructed pylons. It is envisaged to construct one pylon in one land plot. In case if the pylon touches more than one land plot, the alignment will be adjusted to avoid and minimize the impact size during finalization of design. For identification of the pylon's number, the length of the line is divided to average span required for the pylon with capacity of 110 kV.

- *Identification of the affected surface area*-the required surface area for construction of one pylon with capacity of 110 kV is 196 m<sup>2</sup> (14mX14m)<sup>4</sup> . For calculation of the total affected surface area the average number of pylons is multiplied by the surface area required for one pylon.

*Identification of the legal status and target position of the affected land plots*- legal status and target position has been identified based on the information collected during field visit and meetings with head of the affected community.

*Total surface of the affected area is: 196 x 41 = 8036 m<sup>2</sup>:*

**Table 7.4: Determination of affected land plot for high voltage lines**

Capacity of the line	Length of the line	Average span	Average number of Pylon
kV	m	m	no
110	9200	224	41

i. Project Impact on Land

The Land Code of the RA (2 May, 2001) classifies land fund into the following nine categories: (1) Agricultural, (2) Settlements or residential, (3) Industrial, Mining and Production (4) Power, Transport, Communication, Utility infrastructure facilities (5) Specially protected land, (6) Special significance, (7) Forested, (8) Water and (9) State Reserve lands.

ii. Existing categories of affected land

The study has found the following land categories in the study area:

- Agricultural land – used to grow crops, vegetables, perennial plantations, harvesting and cattle grazing.

iii. Existing categories of affected land.

The study has found the following land categories in the study area:

- Agricultural land – used to grow crops, vegetables, perennial plantations, harvesting and cattle grazing.
- Special protected areas - land having aesthetic, environmental, scientific, historical and cultural, recreational and health value.

**7.3.3. Land losses**

The land plots required for the:

- PV Plant is community land plots and free of rights of the third parties, the target position is agricultural. The land impact data is summarized in the table below. There will be only 1 affected land plot with 128.3 ha surface area. The area is used only as a pasture. There are no cereals or other crops, as well as constructions or infrastructures.
- High Voltage Lines (110kV) are privately owned land plots by agricultural target position. The land impact data is summarized in the table below. In the envisaged corridor, there are no constructions or

<sup>4</sup> The surface area includes additional plus 1m from both sides of the poles based on the requirements of the SNIP CH 465-74 dated on 22 June, 1974

infrastructures. The loss of each owner will be calculated when designing the high-voltage line. The areas for the overhead lines bases cover 14 land-plots. Their indicators and terms of compensation will be defined based on the negotiations with the landowners.

State and community/municipal lands will be alienated in accordance with subparagraph 7 of the paragraph 1 of Article 66 of the Land Code of RA and in full compliance with the RPF, and only after the communities have changed the lands category to the category of energy, transportation, communications, utilities infrastructure. In accordance with paragraph 2 of Article 66 of the Land Code of RA the lands will be alienated by price equal to the cadastral price of the lands with category of energy, transportation, communications, utilities infrastructure.

As the private land plots are affected, adoption of the Government Decree for Eminent Domain will be required. It should be noted that in case of privately owned land plot, the acquired area can be more than identified affected area. The land plot can be acquired completely by the request of the owner<sup>5</sup> because of insignificance of the remaining part when it will not be appropriate for the further functional usage.

Taking into account that 14 private land plots are owned by 14 AHs as minimum, the total number of PAPs will be about 56 (4 PAPs per 1 AH in average). The resettlement will be governed by the RPF and Resettlement Action Plan(s) that will be prepared on its basis. No construction works will begin until compensation is paid in full to all project affected people.

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<sup>5</sup> The owner has a right to present request on the acquisition of non-affected part of the property within two months after the GoA decree on acknowledging the exceptional prioritized public interest (RA Law on Expropriation of Property for Public and State Purposes, Article 5, 2.2 point )

## 8. ASSESSMENT OF POTENTIAL ECONOMIC DAMAGE

Assessment of potential economic damage for the environment is carried out as per the environmental components. The economic damage is calculated according to the RA Government Decree №764-N of 27.05.2015.

Potential economic damage is calculated as follows:

$$ED = LIA + WIA + AIA;$$

where:

ED is the potential economic damage in monetary terms;

LIA is the value assessment of impact of damage to land resources as a result of economic activity (adverse environmental changes resulting in natural environment pollution, natural resources depletion, ecosystems degradation or damage). No soil pollution or damage is expected during the construction of Masrik 1 Solar Power Plant and overhead lines (OL).

WIA is the value assessment of impact of damage to water resources caused by the direct and indirect economic impact. No polluted runoff or damage to water resources is expected during the construction and operation of Masrik 1 Solar Power Plant and OL.

AIA is the value assessment of impact of damage to ambient air caused by the economic activity impact.

### *Ambient Air*

Economic damage is the cost of the measures required to eliminate the damage caused to the environment in monetary terms.

The economic damage has been calculated based on the "Procedure of Assessment of Impact on Ambient Air Caused by Economic Activity" approved by the RA Government Decree of January 25, 2005.

Calculation of economic damage done in Annex 2. According to this calculation economic damage is assessed 999364 AMD



## 9. ANALYSES OF ALTERNATIVES

Project alternatives are considered from two perspectives.

### 9.1. The "No Action" Option

The "No Action" alternative refers to a situation in which the Masrik 1 and other PV plants are not built. The no action alternative will result in the demand for electricity exceeding supply, with an increasing deficit as demand increases in future years.

A lack of a secure and reliable electricity generation has significant social and economic implications, since it will:

- constrain existing and future economic development and investment through lack of energy resources to meet industrial demand;
- restrict socio-economic development through lack of electricity supply, or poor reliability and shortages in electricity supply for domestic users, community and other public facilities and public services;
- inhibit provision of social services, including public health and poverty eradication. As a result, the "no action" option is not a viable or acceptable alternative to the proposed project.

### 9.2. Proposed Project of PV plants

Planned Project is intended to achieve the following:

- meet future demand for electricity;
- maintain and improve generation reliability;
- introduce new environmentally friendly technologies.

#### 9.2.1. Technology Assessment

The PV technology is based on the effect of the sunlight (photons) on the molecular structure of some materials. These materials must be semiconductors, for example Silicon, Cadmium telluride (CdTe), Copper indium diselenide (CISG), Gallium arsenide (GaaS) and other organic materials.

These materials, under the effect of sunlight, have the property of produce electrons movement, absorbing then the energy of the photons.

Many are the technologies and designs for Photovoltaic plants. Considering the worldwide recognized commercial viability of numerous types of PV systems, only those solutions which are commercially viable are addressed in this document. This section focuses on the following primary system components:

- i. Module technology:
  - Crystalline (polycrystalline or monocrystalline)
  - Thin-film
- ii. Mounting structure:
  - Fixed Structure
  - Single-axis tracking
  - Double-axis tracking

### Photovoltaic module technologies

There are various models of photovoltaic panels with different types of cells made of silicon, thin film or other technologies. The cost of the panels usually represents more than 40% of the cost of a PV installation and the selection of the panel will, therefore, directly affect the energy production of the plant and the profitability of the project. Recently, a downward cost trend has been developed for panel prices.

The division between technology efficiency c-Si and thin film is significant but with a clear tendency to decline in recent years. Also it can be seen that the learning curve of the thin layer is delayed in time with respect to crystalline technologies.

#### Crystalline technologies

Approximately 75% of the solar PV cells sold are made from crystalline silicon due to the fact that the silicon manufacturing technology is standardized.

The higher efficiency and global production capacity of crystalline technologies are due to the several reasons:

- Crystalline silicon cells have benefited from intensive research and development activities carried out by the semiconductor industry for electronic applications.
- Crystalline silicon is the most intensively studied semiconductor investigated and understood.
- Amorphous silicon and polycrystalline thin-film materials have physical properties more complicated and less studied.
- The crystalline quality of semiconductor wafer substrates deposit may not be as perfect as the crystalline silicon wafers.
- The heterogeneities in polycrystalline material cause losses of efficiency with respect to the ideal crystalline structure.

There are two different types of crystalline technology cells:

- Monocrystalline silicon cells: composed of slices of a single silicon crystal. Their efficiency is higher than polycrystalline cells but they are the most expensive among the commercial technologies based in silicon.
- Polycrystalline silicon cells: composed of several small silicon crystals, and are less expensive than monocrystalline cells; however, they have lower efficiencies.

The main difference between them is the original silicon brick to manufacture the wafers. In the case of monocrystalline cells the initial material is a brick with only one crystalline structure. According to this, all the atoms and molecules of the whole brick (and in consequence the wafers and cells) have the same orientation and they have a perfect crystalline structure.

Nowadays, polycrystalline modules are widely used in commercial PV plants because the reduction of prices clearly compensates efficiency differences with respect to monocrystalline ones.

### Thin film technologies

The manufacture of thin film solar modules involves depositing extremely thin layers of photosensitive materials on glass, metal or plastic. This method of manufacture involves a great saving of raw materials, versatility of installation and reduction of production costs.

The name “thin film” is given by the thickness of the layer of active material deposited on 5-6 microns. The most important materials are amorphous silicon (a-Si), polycrystalline silicon into thin films of cadmium telluride (CdTe), copper indium selenide (CuInSe<sub>2</sub> or CIS) and gallium arsenide (GaAs).

In general it can be understood as valid for all the thin-film photovoltaic materials the following advantages and disadvantages:

Advantages:

- Require less material, representing a cost reduction.
- Continuous manufacturing process that allows for lower cost.
- A variety of methods of manufacture and deposition of the layers. There are many methods for laboratory scale, but it is more difficult to transfer them to industrial scale, especially by the fact that sheets need a huge area and are very consistent with each other.
- Theoretical efficiencies high (in both absorption coefficients and by the energy gap).
- Adjustable gap values (varying material composition: addition of elements in the structure of the material) depending on the device you want to make.
- Variety of substrates (rigid, flexible, plastics, metals).
- Better temperature coefficients.

Disadvantages:

- Achieved conversion efficiencies are lower.
- Industry is less established, at least in some materials, especially because there are innovative manufacturing processes that are not yet ready to develop this kind of technology.
- Staemler Wronski Effect that limits the long term efficiency of photovoltaic devices.

### **9.2.2. Mounting Systems**

#### *Fixed structure mounting*

Fixed structure mounting is based on panels with a fixed orientation and inclination. The efficiency depends exclusively on an optimal orientation of the solar panels and the local solar resource at the site of installation, based on an accurate engineering and otherwise detailed analysis of the solar resource for the selected site.

These types of installations can be installed on land and are suitable for all types of roofs too, including industrial roofs, individual homes and urban buildings. In this case the power installed depends on the area available and the load capacity of the building. The principal benefit is that they are more economical than the tracking systems, the cost of operation and maintenance are significantly lower, and there is no auxiliary electricity consumption from tracking motors. The roof-mounted option can be completely integrated in the roofs of buildings or homes. By installing the panels in roofs, it is not necessary to look for open ground space, and the administrative permitting process may be simplified, depending on the project location.

#### *Mounting with solar tracking equipment*

The objective of this type of mounting is to orient the position of the modules towards the sun in order to increase the exposure to solar radiation and subsequently the performance of the installation. There are several commercial models of solar tracking equipment that use different methods to improve the exposure of the panels to solar radiation.

- Double-axis tracking: The tracking structure rotates in the azimuth and zenith directions. Improvements in solar radiation absorption of 40-50% in comparison to fixed structures.
- Single-axis tracking: The configuration of tracker in N-S horizontal axis is the most widely developed commercial structure. In that case the panel rotates around a horizontal axis orientated in the north-south direction. The rotation is adjusted, so that the angle of the panel surface follows the path of the sun throughout the day. Improvements in solar radiation absorption could be around 20-40%, depending on site.

The backtracking can vary the angles of ideal track, so as to avoid at all times the shadows of some panels towards others and thereby eliminate the losses due to shading in photovoltaic generators.

### **9.2.3. Cost estimation**

Cost estimation has been performed in order to show CAPEX & OPEX of each analyzed scenario based on ARIES worldwide experience in other similar PV plants and on internal databases. In further stages of the project a detailed cost estimation of selected PV plant will be performed.

### **9.2.4. Conclusions**

Different technologies and DC/AC ratios have been taken into account for the determination of the best option. The design cases that have been analyzed are:

- Fixed structure + polycrystalline module (DC/AC ratio variation)
- One axis tracker + polycrystalline module (DC/AC ratio variation)

From this preliminary assessment the following conclusions can be drawn:

- For all locations tariff evaluations shown that the optimum techno-economical solution is the configuration with one axis tracking and polycrystalline modules although not very significant differences have been found.
- Fixed structure configuration shows a tariff 2-4% more expensive than one axis tracker.
- Differences between the DC/AC ratio between each case are due to the variations of the solar radiation distribution in each location.
- Economies of scale should be taken into account. Therefore, when the final configuration is studied for each of the selected sites, the largest plant that fits the available space should be considered in order to achieve the lowest tariff.
- TMYs provided are the result of a preliminary resource assessment. Final data will be generated after the one year ground measurement campaign. This final TMY may have a significant impact on the generation figures and, therefore, on the calculated tariff.

These results are preliminary and just give an idea of the recommended technology to be used on each site given the fact that boundary conditions are the same (except for resource conditions). It is important to take into account that final plant configuration will depend on several factors such as:

- Distance from plant to substation
- Land availability and size
- Topography
- Other strategic issues

All these factors are taken into account for the final plant arrangement.

## 10. INFORMATION DISCLOSURE, CONSULTATIONS, AND PARTICIPATION

### 10.1. Background

According to WB and ADB social safeguard policies the main stakeholders must be fully consulted and provided with opportunities to participate in the planning and implementation of projects and environmental issues. Under the same principles, the APs have to be informed in an appropriate and timely manner of the outcomes of the planning process, as well as the schedules and procedures for the implementation of the Project. A public information and consultation campaign must be carried out by the Developer during all stages of the environmental and social processes.

The Construction Contractor provides the required information to all the affected LSGB's Offices in a form of a non-technical report and posts it on the own or on the R2E2's website. Full ESIA also will be posted on this website. The location of materials to be acquainted with, as well as the addresses and phone numbers through which the questions may be raised, are published in mass media.

This chapter describes the mechanisms for the public consultation process that will be applied (1) in the course of selection of the road alignment that will be held with the main project stakeholders, and (2) consultations with the APs, disclosure of the final report.

### 10.2. Consultations with Main Stakeholders

The main objective of conducting of public consultation is to present to the public draft ESIA document to seek feedback and hear concerns of people affected by the planned works.

The discussions are carried out after the selection of the Main Contractor. After verification of the corridor of the high-voltage lines, the Construction Contractor organizes the consultations, where the representatives of the RA MP and Ministry of Energy, Governor's Offices and LSGB's Offices, are involved. The consultations will be gender-balanced and the Construction Contractor will invest all efforts to actively engage women in the consultations process.

Environmental and social impact surveys have required the meetings with head of affected communities. Stakeholder feedback shall be used to focus the impact assessment and, where appropriate, influence project design and execution.

After the completion of the feasibility study, the IA in cooperation with Consultant will also conduct wide-ranging stakeholder consultations including the representatives of State Bodies and NGOs. In particular intensive consultations will be conducted with representatives of the Historical and Cultural Monument Protection Agency of the Ministry of Culture and with representatives of the Ministry of Nature Protection. The consultations at this stage are necessary to complete the detailed design document. The consultations will be organized both in Yerevan and in the affected communities.

The final Report will be disclosed in the communities where the selected sites are located and after public disclosure of the draft Report stakeholder consultation will be carried out to seek feedback and hear concerns of people affected by the planned works. The hard copy of the final report will be provided to WB, to the affected LSGB's Offices, and will be posted on the official website of MNP. At the later stages of the project, information disclosure and the wide range of consultations with APs will be conducted in accordance with the WB social safeguard policies.

## 11. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

The ESMP establishes a critical link between the management and mitigation measures specified in this report and the proper implementation of the measures during design, construction and operation phases of the Project. It summarizes the anticipated environmental and social impacts and provides details on the measures; responsibilities to mitigate these impacts; the costs of mitigation; and, the ways in which implementation and effectiveness of the measures will be monitored and supervised.

The ESMP will be part of the tender documents for construction of Masrik 1 PV plant and OTLs and will become integral part of civil works contract(s).

In summary it can be concluded that the proposed Masrik 1 PV plant and OTLs can be constructed and operated without having significant adverse impacts on the ecological and social environment, if all mitigation measures proposed in the ESMP are implemented.

### 11.1. Institutional Requirements

This section presents a discussion of the environmental management activities that will be undertaken as part of overall project implementation. The roles and responsibilities of relevant organizations in undertaking these activities are defined and the capacity development and training needs that will be required to allow the organizations to achieve their roles and responsibilities are then provided.

#### *Implementation Agency (IA)*

FVR Masrik CJSC will be an implementation agency of the project.

Particularly in the ESIA framework, IA will be responsible for overall project implementation monitoring and reporting to WB, including but not limited to:

- Guarantee that all relevant requirements of Environmental Management Plan (including nature protection designing and mitigation measures) are properly included in the project tender documents.
- Ensure that all necessary permissions and/or agreement required from the relevant government institutions are received by Developer prior to any construction works under the project.
- Ensure that Developers (contractors) understood their obligations on mitigation of the problems of environmental protection connected with construction and training of their personnel in implementation of EMP.
- Monitoring of EMP implementation by the Developer according to the plan of environment monitoring.

#### *Construction Contractor*

CC being the direct implementing organization for management of construction under the project is responsible for environmental management, but it is not limited, to the following certain obligations:

- receiving of necessary permissions and/or agreement
- ensure that mitigation measures to reduce impacts during the construction phase are implemented;
- ensure that monitoring to be undertaken during construction is implemented;
- ensure compliance with the environmental and social management plan; and
- ensure that health and safety requirements are respected.

## **11.2. Capacity Development and Training**

### *Capacity Development*

IA should be staffed with highly qualified and experienced professionals. With regard to the first in kind utility-scale solar PV project implementation in Armenia, IA will need to hire environmental and social experts to ensure proper implementation and monitoring of the project from the environmental point of view. These specialists can be hired individually on contractual basis or as consulting firm.

The Environmental and Social Specialists will be responsible for overall implementation of the project from environmental aspect and monitoring activities. They will be responsible to perform formal monthly field monitoring checks of all project sites and produce monthly monitoring reports, including photo documentation. Results of environmental monitoring and other findings shall be properly recorded and quarterly submitted to WB.

Environmental and Social Specialists will carry out the overall supervision of the implementation of the Environmental and Social Management Plan, reveal and report on non-compliance with ESMP or issues that may arise in the course of construction works that had not been covered in the ESMP.

### *CC*

While IA is responsible for overall project implementation and monitoring, the project implementation complying with the environmental and safeguards issues will be primarily under the CC's responsibility.

Selected CC will be staffed with highly qualified and experienced professionals, both in environmental and safeguards aspects, to ensure project implementation in accordance with the Operations Manual (OM), as well as to demonstrate that the EMP provisions are fully integrated into project implementation, monitoring and reporting required by the World Bank.

### *Training*

The Environmental and Social Specialists of IA will provide required trainings to relevant staff of CC and OP in order to ensure that all measures of ESMP for both the construction and operation phases are executed in an appropriate manner.

Training of CC staff is required. Training will focus on the application of World Bank safeguard policy and shall contain the implementation of the mitigation and monitoring measures.

All staff employed for construction and operation phases will be trained in the following:

- specific job roles and procedures;
- occupational health and safety; and
- contingency plans and emergency procedures.

Training will include:

- induction training on appointment;
- specialist training (as required for their prescribed job role); and
- refresher training as required.

### 11.3. Mitigation Measures

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
Disturbance and physical damage to Flora and Fauna	To minimize losses of the flora and fauna of the area requested for Masrik 1 PV Plant and its nearby areas the field study of the area biodiversity should be carried out	Consultant	6,000 USD	Pre-Design phase
	Careful design of new access roads (if any); avoid access roads crossing creeks and rivers	DC	Included in design costs	During design phase
	Mark extent of the lay down areas and the routing of the access roads	CC	Included in construction costs	During construction phase
	Use existing roads / tracks as far as possible; refurbish existing access roads /	CC	Included in construction costs	During construction phase
	Tower locations without access track shall be reached along the ROW if possible	CC	Included in construction costs	During construction phase
	Prohibit plant-collecting and hunting; instruct workers not to disturb animals	CC	Included in construction costs	During construction phase
	Re-vegetate all disturbed areas and rehabilitate access roads, workers' camps, lay down and deposit areas with site specific and adaptive plant species	CC	Included in construction costs, 3,000 USD for local expert	After construction phase
	Build (plant) protective green zone around the solar plant	CC	30,000 USD	After construction phase
	Carry out the care of restored and newly planted green zones	OC	Included in maintenance costs	During operation phase
	Strict prohibition of herbicide use for maintaining the ROW	OC	Included in maintenance costs	During operation phase
	Check proper adjustment of bird diverters during maintenance works of towers (pillars)	OC	Included in maintenance costs	During operation phase
Erosion Control	Minimize removing topsoil at all construction sites and ROW	CC	Included in construction costs	During construction phase



Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
	Bring back topsoil to its original place, after having finished the construction works and erection of the towers	CC	Included in construction costs	After construction works
	Reseeding / replanting of native grass / shrub species at tower sites	CC	20,000 USD	During construction phase
	Implement erosion prevention measures at access roads: <ul style="list-style-type: none"> <li>protect the soil surface with some form of cover</li> <li>control runoff before it develops into an erosive force.</li> </ul>	CC	Included in construction costs	During construction phase
	Avoid deposits of loose spoils on steep slopes or near rivers: Mets Masrik and drainage channels of the nearest landplots	CC	Included in construction costs	During construction phase
	Protect excess spoils from runoff	CC	Included in construction costs	During construction phase
	Excess spoil and soil will be left in orderly piles, covered with topsoil, and re-vegetated with native species	CC	Included in construction costs	During construction phase
	Avoid construction near watercourses	CC	N/A	During construction phase
	Rehabilitation of new access roads not needed anymore after construction works	CC	Included in construction costs	After construction works
	Repair landscape damage due to work in wet weather as soon as possible when construction is complete in that area	CC	Included in construction costs	After construction works
	Carry out the care of restored and newly planted green zones	OC	Included in maintenance costs	During operation phase
	Strict prohibition of herbicide use for maintaining the ROW	OC	N/A	During operation phase
	Check proper adjustment of bird diverters during maintenance works of towers (pillars)	OC	Included in maintenance costs	During operation phase
	Implement drainage control measures (culverts, berms, etc.) on permanent access roads, if they are in steep or erosion prone areas	OC	Included in maintenance costs	During operation phase
	Minimize off-road vehicle and equipment use	OC	N/A	During operation phase
Activities concerning Soil	Regular maintenance of all vehicles and machines at regular service	CC	Included in construction	During construction

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
and Water Pollution	stations, if possible		costs	phase
	Maintenance and re-fuelling of the construction equipment only on sealed and enclosed areas	CC	N/A	During construction phase
	Store all liquid materials (e.g. fuel, engine oil, etc.) and lubricants in locked tanks and on sealed and roofed areas	CC	Included in construction costs	During construction phase
	Store construction material as bags of cement etc. in containers in order to avoid rinsing out	CC	Included in construction costs	During construction phase
	Train workers in appropriate sanitation practices	CC, OC	Included in construction and operation costs	During construction and operation phases
	Place plastic or other protective cloth under any areas where towers or other materials will be painted	CC	Included in construction costs	During construction phase
	Train transporters and workers in spill prevention and control especially in handling of oil and fuel	CC, IA	Included in construction costs	During construction phase
	Provide spill-control materials to drivers and workers, in order to clean up spills, if necessary	CC	Included in construction costs	During construction phase
	Report and respond to spills promptly and train workers in how to report	CC, IA	Included in construction costs	During construction phase
	Remove contaminated soil if spills occur and handle as hazardous waste	CC, OC	Included in construction and operation costs	During construction and operation phases
	Collect contaminated spill materials and manage as hazardous waste	CC, OC	Included in construction and operation costs	During construction and operation phases
	Repair any damage to riparian areas, including riverbanks and riverbeds (if any), as soon as construction is complete	CC	Included in construction costs	After construction works
	Provide a drainage for precipitation flows from modules	OC	Included in maintenance costs	During operation phase
	Waste Management	Development of Waste Management Plan within the HSE Management Plan considering following principles: (i) waste management hierarchy of avoidance-minimization-reuse-treatment-disposal; (ii) segregation of waste; (iii) minimization of construction waste by good technical	Consultant, DC	3,000 USD

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
	planning; (iv) training of staff			
	Store all hazardous waste (e.g. oil, fuel, paint, spill contaminated soil) in adequate storage sites	CC	Included in construction costs	During construction phase
	Collect all type of wastes including domestic and sanitary wastes. Agree with municipal authorities about using services of communal service providers for waste disposal purposes.	CC, OC	Included in construction and operation costs	During construction and operation phases
	Train workers in handling and disposal of recyclable, sanitary, solid, liquid and hazardous waste	CC, OC, IA	Included in construction and operation costs	During construction and operation phases
	Only certified companies shall be contracted for waste recycling	CC, OC	Included in construction and operation costs	During construction and operation phases
Landscape and Visual Aspects	Dismantling of workers' camps and harmonization of the areas with the landscape	CC	Included in construction costs	After construction works
Noise	Optimization of transportation management to avoid needless truck drives	CC, OC	Included in construction and operation costs	During construction and operation phases
	Allow truck movements only during daylight	CC, OC	Included in construction and operation costs	During construction and operation phases
	Reduce vehicle speeds (stick to recommended speeds) in populated areas	CC, OC	Included in construction and operation costs	During construction and operation phases
	Use low sound power mechanical equipment, whenever possible	CC	Included in construction costs	During construction phase
	Regular maintenance and service of building machinery and other vehicles	CC	Included in construction costs	During construction phase
	Shut down or throttling down of noisy machinery to a minimum	CC	Included in construction costs	During construction phase
	For workers noise levels shall be kept below 80 dB (A), wherever possible. In case of exceeding this value, hearing protections must be provided to workers and warning signs must be installed	CC, OC	N/A Warning signs: 800 USD	During construction and operation phases
	For residents the noise levels may not exceed 55 dB (A) or result in a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site	CC, OC	N/A	During construction and operation phases
	Notify nearby residents at least 24 hours in advance if particularly noisy	CC, OC	N/A	During construction and

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
	activities are anticipated			operation phases
Activities concerning Air Quality	Optimize transportation management to avoid needless truck trips	CC, OC	N/A	During construction and operation phases
	Maintain vehicles and construction machinery properly, as recommended by suppliers	CC	Included in construction costs	During construction phase
	Cover truck beds with tarps during material transport	CC	Included in construction costs	During construction phase
	Use dust-suppressing water spray during civil works, where necessary	CC	Included in construction costs	During construction phase
	Store and handle material appropriately to limit dust (e.g. protect cement with tarpaulins)	CC	N/A	During construction phase
	Avoid unnecessary idling of construction machines and vehicles	CC	N/A	During construction phase
	Prohibit open burning of construction / waste material at the site	CC, OC	N/A	During construction and operation phases
	Maintain vehicles and engines properly, as recommended by suppliers	CC, OC	N/A	During construction and operation phases
	Avoid unnecessary idling of vehicles	CC, OC	N/A	During construction and operation phases
	Train maintenance workers accordingly	CC, OC, IA	Included in construction and operation costs	During construction and operation phases
Risks for Historical and Cultural Sites	Implementation of Chance Find Procedure and training of the construction workers	CC	N/A	During construction phase
	Report chance finds immediately to the Ministry of Culture of RA, Dep. Protection of Monuments and Historical Sites	CC	N/A	During construction phase
	Agree with representatives of Dep. Protection of Monuments and Historical Sites of RA about location of towers and new access roads (including proposed bypasses) in advance of construction	CC	N/A	During construction phase
Risks for Public and Employee Health and Safety	Development of an HSE Policy for the construction phase, in advance of construction activities	CC	Included in construction costs	Before construction works
	Development of an HSE Management Plan for the construction phase (shall include Waste Management Plan), in advance of construction	CC	Included in construction costs	Before construction works

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
	activities			
	Installation of an HSE Management System (HSEMS)	CC	Included in construction costs	During construction phase
	Make sure that all workers have a health insurance	CC	N/A	Before construction works
	Provide proper sanitation facilities with hand-washing facilities in adequate number, separately for men and women	CC	Included in construction costs	Before construction works
	Provide HIV/AIDS protection equipment for workers	CC	Included in construction costs	Before construction works
	Install warning signs “Danger of Electrocution” at towers, substations etc.	CC	800 USD	Before construction works
	Accommodation of workers in adjacent villages has the first priority. In the case that construction camps are necessary these will be located in accordance with relevant municipal authorities	CC	Included in construction costs	Before construction works
	Provide workers with appropriate protective equipment (PPE)		20,000 USD	During construction phase
	Train workers accordingly regarding work at heights, electrical and vehicular safety, handling of hazardous materials, PPE, hazard avoidance and reduction measures, use of first aid and rescue techniques, emergency response etc.	CC, IA	Included in construction costs	During construction phase
Risks for Public and Employee Health and Safety	All work crews shall have at least one person (two is strongly preferred) trained in first aid	CC	Included in construction costs	During construction phase
	Provide first aid kits and fire extinguishers at all Project sites and in all vehicles	CC	Included in construction costs	Before construction works
	If work crews are in remote areas, they shall be equipped with cellular phones or radios	CC	2,000 USD	During construction phase
	Forbid alcohol and other drugs at construction sites / workers’ camps	CC	N/A	During construction phase
	Set up mobile clinics for workers capable of treating all injuries and diseases occurring at the construction sites	CC	Included in construction costs	Before construction works
	Assure transfer of injured workers to hospitals in the case of serious accidents	CC	Included in construction costs	During construction phase
	Identify area emergency responders, hospitals, and clinics, and provide	CC	N/A	During construction phase

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
	advance notice of Project activities			
	Implement programs for medical screening, health and safety monitoring, and reporting	CC	Included in construction costs	During construction phase
	Limit occupational exposure to EMF by use of shielding materials, and train workers accordingly	CC	Included in construction costs	During construction phase
	Record work-hours as well as all accidents and incidents	CC	Included in construction costs	During construction phase
	Notification of the public on upcoming construction activities in adjacent villages and through media, in advance of construction period	CC	200 USD	During construction phase
	Public education and outreach efforts to provide information about hazard awareness, safety measures, reporting unsafe conditions and environmental impacts in adjacent villages, in advance of construction period	CC	2,000 USD	During construction phase
	Inform population along public roads in advance in case of transporting heavy equipment	CC	N/A	During construction phase
	Provide adequate security measures to prevent accidents and injury (e.g. keeping speed limits on public roads, grounding objects)	CC	N/A	During construction phase
	Use warning signs at access points along main roads, and around work sites near villages or residences	CC	800 USD	During construction and operation phases
Risks for Public and Employee Health and Safety	Provide clear and adequate signage to identify work areas and hazardous equipment, before commencement of relevant construction	CC	800 USD	After construction works
	Install warning signs at all towers and sensitize the community on dangers of electricity, and risks of electrocution	CC, OC	800 USD	After construction works
	Provide adequate security to prevent public access to the substations, work sites, hazardous materials and waste	CC, OC	Included in construction costs	Before operation phase
	Establish worker code of conduct to help prevent friction or conflict with communities	OC	Included in operation costs	During operation phase
	No houses are allowed in 50 m corridor (way leave) of the overhead line	OC	N/A	During construction phase
	Develop a Health and Safety Management Plan (HSMP) and implement an Health and Safety Management System (HSMS) for operation and maintenance	OC	Included in operation costs	During operation phase

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
Social Impact	Announce start and duration of works through media and signs to the public in advance of construction period	CC	800 USD	Before construction works
	Limitation of construction of access roads and careful routing to minimize impacts on agricultural land	CC	Included in construction costs	During construction phase
	Location of laydown areas close to existing roads in nonproductive areas to minimize interference with agricultural activities and to facilitate site clean-up and rehabilitation	CC	Included in construction costs	During construction phase
	Keep speed limits in public roads	CC, OC	N/A	During construction and operation phases
	Minimize surface of and damage caused by workers' camps	CC	N/A	During construction phase
	Shift towers to avoid orchards, vineyards, gardens	CC	Included in construction costs	During construction phase
	Establishment and operationalization of a grievance redress mechanism	CC, Consultant	Included in construction costs	During construction phase
	Presence of an impartial person to receive complaints during the construction process	CC, IA	Should be included in construction costs	During construction phase
Social Impact	Develop and implement a non-discriminatory hiring and wage policy (clearly stating that the company will not discriminate in hiring and salaries based on gender, age, religion, ethnicity or place of origin)	CC, Consultant	Included in construction costs	During construction phase
	Prioritize employment of local people for construction works	CC	N/A	During construction phase
	Legal experts will support PAP who are not registered land owners with legalization of land titles	CC, Consultant	Included in construction costs	During construction phase
	Social consultant will work with vulnerable APs in the project area.	CC	Included in construction costs	During construction phase
	Independent monitoring consultant will oversee all resettlement-related activities.	IA, Consultant	Included in construction costs	During construction phase
	Develop and implement a RAP based on the Project related RPF (Consultation with PAP about their development priorities in the framework of RAP development)	CC, Consultant	Included in construction costs	During construction phase
	Develop and implement a RAP implementation compliance report	CC, Consultant	Included in construction	During construction phase

Issue / Potential Impact	Mitigation Measures	Responsible party	Costs	Period for Implementation
			costs	
Gender Issues	Improve recruitment of women for construction works according to consultations and interviews with householder women	CC	N/A	During construction phase
	Strengthen district administrations on gender issues (i.e. Social expert will check receiving complaints by women)	CC, Consultant	N/A	During construction phase
	Zero tolerance for sexual harassment at the work place or in workers' camps / overnight locations	CC	N/A	During construction phase



#### 11.4. Monitoring Measures

<i>What parameter is to be monitored</i>	<i>Why is parameter to be monitored</i>	<i>Where is the parameter to be monitored</i>	<i>When (or how often) is the parameter to be monitored</i>	<i>How is the parameter to be monitored</i>	<i>What is the cost of monitoring</i>	<i>Who is responsible for monitoring</i>
Survey of Biodiversity of selected area	To avoid loss of species registered in the Red Book of Armenia	Area of Masrik 1 PV	Before construction works	Inspection of the report on preconstruction survey of PV Plant area	3,000 USD	DC, Consultant, IA
		Corridor of OTL	Before the selection of the OTL corridor	Inspection of the report on preconstruction survey of OTL corridor	4,000 USD	DC, Consultant, IA
Historical and cultural sites	To avoid damages of Historical and cultural monuments	Location of PV plant, towers and new access roads	Before construction works Before the selection of OTL corridor	Inspection of records	Included in design costs	DC, Consultant, IA
Top soil: depth of top soil, content of humus, pH	To minimize loss of top soil	Area of Masrik 1 PV Plant Corridor of OTL.  Place for new roads	Before construction works	Measurement of depth, sampling and analyzing	4,000 USD	DC, Consultant
Quality of construction materials	Ensure reliability of construction materials and their safety for human health	In the provider's office or warehouse	During conclusion of supply contracts	Verification of documents	Included in construction costs	CC

Transportation of construction materials and waste	- Limit pollution of soil and air from emissions; - Limit nuisance to local communities from noise and vibration; - Minimize traffic disruption.	- Construction site - Routs of transportation of construction materials and wastes	Undeclared inspections during work hours and beyond	Inspection of roads adjacent to the construction object in the direction of the movement rout	Included in construction costs	CC
Movement of construction machinery	- Avoid pollution of water and soil with oil products due to operation of equipment	Construction camp and temporary sites along of OTLs	During operation of equipment	Inspection of activities	Included in construction costs	CC
Soil Erosion	To prevent further erosion	Side slopes and material storage sites	Weekly during construction works	Visual inspection of erosion prevention measures and occurrence of erosion	Included in construction costs	CC
Soil Pollution	To minimize pollution of soil	At all construction sites, including construction camp, approach roads and OTL corridor	Weekly during construction works	Visual inspection	Included in construction costs	CC
	To prevent pollution of soil	Parking sites, approach roads and OTL corridor	Monthly during operation phase	Visual inspection	Included in operation costs	OC
Air Quality: dust, smoke	To minimize pollution of air	At all construction sites, including construction camp, approach roads and OTL corridor	Daily during construction works	Visual inspection	Included in operation costs	CC
Air Quality: smoke	To minimize pollution of air	Parking sites, approach roads	Weekly during operation phase	Visual inspection	Included in operation costs	OC

Noise	To minimize level of noise	At all construction sites, including construction camp, approach roads and OTL corridor	Weekly during construction works	Sound meter	80 USD	CC
Noise	To minimize level of noise	Parking sites, approach roads	Weekly	Sound meter	80 USD	OC
Traffic Safety	To ensure safety of traffic	All common roads used by CC	Daily during construction works	Visual inspection	Included in construction costs	CC
		All common roads used by CC	Weekly during operation phase	Visual inspection	Included in operation costs	OC
Generation of construction waste	Prevent pollution of soil, surface water and ground water,  Avoid accidents at the construction site due to scattered fragments of construction materials and debris,  Retain esthetic appearance of the construction site and its surroundings	Construction site; Waste disposal site	Periodically during construction and upon its completion	Inspection of construction camp and temporary sites	Included in construction costs	CC
Generation of domestic wastes	Prevent pollution of soil, surface water and ground water	PV Plant site and surrounding area	Periodically during operation phase	Visual observation	Included in operation costs	OC

Construction site re-cultivation and landscaping	Reduce loss of aesthetical value of the landscape due to the PV Plant and OTLs construction	At all construction sites, including construction camp, approach roads and OTL corridor	Final period of construction	Visual inspection	Included in construction costs	CC, Consultant, IA
Workers' health and safety	Reduce probability of traumas and accidents	At all construction sites	Total period of construction works	Inspection of activities	Included in construction costs	CC, IA
		PV plant	Total period of operation	Inspection of logs	Included in operation costs	OC, IA
Emergency preparedness	- Reduce risks for the construction workers	At all construction sites	Total period of construction works	Periodic check-ups	Included in construction costs	CC, IA
	-Reduce risks for the staff of the PV Plant - Avoid disruption in the maintenance of the PV Plant and OTLs	PV Plant and OTLs	Total period of operation of the PV Plant	Periodic check-ups	Included in operation costs	OC, IA
Awareness of Communities	Reduce risks for the Residents living near to construction sites	Local Communities	Before construction works	Inspection of notification documents Interviews of Residents living near to construction sites	Included in operation costs	DC, Consultant

Public Health and Security	To provide adequate warning of residents	Access points along main roads, and around work sites near villages or residences	Monthly	Inspection of warning signs	Included in construction costs	CC, Consultant, IA
Employment	-Implementation of a non-discriminatory hiring and wage policy -Prioritization of employment of local people for construction works	- Local communities - PV Plant office	Regularly during construction	Interviews	Included in construction costs	CC, Consultant
Gender aspects	To ensure zero tolerance for sexual harassment at the work place or in workers' camps / overnight locations	- All construction sites; - PV Plant; - Local Communities	Monthly during construction phase Quarterly during operation phase	- Interviews with women Inspection of complaints	Included in construction and operation costs	CC, OC, Consultant, IA
	To provide strengthen district administrations on gender issues (i.e. receive complaints by women)					
Grievance Redress Mechanism	To ensure implementation of Grievance Redress Mechanism and its effectiveness	- Local communities - PV Plant office	Monthly	- Inspection of complaints - Interviews with employees - Interviews with Communities heads	Included in construction and operation costs	CC, OC, Consultant, IA

## 12. GRIEVANCE REDRESS MECHANISM

In the course of the construction process, people affected by the project may feel treated unjustly. This might happen for various reasons: the CC does not adhere to sound construction principles, the damages to crops are not paid for, resettlement measures have not been implemented, people have been forgotten during land survey or simply misunderstandings have arisen and so forth. This may also be disagreement with procedures of consultation, notification or valuation.

When this happens people are encouraged to lodge their complaints. The grievance redress mechanism is implemented, so that people can get their problems solved and grievances redressed in a timely and effective manner without directly addressing the court.

During consultation, survey and compensation the AP shall be notified orally or in a written form about their rights and the procedure of complaints introduction. Local NGOs e.g. via the local Aarhus Centre can inform communities about the possibility to raise complaints and how and where to address them. The grievance redress mechanism has to be locally implemented at the level of village institutions and local self-government as well as bundled on national level at the IA.

Grievances can be addressed at the local community level ("Head of the LSGB"), where the grievance is recorded and forwarded to the IA's grievance coordinator responsible for registration of grievances and decision on grievance redress.

Grievances that are addressed to the CC during the execution of civil works shall also be forwarded to the IA grievance coordinator. Even if the constructor decides to settle the grievance on the spot, the documentation of the grievance settlement procedure needs to be documented at the IE's grievance coordinator/focal point.

Also, all project related complaints can be directly addressed to the IA grievance coordinator via phone, e-mail or grievance form. A project grievance hotline shall be made available by the IA for direct complaints (at national level) and all received grievances shall be recorded by the IA grievance coordinator in a grievance log-book.

The IE's grievance coordinator then decides whether to settle directly, call for grievance committee meeting or go to the court. The decision has to be taken within 2 (two) days after receipt and registration of the grievance.

In case of major grievances, that cannot be directly settled, permanent and non-permanent members of the grievance committee will be called for a meeting. The meeting will take place during 15 (fifteen) business days after receipt and registration of the grievance. Decisions in the grievance committee are taken by majority vote of the members who registered in the protocol of the meeting (Permanent and Non-permanent). PAP will be informed about time and place of the meeting 10 (ten) days before (as Non-permanent member).

In case of failure of the grievance redress system, the PAPs can submit their case to the appropriate court.

The Committee will be composed of permanent and non-permanent members.

Permanent members: IA, the CC and a lawyer.

Non-permanent members: PAP, Appropriate marz representative, community representative and NGO representative. Non-permanent members will be notified of the date and venue of the meeting 10 (ten) days

before the meeting. Absence of non-permanent members cannot be the reason for the cancellation of the meeting. A lawyer can represent one of the permanent members.

The CC is obliged to carry out the work in accordance with the contractual requirements that include:

- A person of staff responsible for grievance procedure who will provide technical assistance to the IA in handling any grievances that may arise during RAP preparation and implementation (The person shall have 3 or more years of similar experience, bachelor/master degree in Law or Sociology is preferable);
- Preparation of regular monitoring reports on the status of RAP preparation and implementation, including details of any complaints that arose and how they were handled (if the RAP preparation obligation is delegated to the CC);
- If vulnerable affected people are identified following census completion, then the CC will appoint professional advocates (social workers / legal experts) to assist those people during the entire process, and to act as independent advocates for them should any grievances arise (if the RAP preparation obligation is delegated to the CC);
- Handling of grievances with the IA and PAP and participation in the grievance committee.

The IA will carry out works that include:

- A person of staff responsible for the grievance procedure coordination, hereby referred to as grievance coordinator (including first contact, periodical site visiting of mitigation measure to be implemented by CC);
- A telephone line, e-mail address and contact name on project boards;
- Handling of grievances with the CC and PAP and participation in the grievance committee.
- Liaison with court.

However PAPs have the option to choose a different representative or directly liaison with the IA staff, responsible for grievance redress. Vulnerable households will have the support of their individual social worker and legal support.

Additionally, legal experts will support PAPs who are not registered land owners with legalization of land titles.

NGOs, e.g. Aarhus Centre or local member organizations will monitor grievance redress negotiations, assist with grievance arbitration, raise public awareness (local legislation doesn't define any formal arrangement for monitoring; this issue is regulated by the company's internal documentation, which may differ depending on the company charter). PAPs need to be informed that in case of conflict with the community leader they can address NGO staff to follow up their complaint. NGOs will monitor relationship between PAPs and community leader.

The World Bank is not directly a part of the Grievance procedure but should receive regular reports on which complaints were received and how they have been followed up / mitigated.

Special consideration has to be taken for PAPs living in remote areas and vulnerable people as complaint mechanisms may be unusual and contact with legal procedures let alone courts of law may appear not very promising from their experience. This would prevent the most disadvantaged persons from addressing their grievance.

A close monitoring on village level by an independent social expert during the implementation of the project and a personal contact with PAPs is therefore recommended.

Vulnerable PAPs (all women headed households and all households below the poverty line) will be entitled to a legal aid / social worker to support them with complaints procedures.

*Communication with CC Staff:*

During the construction phase there will be an influx of people into the project area. As these people would have cultural differences with the resident population there are potential that a conflicts may arise because of issues related to the environment, safety and privacy issues of the women in the surrounding villages, spread of various communicable diseases, nuisance caused by workers due to improper sanitation facilities, etc.

The Project will provide a grievance mechanism where employees may raise reasonable work place concerns. The mechanism should involve appropriate level of management involvement and address concerns promptly, using a transparent process that provides feedback to those concerns without any retribution.

During design phase the Consultant should prepare a framework for redressal of grievances/complaints during all phases of the project. This framework will be continuously monitored & improved as the project moves from one stage to other.

As a part of the grievance redressal, it will perform the following actions.

- Continuously collect and analyze complaint/grievance related data and
- Disseminate this information into its organizational set up
- Review and upgrade exiting plans if required;
- Publicize the existence of the GRM among local communities

In addition, this procedure will help to improve the project social performance. This is because the number and nature of received complaints including punctuality, nature and effectiveness of grievance redressal are indicators of the manner in which the Project should be implemented.



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## 14. ANNEXES

ANNEX 1. Calculation of Emissions Occuring During the Construction of the Masrik 1 Solar Power Plant and Overhead Lines

ANNEX 2. Assessment of Economic Damage

## **ANNEX 1. Calculation of Emissions Occuring During the Construction of the Masrik 1 Solar Power Plant and Overhead Lines**

### *Earthworks*

Dust emissions occur during the earthworks. They are caused by the drilling and loading operations, mainly during the operation of excavators, cranes and bulldozers. The drilling and loading operations are implemented:

12 months x 22 days/month x 8 hour/day = 2112 hours (264 days).

Calculations are made according to the following methodology formula of "TEMPORARY METHODOICAL GUIDE FOR CALCULATION OF EMISSIONS FROM UNORGANIZED SOURCES IN THE INDUSTRY OF CONSTRUCTION MATERIALS", Ministry of Construction Materials Industry of the USSR, 1987:

$Q_{D.E.} = (P1 \times P2 \times P3 \times P4 \times P5 \times G \times P6 \times B) \times 106/3600$  year/hour, where (Table 1 of the mentioned methodology);

P1 – is the share of dust fraction, accepted to be 0.05;

P2 – 0-50 m/km size particles share in the distributed dust aerosol, 0.02;

P3 - coefficient, considering the wind speed in the construction machinery operation zone, 1.0;

P4 – coefficient, considering the moisture content of the substance, 0.4<sup>6</sup>;

P5 - coefficient, considering the mass of the substance, 0.5;

P6 - coefficient, considering the location conditions, 1.0;

G – removed soil mass.

The excavated soil mass during the construction of the Solar Power Plant will be 14950 m<sup>3</sup>, and during construction of OL - 5624.2 m<sup>3</sup>, making total 20575.2 m<sup>3</sup>, or considering the average specific weight of soil masses - 34000 tones.

The amount of soil removed and transported in an hour will be:

34000t.: 2112 hours/construction period = 16.1 t./hour;

B - coefficient, considering the substance discharge height, 0.6;

$Q_{D.E.} = 0.05 \times 0.02 \times 1.0 \times 0.4 \times 0.5 \times 16.1 \times 1.0 \times 0.6 \times 10^6/3600 = 0.53$  g/sec, or

$0.53 \times 3600 \times 2112 : 10^6 = 4.03$  tons/construction period.

### *Operation of Construction Machinery and Vehicles*

During the operation of construction machinery and vehicles, the emissions are generated by fuel combustion. Diesel fuel is mainly used.

Emissions related to the diesel fuel are calculated based on the RA Ministry of Nature Protection developed methodological instructions<sup>7</sup>.

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<sup>6</sup> Considering also the watering

<sup>7</sup> The Methodology uses the vehicle classification according to the methodology of "Core Inventory of Emissions in Europe" (hereinafter referred to as CORINAIR) "The Baseline Emission Inventory for Europe";

This calculation is made according to the amount of fuel consumption, which is mainly diesel in this case.

According to the mentioned methodology, the specific emissions of vehicles and construction machinery are presented in the below Table 1.

Table 1. Specific Emissions (g/kg fuel)

Type of Fuel	Name of Substance						
	NO <sub>2</sub>	CH	VOCs	CO	N <sub>2</sub> O	CO <sub>2</sub> <sup>8</sup>	PM
Diesel Fuel	42.3	0.243	8.16	36.4	0.122	3138	4.3

Excavators, bulldozers, road rollers and trucks will be operated during construction. Passenger cars are not considered in this assessment.

The construction machinery will be operated throughout the whole construction process which is 2 years (440 days, 3520 hours).

As there are no accurate design data, indicators based on experts' assessments were used for the calculations, according to which, the amounts of diesel fuel are as follows:

- Construction machinery: 0.1 t/day; total - 0.1 t/day x 264 days = 26.4 tons;
- Motor vehicles: 0.2 t/day; total - 0.2t/day x 264 days = 52.8 tons. In total - 79.2 tons.

Calculations of emissions by type of the equipment operated are mentioned in Table 2. Nitrogen oxide, as well as border hydrocarbons have been combined in the Table.

Table 2. Results of Emission Calculations

Harmful Substance	Specific Emissions, g/kg	Emissions, t	
		g/sec	t
CO (Carbon monoxide)	36.4	0.379	2.88
CH (Carbohydrates)	8.403	0.087	0.66
NO <sub>2</sub> (Nitrogen oxides, with Dioxide calculation)	42.422	0.44	3.36
PM (Particulate matter)	4.3	0.045	0.34

#### Sulfuric Anhydride

Sulfuric Anhydride (SO<sub>2</sub>) emissions are calculated based on the approach that all the sulfur contained in the fuel is entirely converted into SO<sub>2</sub>. In that case the CORINAIR Inventory System formula is applied.

$ESO_2 = 2 \sum k_s b$ , where:

ks is the average sulfur content in fuel 0.002 t/t;

b is the fuel consumption – 79.2 t/construction hour;

$SO_2 = 2 \times 79.2 \times 0.002 = 0.32 \text{ t. or } 0.042 \text{ g/sec.}$

<sup>8</sup> According to the RA Legislation, the Carbon Dioxide is not a harmful substance and is not subject to regulation, therefore it was not considered in further calculations.

## ANNEX 2. Assessment of Economic Damage

The potential economic impact for each emission source is assessed according to the following formula:

$$I = S_c T_c \sum S_i Q_i, \text{ where: (1)}$$

$I$  is the impact expressed in Drams of the Republic of Armenia;

$S_c$  is the coefficient expressing the characteristics of the surrounding of contaminating source (active contaminating zone); according to the mentioned procedure's Table 9, it is 0.1 for pasture areas;

$S_i$  is the value expressing the comparative harmfulness of the substance  $i$  (dust type); according to the mentioned procedure's Tables 10 and 11, for inorganic powder it is 10, for carbon oxide – 1, for nitrogen dioxide – 12.5, for sulfur anhydride – 16.5, for carbohydrates – 3.16 and for soot it is 41.5;

$Q_i$  is the coefficient connected with the emissions of the given ( $i$ ) substance;

$T_c$  is the transportation coefficient, which is constant and is selected based on the principle of promotion of environmental process.

According to this procedure:

$$T_c = 1000 \text{ AMD.}$$

$Q_i$  coefficient is determined according to the following formula:

$$Q_i = g (3 S_{ei} - 2 MPE_i), S_{ei} > MPE_i \text{ (2), where:}$$

$MPE_i$  – is the annual maximum permissible emission of substance  $i$  in tones. Given the emissions of harmful substances are few and of temporary nature, actual emissions are considered as MPE.

$S_{ei}$  – is the actual annual emissions of substance  $i$  in tones:

$g = 1$  – for fixed sources;

$g = 3$  – for mobile sources.

The impact is not assessed for substances the normative concentration of which is not defined by the State Standards.

The fixed and mobile sources have been distinguished during the calculation.

The calculation of economic damage resulting from the construction of Masrik 1 and OL is presented in the Table 2. Emissions' quantities are in the Annex 1.

Table 2. Results of Economic Damage Indicators Calculation

Name of Emitted Substance	Indicators Required for Calculation			D	Sc	Economic Damage: AMD
	$S_i$	g	$S_i = S_i \times g$			$I = S_c T_c \sum S_i Q_i$
Mineral Dust	4.03	1	4.03	10	0.1	4030
Carbone Monoxide	2.88	3	8.64	1	5	43200
Carbohydrates	0.66	3	1.98	3.16	5	31284
Nitrogen Dioxide	3.36	3	10.08	12.5	5	630000
PM	0.34	3	1.02	41.5	5	211650
Sulfur Anhydride	0.32	3	0.96	16.5	5	79200
Total						999364

Total: 999364 AMD.