Source: Photos taken by the Consultant during the site visits

# WATER RESERVOIRS PROJECT - ARMENIA

## Environmental and Social Impact Assessment for the Astghadzor Reservoir Construction Project

# ESIA REPORT

**Rev02**

**December 2025**

**Prepared for:**

**European Bank for Reconstruction and Development**

***and***

**Water Committee under the Ministry of Territorial Administration and Infrastructure of the Republic of Armenia**

ATMS Solutions

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**Consultancy Services Contract № 2023.009567**

**Prepared for:**

- **European Bank for Reconstruction and Development**
- **Water Committee under the Ministry of Territorial Administration and Infrastructure of the Republic of Armenia**

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| | | | | | |

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## Disclaimer

This Environmental and Social Impact Assessment (ESIA) Report has been prepared at the request of the Client in accordance with applicable national legislation, the European Bank for Reconstruction and Development (EBRD) Environmental and Social Policy (ESP, 2019) and Performance Requirements (PRs) as well as Good International Practices (GIP).

The ESIA is based on information, data, and documentation provided by the Client, third parties, and publicly available sources, as well as site visits and stakeholder engagement activities undertaken at the time of assessment. Reasonable efforts have been made to verify the accuracy and completeness of the information used; however, the consultants do not warrant that such information is complete or free from error. Any reliance placed on this Report by third parties is at their own risk.

This Report reflects the professional judgment of the consultants, taking into account the scope of work agreed with the Client, the conditions prevailing at the time of preparation, and the information reasonably available. Environmental and social conditions, regulatory frameworks, project design, and stakeholder concerns may change over time. Accordingly, the findings, conclusions, and recommendations presented herein may require revision should new information become available or should material changes to the Project occur.

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# List of Abbreviations

ACL - Admissible Concentration Limits
BAP - Biodiversity Action Plan
BMP - Biodiversity Management Plan
BSMP - Blasting Safety Management Plan
CCSM - Community Climate System Model
CESMP - Construction Environmental and Social Management Plan
CH - Critical Habitat
CJSC - Close Joint Stock Company
CIA - Cumulative Impact Assessment
CN - Construction Norms
CN&R - Construction Norms and Rules
NDC - Nationally Determined Contribution
DSL - Dead Storage Level
EBRD - European Bank for Reconstruction and Development
EIA - Environmental Impact Assessment
EIEC - Environmental Impact Examination Center
EPRP - Emergency Preparadness and Response Plan
ESAP - Environmental and Social Action Plan
ESIA - Environmental and Social Impact Assessment
ESMP - Environmental and Social Management Plan
ESMS - Environmental and Social Management System
ESP - Environmental and Social Policy
EU - European Union
E&S - Environmental and Social
FSL - Full Supply Level
GBVH - Gender-Based Violence and Harassment
GHG - Greenhouse Gas
GPN - Good Practise Note
GRP - Glass-Reinforced Plastic
HMMP - Hazardous Materials Management Plan
ICH - Intangible Cultural Heritage
IFI - International Financial Institution
LLC - Limited Liability Company
LT-LEDS - Long Term - Low Emission Development Strategy
ME - Ministry of Environment
MSDS - Material Safety Data Sheets

MWL - Maximum Water Level
OHS - Occupational Health and Safety
OHSMP - Occupational Health and Safety Management Plan
GA - Government of Armenia
PAP - Project Affected Person
PBF - Priority Biodiversity Features
PE - Polyethylene
PPE - Personal Protective Equipment
PR - Performance Requirement
PSHA - Probabilistic Seismic Hazard Assessment
RA - Republic of Armenia
SDA - Spoil Disposal Area
SDMP - Spoil Disposal Management Plan
SPA - Spoil Disposal Area
SPMP - Spill Prevention and Management Plan
SEP - Stakeholder Engagement Plan
SNCO - State None Commercial Organization
SSESMP - Site-Specific Environmental and Social Management and Monitoring Plan
STD - Sexually Transmitted Disease
TLV - Threshold Limit Value
TMP - Traffic Management Plan
TrMP - Tree Management Plan
TsMP - Topsoil Management Plan
ToR - Terms of Reference
VEC - Valued Environmental and Social Component
WB - World Bank
WMP - Waste Management Plan
WUA - Water Users Association

# Content

# 1. Introduction

## 1.1 Background

The Government of the Republic of Armenia ('RA') plans to construct 17 reservoirs within the EU support initiative 'Recovery, resilience and reform: post 2020 Eastern Partnership priorities' to the Government of Armenia ('GA') to enhance the water and food security level in the country. The European Bank for Reconstruction and Development ('EBRD' or the 'Bank') is considering provision of a loan to the GA to finance the construction of five water reservoirs in different regions (marzes) of Armenia (the 'Project'):

- Kasakh reservoir in Aragatsotn Marz[1],
- Lichk reservoir in Syunik Marz,
- Yelpin reservoir in Vayots Dzor Marz,
- Artik reservoir in Shirak Marz,
- Astghadzor reservoir in Gegharkunik Marz.

The EBRD has categorized this greenfield project as 'A' in line with its Environmental and Social Policy ('ESP') (2019) because it may cause significant environmental and social impacts. This means that a comprehensive Environmental and Social Impact Assessment ('ESIA') report and associated documents must be elaborated, followed by their public disclosure for a minimum period of 120 days.

The Project's implementing agency is the Water Committee under the RA Ministry of Territorial Administration and Infrastructure ('Client' or 'Water Committee' or 'WCRA'). The Water Committee hired a national consultants to carry out Environmental and Social ('E&S') studies, develop Environmental Impact Assessment ('EIA') reports for the Project's five reservoirs in accordance with the relevant national legislation, and obtain environmental expert examination conclusions (permits) from the State Authorized Body (that is, the Environmental Impact Examination Center (EIEC) under the RA Ministry of Environment (ME)).

The national EIA reports for the five reservoirs have passed the national expert examination process and received positive environmental expert examination conclusions. Although the national EIA reports comply with national requirements, they need to be further upgraded to align with the EBRD Environmental and Social Policy (ESP), including the implementation of a series of supplementary E&S studies:

- Spring season field biodiversity surveys and Critical Habitat Assessment,
- Appropriate Assessments and Biodiversity Action Plans (if required),
- Analysis of Project alternatives,
- Cumulative impact assessment,
- Assessment of impacts of the associated facilities,
- Assessment of greenhouse gas emissions and climate change mitigation measures,
- Water infiltration and loss study, water and soil quality surveys, etc.

One of the five reservoirs listed above is planned for construction within the administrative boundaries of Astghadzor and Zolaqar rural settlements in Martuni community (Gegharkunik Marz, RA). The Astghadzor Reservoir is designed with a capacity of 1.55 mln. $m^3$ and will be fed by the

[1]Marz - Region in Armenian

Astghadzor River. It is intended to provide irrigation water to Astghadzor, Zolaqar, Vaghashen, and parts of Martuni settlements.

The positive environmental expert examination conclusion №265-24 for the Astghadzor EIA report was issued by the EIEC under the ME on 06.12.2024 (**Annex 1**).

This ESIA report presents the key findings of the national EIA report for the Astghadzor reservoir, which has been significantly upgraded to incorporate the outcomes of the supplementary studies outlined above as well as restructured and refined to ensure alignment with the EBRD ESP.

## 1.2 Objective and Scope of Works

The objective of the Assignment is to identify and assess any potentially significant future adverse environmental and social impacts associated with the proposed Project, assess compliance with applicable national E&S legislation and the EBRD ESP (2019) and Performance Requirements ('PR'), determine the measures needed to prevent or minimize and mitigate the adverse impacts, and identify potential environmental and social benefits / opportunities, including those that would improve the environmental and social sustainability of the Project.

The scope of work under the Assignment included the following tasks:

1) Reviewing and identifying applicable national E&S legislative requirements, as well as EU substantive environmental standards, Good International Practices ('GIP'), and EBRD Performance Requirements ('PR').
2) Outlining the Project components and associated facilities.
3) Updating the existing E&S baseline data developed during the national EIA studies by incorporating the results of the supplementary studies.
4) Analyzing the outputs of the stakeholder consultation process conducted during the national EIA studies, and identifying key stakeholder concerns and recommendations.
5) Analyzing project alternatives and justifying the selected option.
6) Identifying the Project’s footprint and assessing its impacts on the physical, biological, socio-economic, and cultural environments, including potential benefits and opportunities from Project implementation.
7) Cumulative impact assessment and transboundary impact.
8) Proposing E&S management and mitigation measures, and assessing residual impacts.
9) Developing an environmental monitoring plan and site-specific E&S management plans.

## 1.3 Content of the ESIA Report

This report has been prepared as part of the Project’s ESIA study. It is structured in a manner to address the following sections requested by the Project 'ToR':

Chapter 1 - Introduction,

Chapter 2 - Project Description,

Chapter 3 - Project Alternatives,

Chapter 4 - Legal and Regulatory Framework,

Chapter 5 - ESIA Methodology and Approach,

Chapter 6 - E&S baseline,

Chapter 7 - Stakeholder Consultation,

Chapter 8 - E&S Impacts Assessment, Benefits and Opportunities, Mitigation Measures,

Chapter 9 - E&S Management and Monitoring.

## 1.4 Sources of Information

The key information and data sources used to prepare this ESIA report include:

- Project ToR (issued by the EBRD),
- ToR for the local EIA consultant,
- National EIA report for the Astghadzor reservoir (in Armenian) (minenv.am),
- Project design document for the Astghadzor reservoir,
- Information about the Water Committee from its website (scws.am),
- Armenia Water Reservoirs - Technical, Economic and Green Due Diligence Gap Analysis, Draft Final Report, 2023-2024, Ove Arup & Partners,
- Technical, Economic and Green Due Diligence of Water Reservoirs in Armenia Inception Report, March 2024, Ove Arup & Partners,
- Documents/information provided by the Water Committee,
- E&S reports and documents related to the ongoing water sector projects (Vedi and Kaps reservoirs),
- Meetings/consultations with the national EIA Consultant,
- Result of field studies and meetings with the project stakeholders,
- Key findings of supplementary studies,
- Available maps, layouts, reports, etc. related to the project area.

# 2. Project Description

## 2.1 Agricultural Problems specific to the Project Region

The agricultural lands of Astghadzor, Zolaqar, Vaghashen, and parts of the Martuni settlement were planned to be irrigated by the Astghadzor, Zolaqar, and Martuni pumping stations, which draw water from Lake Sevan, as well as by gravity-fed water intakes, small irrigation channels from the Astghadzor River, and several boreholes.

The Astghadzor pumping station was designed to irrigate 800 ha of land, but due to the worn-out and inefficient operation of the pumping units, only 450 ha are currently irrigated. A similar situation exists at other pumping stations. To mechanically supply water to the rural settlements of Astghadzor and Zolaqar, approximately 8-8.5 mln. kWh of electricity is consumed by the pumping stations during the irrigation season alone. In addition to these costs, the pumping stations also cause significant damage to the fish stocks of Lake Sevan.

Even in years with 50% water availability, the irrigation of agricultural lands within the service area of the gravity channels during the June-September period remains incomplete and intermittent due to severe water shortages in the Astghadzor River. In some cases, irrigation water is supplied in shifts. Currently, 167 ha of agricultural land in the command area are irrigated mechanically, and 34 ha by gravity. Due to the lack of irrigation water, about 150 ha belonging to Martuni settlement and most of the agricultural lands in Astghadzor, Zolaqar, Vaghashen settlements are not irrigated.

The experience of years of irrigation of the mentioned areas, under the existing conditions of water intake and water supply by irrigation methods, has revealed a number of problems and shortcomings, which have become even more acute especially in recent years and the necessity of their mandatory solution is conditioned by justified technical, economic, social, and environmental requirements.

Over the years of irrigating agricultural lands in the command area under existing conditions, a number of problems and shortcomings have been identified. These issues have become particularly acute in recent years, and addressing them is necessary due to well-founded technical, economic, social, and environmental considerations. Supplying irrigation water through pumping stations requires substantial annual financial allocations for repairs, operating costs, and electricity consumption.

## 2.2 Water Demand and Command Area

The Astghadzor reservoir is planned to be constructed to irrigate 740 ha of agricultural land in Astghadzor, Zolaqar, Vaghashen, and parts of the Martuni settlements.

Taking into account the climatic conditions of the project region, the main crops cultivated are wheat, potatoes, and other vegetables. The irrigation water requirements for agricultural croplands are estimated based on the bulletin 'Norms and Regimes of Crop Irrigation for Irrigated Lands in the Republic of Armenia', approved by a joint decree of the RA Minister of Territorial Administration and the RA Minister of Agriculture in 2007[2].

Calculations conducted during the design study[3] show that cultivating wheat, potatoes, and other vegetables on 740 ha of land in the beneficiary rural settlements of Astghadzor, Vaghashen, Zolaqar, and Martuni will require 2.364 mln. $m^3$ of irrigation water, assuming 100% water use efficiency.

[2]Preparation of design and cost estimation documents for construction of Astghadzor reservoir in Gegharquniq Marz of the Republic of Armenia, Explanatory Note, 2024

[3]Ibid

Taking into account the current 75% efficiency of the irrigation network (i.e., 25% water losses), the actual water requirement will be 3.152 mln. $m^3$ (**Table 2-1**).

**Table 2-1. Calculations of specific and annual water demand**

| № | Agricultural crop | Occupied area, ha | Irrigation water rate, $m^3$/ha | Average balanced irrigation rate, $m^3$/ha | Water demand, mln. $m^3$ |
|---|---|---|---|---|---|
| 1 | Potato | 320 | 3,600 | 1,556.8 | |
| 2 | Other vegetables | 130 | 3,300 | 579.7 | |
| 3 | Wheat | 290 | 2,700 | 1,058.1 | |
| Total (100% efficiency) | | 740 | 9,600 | 3,195.0 | **2.364** |
| Total (75% efficiency) | | | | 4,259.0 | **3.152** |

The volume of water to be stored as a result of the reservoir construction will make it possible to switch from mechanical irrigation to gravity-based irrigation in the beneficiary settlements. It will also enable the irrigation of lands that have so far remained uncultivated due to a shortage of water.

The availability of a pressurized pipeline creates an opportunity to replace mechanical irrigation using pumping stations with gravity-based irrigation through the construction of an appropriate irrigation network, thereby reducing electricity consumption.

## 2.3 Key Outputs of the Hydrological Study

The Astghadzor River is located in the Gegharkunik region and is part of the Lake Sevan watershed. Its basin lies on the northern slopes of the Vardenis mountain range. The highest point in the river basin is Astghonq Peak (3,470 m), situated in the southern part of the basin. The watershed has an elongated shape, which indicates a low probability of simultaneous accumulation of maximum discharges in the river.

The Astghadzor River exhibits an annual flow pattern typical of Armenian rivers. It features a pronounced spring flood phase, low-water periods in winter and summer, and a less distinct autumn flood phase. Spring floods are primarily driven by snowmelt and rainfall, while autumn floods caused mainly by rainfall are short-lived and not well-defined. During low-water periods, the river is mainly fed by springs, although summer low-water conditions can occasionally be interrupted by sudden heavy rains.

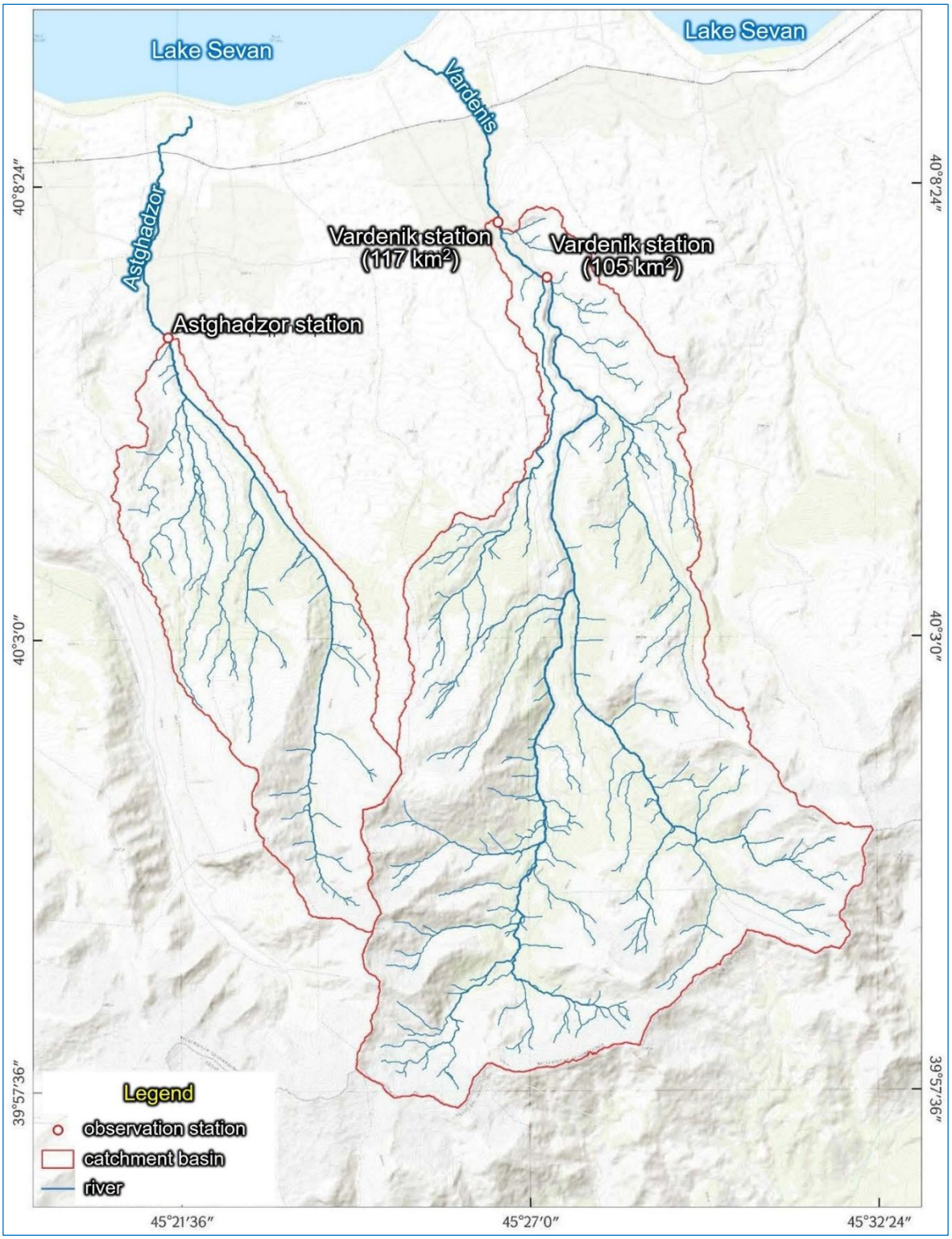
The catchment basin of the Astghadzor River at the planned reservoir dam site covers an area of 37.8 $km^2$. The length of the river from this point to its source is approximately 14 km. The basin's elevation ranges from 2,100 to 3,500 meters above sea level (masl). The average weighted elevation of the basin is 2,733 masl, which is comparable to the corresponding value for the Vardenik observation point on the Vardenis River catchment (2,756 m). The map of Astghadzor River and Vardenis River basins is presented in **Figure 2-1**.

Hydrological surveys for the Astghadzor River were conducted by the "Modul" design company as part of the feasibility and design studies. Since flow data at the Astghadzor hydrometric station were recorded for only 10 years, database from the Vardenik station on the Vardenis River (**Figure 2-1**) were used as analogue data. Flow observations at the Vardenik hydrometric station have been recorded for 95 years and are therefore sufficient for estimating reliable hydrological parameters for the Astghadzor River.

The observation series at the Vardenik hydrometric station from 1927 to 2021 has a 97% data completion rate. Average monthly discharge data are missing for the periods January-March 1939, June-August 1941, July-August 1942, September-December 1948, March-December 1995,

January-June 1996, and the entire year of 1997. The missing monthly values have been estimated using the multi-year average discharges. Data for annual maximum discharges are missing for the years 1941, 1995, and 1996.

**Figure 2-1. Map of Astghadzor River and Vardenis River basins**



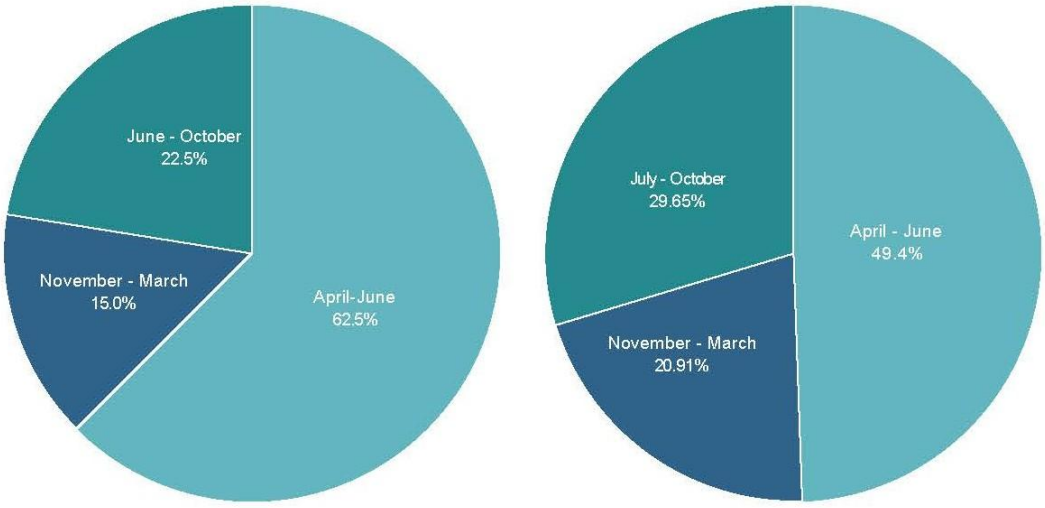

The calculated annual water flows of the Astghadzor River corresponding to 5%, 50%, 75%, and 95% probability levels are summarized in **Table 2-2**.

**Table 2-2. Annual flow distribution at the Astghadzor hydrometric station for different probability levels**

| Year | Month | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| 5% | 0.15 | 0.13 | 0.11 | 0.25 | 1.18 | 1.46 | 0.63 | 0.22 | 0.16 | 0.14 | 0.16 | 0.16 |
| 50% | 0.08 | 0.09 | 0.09 | 0.33 | 0.77 | 0.76 | 0.34 | 0.15 | 0.08 | 0.09 | 0.09 | 0.10 |
| 75% | 0.08 | 0.07 | 0.08 | 0.24 | 0.70 | 0.55 | 0.20 | 0.12 | 0.10 | 0.09 | 0.09 | 0.09 |
| 95% | 0.06 | 0.05 | 0.06 | 0.14 | 0.24 | 0.26 | 0.15 | 0.10 | 0.07 | 0.06 | 0.05 | 0.05 |

The seasonal cumulative profile of the intra-annual flow distribution (**Figure 2-2**) shows that in years with a 50% probability level, 62.5% of the Astghadzor River's annual flow occurs during the spring flood period. In years with a 95% probability level (low-water years), the share of spring flood flows decreases to 49.4%, indicating a significant reduction in the total volume of floodwater during dry years.

**Figure 2-2. Intra-annual (seasonal) flow distribution for years corresponding to the 50% and 95% probability levels**




Based on the calculated average flow rate of 0.25 m³/s at the Astghadzor hydrometric station, the total flow volume during the spring flood season is estimated to reach approximately 5 mln. $m^3$ in years with 50% probability (normal years), and around 1.6 mln. $m^3$ in years with 95% probability (low-water years).

### *Maximum Flow*

According to the calculations performed within the hydrological study[4], the maximum discharge at the Astghadzor hydrometric station is 27.2 $m^3$/s for a 0.01% probability (return period), 22.9 $m^3$/s for 0.1%, and 18.4 $m^3$/s for 1%. The guaranteed adjustment for the 0.01% probability discharge is 2.3 $m^3$/s.

The flows at the Astghadzor hydrometric station determined in line with the Gumbel's formula[5] are as follows: 20.2 $m^3$/s for 100 (1%), 26.9 $m^3$/s for 1000 (0.1%) and 33.6 $m^3$/s for 10000 (0.01%) recurrence period.

[4]Ibid

[5]The Gumbel formula is widely used in hydrology to estimate extreme values of events such as maximum annual discharges, flood peaks, or rainfall intensities associated with specific return periods (e.g., 10-year, 100-year floods)

### *Minimal Flow*

At the Vardenik hydrometric station, the average minimum discharge is 0.41 $m^3/s$, with a standard deviation of 0.17 $m^3/s$, a coefficient of variation of 0.42, and a coefficient of asymmetry of 0.1. According to the Construction Norms and Rules (CN&R) №2.01.14-83[6], the discharge corresponding to an 80% probability of minimum flow (P80%) is used for design calculations. Based on the empirical curve, the P80% discharge at the Vardenik station is 0.25 $m^3/s$, while the theoretical curve gives a value of 0.26 $m^3/s$. Using the same approach, the minimum flow rate for the Astghadzor station is estimated at 0.19 $m^3/s$.

### *Environmental Flow*

The environmental flow for the reservoir area was calculated in line with the RA Government Decree №57-N, dated 25.01.2018 based on data from the Astghadzor and Verdenik hydrometric stations. According to the noted Government Decree, the environmental flow for each month is calculated by adding the average of the minimum 10-day discharge values from the winter low-flow period to 33% of the minimum monthly discharge.

The results of the environmental flow calculation for the Astghadzor River are presented in **Table 2-3**.

**Table 2-3. Environmental flow in Astghadzor River, $m^3/sec$**

| Parameter | Months | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII |
| Calculated environmental flow | 0.015 | 0.016 | 0.018 | 0.140 | 0.224 | 0.410 | 0.242 | 0.099 | 0.031 | 0.013 | 0.017 | 0.015 |
| Actual minimal flow | 0.015 | 0.016 | 0.018 | 0.140 | 0.110 | 0.160 | 0.088 | 0.054 | 0.011 | 0.013 | 0.017 | 0.015 |
| Environmental flow after comparison with actual minimal flow | 0.015 | 0.016 | 0.018 | 0.058 | 0.086 | 0.147 | 0.092 | 0.045 | 0.022 | 0.013 | 0.017 | 0.015 |

## 2.4 Sediment Load of the Astghadzor River

The hydrological calculation of sediment transport at the Astghadzor Reservoir dam site (Astghadzor hydrometric station) was based on data from the Vardenik hydrometric point on the Vardenis River. The available data cover the period from 1950 to 1975. The annual average sediment flow at the Vardenik observation point is 0.057 $m^3/s$.

According to these calculations, the volume of sediment at 50% probability level of the river flow is 0.044 kg/s, or approximately 1,600 t/year. In this case, the flow module at the Vardenik hydrometric station is 14.54 tons/$km^2$. Based on this flow module, the annual sediment transport at the Astghadzor hydrometric station (at 50% probability level) is estimated to be 0.018 kg/s or 558 t/year.

Considering the composition of the sediment (sand, clay, silt, etc.) and the densities of its components (e.g., 1 $m^3$ of sand ≈ 1.53 tons, clay ≈ 1.1-1.6 tons, silt ≈ 1.3-1.7 tons), the estimated sediment volume at the Astghadzor hydrometric station, at a 50% probability level, is 372 $m^3$/year.

Sedimentation in the reservoir reduces its operational lifetime (T), which is determined by the following formula:

[6]CN&R №2.01.14-83 'Definition of Calculated Hydrological Characteristics'

$$T = W_{DSV} / W_S$$[7]

According to this formula, assuming that the entire volume of sediment accumulates in the dead storage of the reservoir, its required dead storage capacity would be 18,600 $m^3$ for a 50-year operation period, and 74,400 $m^3$ for a 200-year operation period.

## 2.5 Water Infiltration from the Reservoir Body

Water infiltration from the reservoir body was estimated during the engineering-geological surveys conducted as part of the Project design study.

According to the lithological section and topographic features, the selected dam axis site (base) is divided into 3 blocks: left side area (1st block 1, left bank of the river), central area (2nd block, river bed), right side area (3rd block 3, right bank of the river). The calculations were carried out assuming a normal reservoir level of 2,164 masl.

The results of water infiltration calculations from the 3 blocks under the reservoir body are summarised in **Table 2-4**.

**Table 2-4. Water infiltration from reservoir body**

| Parameter | Unit | 1st block | 2nd block | 3th block |
|---|---|---|---|---|
| Water infiltration | $m^3$/day | 1,295.0 | 1,651.0 | 2,058 |
| | $m^3$/year | 472,675 | 602,615 | 751,170 |
| | | ≈ 1.8 mln. | | |

The annual water infiltration volume from the reservoir body is estimated at approximately 1.8 mln. $m^3$ per year, which requires the implementation of anti-infiltration measures.

## 2.6 Project Overview

### 2.6.1 Background

To ensure sustainable and reliable irrigation of agricultural crops, water balance calculations for the Astghadzor Reservoir were carried out based on the annual flow and discharge at the dam site, assuming a 75% probability (dry) year. The available river flow at the dam site was determined by deducting the irrigation demand and total water losses. The flow is distributed in such a way that the Dead Storage Level (DSL) is maintained in the reservoir at the end of the irrigation season.

The results of the annual seasonal flow regulation, calculated as part of the Project design study, indicate that the total volume of the reservoir is 1.55 mln. $m^3$, the dead storage is 0.036 mln. $m^3$ and the useful (active) storage is 1.514 mln. $m^3$. The technical parameters of the reservoir and supporting infrastructure are presented in **Table 2-5**.

The annual volume of water required for the irrigation of 740 ha of agricultural land in the rural settlements of Astghadzor, Zolaqar, Vaghashen, and Martuni is 3.13 mln. $m^3$, of which 1.514 mln. $m^3$ will be supplied from the reservoir and 1.61 mln. $m^3$ from the river.

[7] $W_{DSV}$ - dead storage volume of the reservoir, $W_S$ - annual volume of sediments

### 2.6.2 Current Design Study

Based on Contract № JK-BMKhTsZB 22/5-N signed on 22.11.2022 between the Water Committee and Modul LLC design company, the latter was appointed to develop the design documentation for the construction of the Astghadzor Reservoir. As a part of the feasibility and design studies, a combination of desktop and field surveys to collect baseline data were carried out by the designers, including:

- Geodetic survey,
- Hydrological studies,
- Hydroeconomic calculations,
- Engineering-geological investigations,
- Seismic microzoning study and seismic risk probability assessment,
- Design solutions for the reservoir, dam and supporting infrastructure,
- Feasibility study.

The results of the above-mentioned surveys and studies are summarised in the relevant volumes of the Project design document. In addition, calculations of the main structures and determination of their dimensions were carried out based on the principle of integrating modern studies with alternative solutions to ensure the selection of the most efficient option.

The national EIA study for the Project started in 2023, and the positive environmental expert examination conclusion № 265-24 for the Astghadzor EIA report was issued by the EIEC under the Ministry of Environment on 06.12.2024 (**Annex 1**).

In parallel, a licensed company was engaged in 2024 by the Water Committee to identify the scope of the main impacts based on a social impact assessment, conduct detailed measurement survey, determine the affected lands and persons, assess their physical and economic losses resulting from the project implementation, and propose measures to compensate affected persons (APs) and assist them in restoring their livelihoods, in accordance with PR5 of the EBRD ESP, as well as the applicable regulations of the RA. All of the above has already been formalised in the draft Resettlement Plan (RP) for the Project.

### 2.6.3 Project Location

The Astghadzor Reservoir is planned to be constructed within the administrative boundaries of the Astghadzor and Zolaqar rural settlements. It will be located on the Astghadzor River, at an elevation of 2,100-2,160 masl. The reservoir is intended to accumulate the river's floodwaters and ensure sustainable irrigation of 740 ha of agricultural land in the settlements of Astghadzor, Zolaqar, Vaghashen, and part of Martuni in the Gegharkunik Marz, during the low-water months.

The reservoir will be situated in the middle reaches of the Astghadzor River. Some of the land in this area is privately owned, while other portions are communal, belonging to the Astghadzor settlement, and their use is governed by the relevant legislation of the Republic of Armenia.

Astghadzor settlement (also known as Khachadzor or Dzor) is located 39 km southeast of the regional center, the town of Gavar. The settlement is situated on a low hill at an elevation of 2,030 meters above sea level (masl), approximately two kilometers from Lake Sevan. The road distance between Astghadzor and Yerevan, the capital of Armenia, via the M11, M10, and M4 highways is approximately 130 km. The Zolaqar settlement borders Astghadzor to the east (**Figure 2-3**) and the two settlements are connected by an inter-community road.

During the field studies, a landslide body was identified in the investigated area. It extends approximately 80 m upslope and 50 meters in width. According to engineering and geological data,

the maximum thickness of the landslide body reaches 15 m. The vertical difference in elevation between the landslide head and foot is about 50 m, and the total volume of the unstable soil mass is estimated at approximately 40,000 $m^3$.

**Figure 2-3. Location of the Astghadzor Reservoir site and the surrounding rural settlements**


### 2.6.4 Project Components

The Astghadzor Reservoir and its associated structures will cover an area of 13.53 ha, of which 11.6 ha will be occupied by the dam and its auxiliary facilities. The reservoir will have a storage capacity of 1.55 mln. $m^3$. The reservoir is planned to be constructed to irrigate 740 ha[8] of agricultural land in Astghadzor, Zolaqar, Vaghashen, and parts of the Martuni settlements.

The reservoir hydraulic unit consists of:

1. Dam,
2. Spillway,
3. Construction (diversion) outlet,
4. Irrigation main outlet OJ 1 and Irrigation pipelines OJ 1-1 and OJ 1-2,
5. Emergency spillway.

The Master Plan of the Project area, indicating Astghadzor reservoir, its components and supporting infrastructure is provided in **Annex 2** of this ESIA report.

### 2.6.5 Technical Solutions

Dam structure

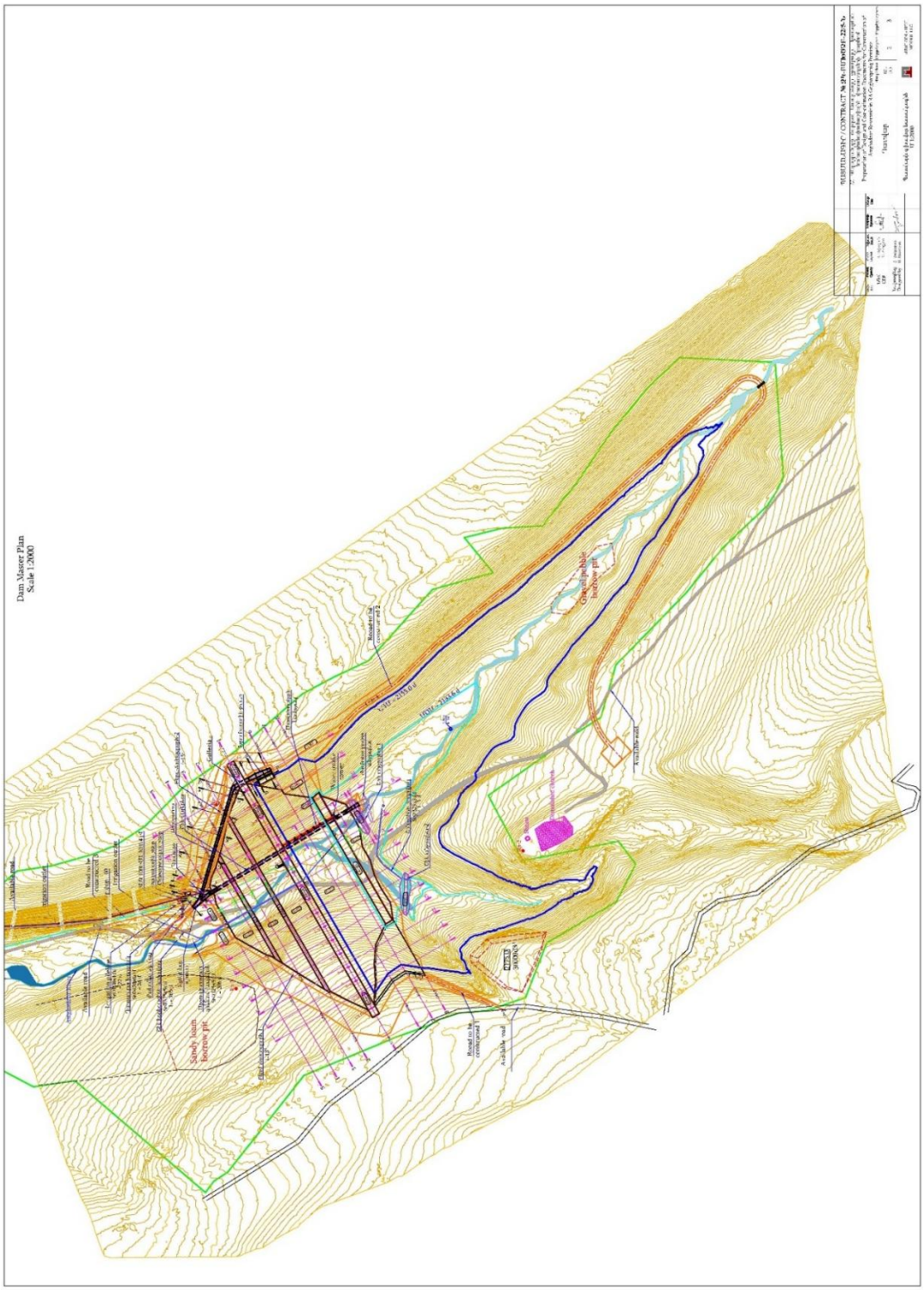
[8]To irrigate 740 ha of agricultural land in the rural settlements of Astghadzor, Zolaqar, Vaghashen, and Martuni 3.13 mln. $m^3$ is required of which 1.514 mln. $m^3$ will be supplied from the reservoir and 1.61 mln. $m^3$ from the river

A number of studies were conducted to determine the optimal axis for the dam. Based on topographic and geological assessments of various options, the final selected axis was identified as the most suitable for reservoir construction (**Figure 2-4**).

The dam alignment was selected based on several considerations:

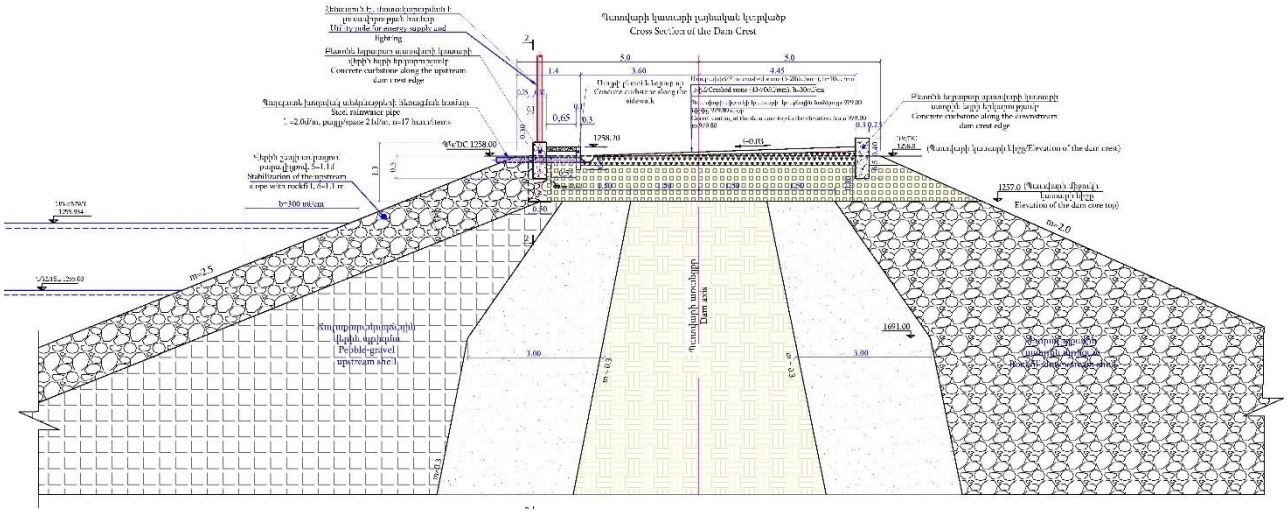
a) Creation of a reservoir area with the required storage capacity,
b) A dam with a relatively short crest,
c) A riverbed that does not widen downstream.

**Figure 2-4. Hydraulic unit of the Astghadzor reservoir**



The dam is planned to be constructed using locally available materials, with pebble-gravel shells. A central loam core is envisaged as an anti-filtration measure (**Figure 2.5**). The dam crest level was determined for both scenarios: Full Supply Level (FSL) and Maximum Water Level (MWL) and the higher of the two was selected.

**Figure 2-5. Cross-section of the reservoir dam**




The height of the dam is 27.9 m from the upstream channel bed and 43.85 m from the downstream side. The total length of the dam is 260 m. The upstream slope has an inclination of m = 3.5, while the downstream slope is m = 2.5. The crest width is 10.0 m, and the length of the weir is 14 m.

The upstream slope of the dam will be protected with masonry, while the downstream slope will be covered with greensward and perennial grass. The minimum width of the core (3 m) and its slope inclination (1:3) were selected based on the average critical value of the filtration gradient. A transition filter layer will protect the loam core on both the upstream and downstream sides.

Pebble-gravel, gravel-sand, and rock materials required for the construction of the earth dam can be sourced from the reservoir area and the riverbed up to 1 km downstream of the dam axis. Additionally, 100,000 $m^3$ of loam required for the core and other construction needs will be procured from licensed suppliers.

Construction (diversion) outlet

The construction outlet is a temporary working structure designed to divert construction-phase river flows downstream of the construction site and to keep it dry. The Project design envisions that construction discharges will be conveyed through a floor gallery (or tunnel) with a square cross-section of 2.0 × 2.0 m and a total length of 216.0 m. Calculations for a 10% exceedance flow ($Q_{10\%}$ = 13.1 $m^3/s$) were used to determine the gallery's cross-sectional dimensions and floor slope.

To manage river discharges and direct them into the floor gallery, an upper weir will be constructed. This weir will later become part of the dam body. Additionally, to prevent water conveyed through the gallery from returning and flooding the construction site, a lower weir will also be constructed.

Irrigation main outlet OJ 1 and Irrigation pipelines OJ 1-1 and OJ 1-2

For the irrigation purposes it is planned to install steel pipes with a diameter of 600 mm and a length of 240.0 m in the foundation to take water from the reservoir at a rate of Q = 633.5 l/s. The minimum water intake level is assumed to correspond to the dead storage level at an elevation of 2133.6 masl.

At the entrance of the water intake, a manhole covered with a metal grate is planned. To allow for the removal of sediment from the water intake manhole, a 300 mm diameter pipe with a regulating valve will be installed in the concrete plug. If necessary, maintenance or repair of this pipe can be carried out during the reservoir's drawdown.

To control the operation of the irrigation outlet, two valves are planned to be installed at the beginning of the pipeline, and one valve with a water meter at the end. The total length of the irrigation outlet pipeline (Ø630×10 mm) from the intake tower to the valve structure is 240 m, of which 183 m pass through the construction gallery. Inside the gallery, at the beginning of the pipeline, emergency (Ø600 mm) and air-relief (Ø100 mm) disc valves will be installed. In the downstream section, after the Ø600 mm emergency disc valve located on the irrigation outlet pipe within the valve structure, a 1193 m long Ø630×10 mm OJ irrigation pipeline begins.

In the valve structure, a Ø630×10 mm irrigation discharge pipe branches into the following outlets:

- A 26 m long Ø426×6 mm discharge pipe equipped with a Ø400 mm disc valve,
- A 26 m long Ø219×5 mm environmental flow pipe equipped with two Ø200 mm disc valves and one Ø200 mm water meter,
- A 22 m long Ø108×4 mm pipe providing irrigation water subsidy, equipped with two Ø100 mm disc valves and one Ø100 mm water meter.

A 342 m long stainless steel irrigation pipeline OJ 1-1 (Ø426×6 mm) to the Astghadzor settlement, and a 3,254 m long stainless steel irrigation pipeline OJ 1-2 (Ø426×6 mm) to Vaghashen, equipped with Ø400 mm disc valves and Ø400 mm water meters, will be constructed (see **Annex 2**).

Emergency spillway

An open side channel spillway has been designed to discharge flood flows. The spillway will consist of the following main components:

1. Side weir,
2. Transition section - 1,
3. Passway beneath the dam,
4. Transition section - 2,
5. Chute,
6. Surge tank.

The main technical characteristics of the reservoir and dam are presented in **Table 2-5**.

**Table 2-5. Main technical characteristics of the Astghadzor reservoir**

| № | Key technical data | Measurement unit | Details |
|---|---|---|---|
| **1. General data** | | | |
| 1.1 | Location of the reservoir | | Astghadzor and Zolaqar villages of Martuni community (RA Gegharkunik Marz)<br>The proposed reservoir will be located at elevations of 2100-2160 m |
| 1.2 | Capacity of the Astghadzor reservoir | mln. $m^3$ | Total: 1.55 |
| | | mln. $m^3$ | Active: 1.512 |
| | | mln. $m^3$ | Dead: 0.036 |

| № | Key technical data | Measurement unit | Details |
|---|---|---|---|
| 1.3 | Reservoir surface area (at top water level) | ha | 13.53 |
| 1.4 | Area to be permanently allocated for the Project needs | ha | 42.011 |
| 1.5 | Top water level (weir level) | masl | 2155.0 |
| 1.6 | Surface area of the water horizon at the FSL | $m^2$ | 91,300 |
| **2. Dam** | | | |
| 2.1 | Material of the body | | Pebble-gravel |
| 2.2 | Dam type | | Embankment dam with a loam screen |
| 2.3 | Dam slopes (v:h) | | Upstream slope: 1:3.5 |
| | | | Downstream slope: 1:2.5, 1.2.0 |
| 2.4 | Dam class (Armenian Standards) | | II |
| 2.5 | ICOLD - Dam class | | II |
| 2.6 | ICOLD - Dam hazard | | ICOLD 121 Global FoS |
| 2.7 | Dam crest level | masl | 2158.0 |
| 2.8 | Dam height | m | From channel bed upstream - 27.9 |
| | | | From channel bed downstream - 43.85 |
| 2.9 | Dam length | m | 260 |
| 2.10 | Length of weir | m | 14 |
| 2.11 | Length of the dam with the crest | m | 371.6 |
| 2.12 | Width of the crest | m | 10.0 |
| 2.15 | Botom level | masl | 2114.4 |
| **3. Reservoir** | | | |
| 3.1 | Type | | On-stream |
| 3.2 | Dead Storage Level (DSL) | masl | 2133.6 m |
| 3.3 | Full Supply Level (FSL) | masl | 2155.0 |
| 3.4 | Maximum Water Level (MWL) | masl | 2155.93 |
| **4. Construction (diversion) outlet** | | | |
| 4.1 | Type | | Bottom gallery |
| 4.2 | Construction discharge, $Q_{10\%}$ | $m^3$/sec | 13.1 |
| 4.3 | Cross-section | m | 2.5×2.5 |
| 4.4 | Length of outlet | m | 30.0 |
| 4.5 | Length of gallery | m | 216.0 |
| 4.6 | Length of the construction outlet pipeline | m | 115 |
| 4.7 | Type of the construction pipeline | | Steel pipe |
| 4.8 | Cross-section of the construction pipeline | | ∅325×5մմ |

| № | Key technical data | Measurement unit | Details |
|---|---|---|---|
| **5. Irrigation main outlet OJ 1** | | | |
| 5.1 | Water intake structure | | Reinforced concrete water intake well and metal tower |
| 5.2 | Garbage collection | | Metallic mesh |
| 5.3 | Type of spillway | | A steel pipe with a ∅630×10mm |
| 5.4 | Length | m | 1433.0 (240+1193) |
| **6. Irrigation pipeline OJ 1-1** | | | |
| 6.1 | Type of pipeline | | A steel pipe with a ∅426×6mm |
| 6.2 | Length of pipeline | m | 342 |
| **7. Irrigation pipeline OJ 1-2** | | | |
| 7.1 | Type of pipeline | | A steel pipe with a ∅426×6mm |
| 7.2 | Length of pipeline | m | 3254 |
| **8. Emergency spillway** | | | |
| 8.1 | Type | | trench |
| 8.2 | Outflow | $m^3/s$ | 33.6 (P=0.01%) |
| 8.3 | Outflow after transformation | $m^3/s$ | 27.19 |
| 8.4 | Type of spillway | | high velocity |
| 8.5 | Length of spillway | m | 189.0 |
| **9. Electricty supply** | | | |
| 9.1 | Transformer station | | 10/0.4 kV, 100 kVA |
| 9.2 | Transformer station | | 10/0.4 kV, 25 kVA |
| 9.3 | Supply source | | 2000 m from "Astghadzor" 10 kV overhead transmission line |

### 2.6.6 Land Resources Required for the Project

In total, 54 land plots covering a surface area of 420,111.30 $m^2$ will be affected as a result of the Project implementation. Of these, 19 are community-owned, and 35 are privately owned. The 19 community-owned plots are agricultural arable lands, totaling 353,510.10 $m^2$. The 35 private plots cover 66,601.20 $m^2$, with 27 plots (52,875.10 $m^2$) classified as agricultural arable lands and 8 plots (13,726.10 $m^2$) as agricultural grasslands.

There are 30 affected households with 93 affected persons within the Project area.

Temporary land use

All facilities required for the reservoir construction, except of the sandy loam borrow pit, are situated within the Construciton site (42.011 ha area permanently allocated for the Project needs). These facilities include construction camp, pebble-gravel and loam borrow pits and topsoil temporary storage area.

Therefore, no temporary land use will be needed from the Project needs.

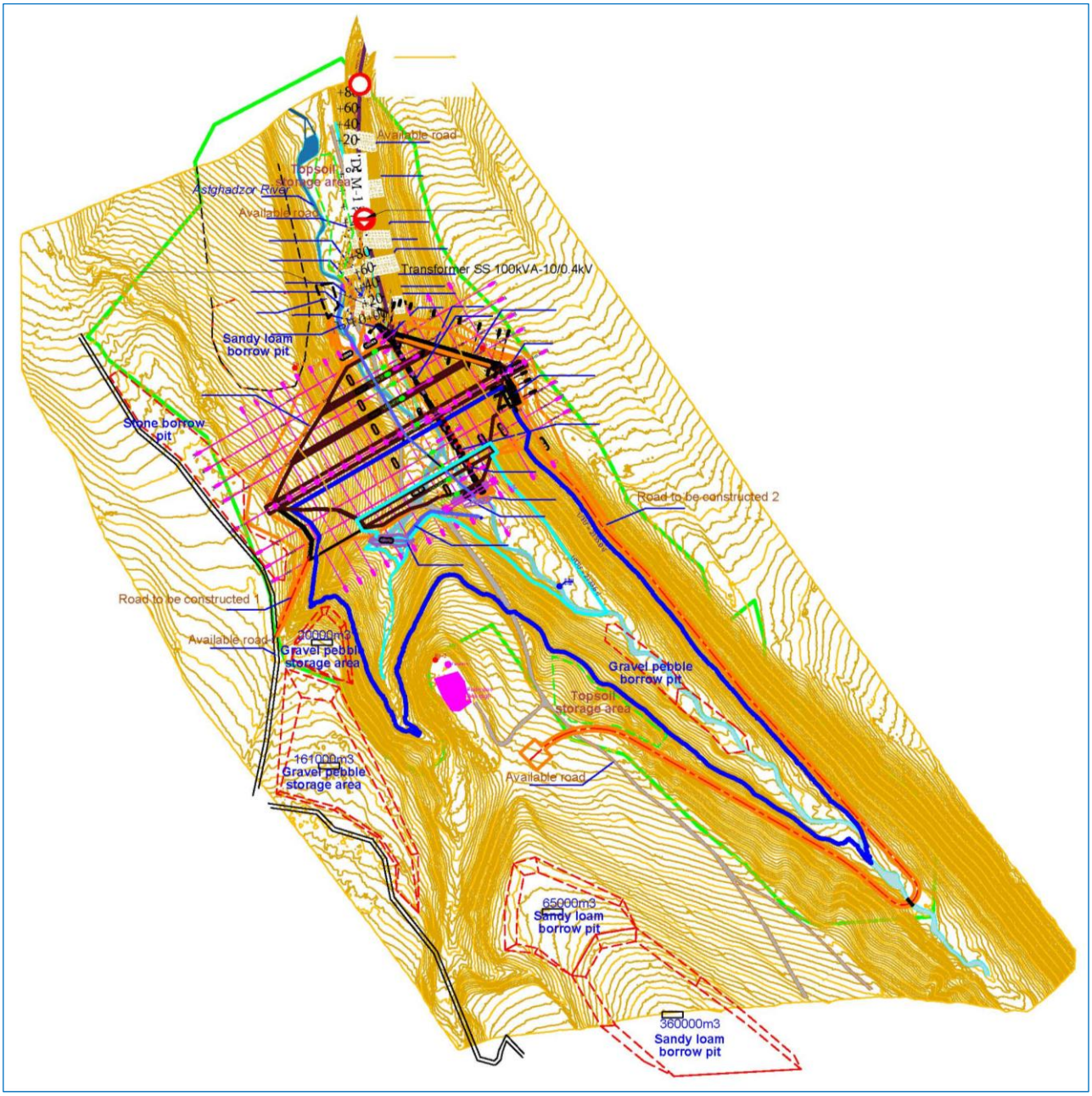
### 2.6.7 Description of the Construction Activities

The construction site will cover an area of 42.011 ha, which will be permanently allocated for the project's needs, including:

- Two sandy loam borrow pits,
- Stone borrow pit,
- One gravel pebble borrow pit,
- One gravel pebble storage area,
- Two topsoil temporary storage areas,
- Construction camp (location will be selected later).

The Master plan of the construction site is presented in **Figure 2-6**.

**Figure 2-6. Master plan of the construction site**



The materials required for the construction of the reservoir dam, such as sandy loam, gravel-pebble mix, and stone, will be extracted from areas located within the construction site. For this purpose, borrow pits will be organized and operated during the Project's construction phase (**Figure 2-6**). Additionally, stone masses generated from rock blasting and structural demolitions will be used as backfill material for the dam prisms.

Upon completion of the reservoir and dam construction, the used borrow pits will be remediated and landscaped, and the land will be returned to Martini community.

The construction machinery and equipment will be transported to Astghadzor rural settlement via M10 and M11 highways and communal roads. The access to the construction site from Astghadzor settlement will be through the avaialble earthen roads and three new earthen roads to be constructed for the Project needs (**Figure 2-6**).

During the earthworks and excavation activities, the topsoil from the site will be removed and stored in accordance with existing regulations[9],[10]. According to the Project design study, 48,640 $m^3$ of topsoil will be stripped and stored in temporary topsoil storage areas located outside the reservoir area but within the construction site (**Figure 2-6**). The topsoil will later be used for landscaping activities.

According to the Project Design Document, a combination of drilling and blasting operations is planned for use in the stone borrow pit, as well as for the removal and dislodgement of rock masses. The blasting methodology will be determined by the construction contractor. Blasting operations must be conducted in accordance with the "Uniform Rules for the Performance of Blasting Operations". Individuals under the age of 18 and those without a special certificate are not permitted to carry out blasting activities.

The Project design document also envisions the construction of power supply lines and a substation.

The main activities during the Project implementation, associated with the construction of the reservoir, dam and its supporting infrastructure, as well as the volumes of work to be performed and materials to be handled, are summarised in **Table 2-6**.

**Table 2-6. Main activities and quantities of materials to be managed during the construciton phase**

| № | Activity/operation | Project component | Materials to be managed | Measures proposed by the Design document |
|---|---|---|---|---|
| 1 | Vegetation clearance and removal of topsoil | Reservoir area | 42,800 $m^3$ | Topsoil will be temporarily stored in the two designated storage areas within the construction site (**Figure 2-6**) |
| | | Dam area | 5,840 $m^3$ | |
| 2 | Preparation of the dam basis | | | |
| 2.1 | Removal of the gravel pebble mixture | Dam area | 156,081 $m^3$ | It will be temporarily stored at the construction site (**Figure 2-6**) and then used as backfill material in the construction of the dam |
| 2.2 | Removal of sandy loam ground | | 420,730 $m^3$ | |
| 3 | Excavation and backfill of gravel- | Emergency spillway | 3,926 $m^3$ | |
| | | Irrigation outliets | 30,770 $m^3$ | |

[9]The procedure for topsoil use, approved by the RA Government Decree №1396-N dated 08.09.2011

[10]The requirements for determination of topsoil stripping norms and for stripped topsoil preservation and use, approved by the RA Government Decree №1404-N dated 02.11.2017

| № | Activity/operation | Project component | Materials to be managed | Measures proposed by the Design document |
|---|---|---|---|---|
| | pebble and sandy loam mixtures | Construction (diversion) outlet | 2,452 $m^3$ + 2,485 | |
| 4 | Access road construction works | Earth roads 1, 2, 3 | 31,278 $m^3$ | Will be used as backfill material |
| 5 | Concrete / reinforcement works | Dam area | 5,420 $m^3$ | |
| | | Emergency spillway | 1,389.3 $m^3$ / 80.9 t | |
| | | Construction (diversion) outlet | 2,452 $m^3$ / 321 t | |
| | | Irrigation outliets | 12 $m^3$ | |
| | | Valve structure | 62.3 $m^3$ / 2.23 t | |
| 6 | Mining of stone, pebble-gravel, sandy loam materials and their use in dam construction | Gravel pebble borrow pits | 118,800 $m^3$ + 181472 $m^3$ | Borrow pits will be located within the construciton site (**Figure 2-6**) |
| | | Stone borrow pit | 3,039 $m^3$ | |
| | | Sandy loan borrow pits | 148,700 $m^3$ + 754 $m^3$ | |
| 7 | Construction of the overhead transmission lines and substation | | Spoil materials, towels, concrete | |

The work schedule including the required workforce and types of construction machinery to be used during the construction is presented in **Figure 2-7**.

**Figure 2-7. Construction time-schedule, required workforce and machinery**

Time schedule for the construction works

| Working staff, construction machinery | 1st year Months | | | | | | | | | | | | 2nd year Months | | | | | | | | | | | | 3rd year Months | | | | | | | | | | | | 4th year Months | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | I | II | III | IV | V |
| Working staff | | | | 6 | 5 | 7 | 36 | 49 | 54 | 38 | 36 | 38 | 50 | 66 | 47 | 63 | 61 | 57 | 33 | 49 | 31 | 27 | 43 | 27 | 17 | 35 | 21 | 17 | 29 | 19 | 21 | 33 | 19 | 26 | 30 | 57 | 59 | 31 | 18 | | |
| Excavator 0.5$m^3$ | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | 2 | 1 | | |
| Excavator 1.25$m^3$ | | | | 2 | 6 | 6 | 5 | 6 | 6 | 1 | 1 | 3 | 5 | 5 | 8 | 4 | 1 | 2 | 4 | 6 | | | 1 | | | 6 | | | 1 | 1 | | 5 | 1 | | | 1 | | | | | |
| Excavator 2.5$m^3$ | | | | | | | 2 | | 2 | | | | | 4 | 2 | 5 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 3 | 3 | 5 | 3 | 3 | 3 | 5 | 3 | 3 | 2 | 4 | | | | | |
| Excavator with hydrohammer | | | | 2 | 2 | 4 | 4 | 6 | 6 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Bulldozer 79 kW | | | | 6 | 5 | 4 | 4 | 4 | 5 | 1 | 1 | 3 | 6 | 10 | 7 | 6 | 3 | 5 | 5 | 10 | 3 | 2 | 4 | 2 | 2 | 9 | 3 | 2 | 3 | 3 | 3 | 7 | 3 | 1 | 2 | 1 | | | | | |
| Bulldozer 132 kW | | | | | | 1 | 1 | 1 | 1 | 1 | | 1 | | 2,5 | 2 | 3,1 | 5,2 | 4,6 | 4,6 | 5,2 | 4,6 | 2,6 | 5,2 | 2,6 | 2,6 | 3,2 | 4,6 | 2,6 | 3,2 | 2,6 | 4,6 | 3,2 | 2,6 | 2,1 | 4,1 | 1,6 | | | | | |
| Roller 16t | | | | | | 1 | 1 | 1 | 1 | 1 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Pneumoroller 25t | | | | | | | | | | | | | | 0,3 | 0,1 | 1,2 | 1,8 | 0,8 | 0,8 | 1,8 | 0,8 | 0,8 | 1,8 | 0,7 | 0,7 | 1,7 | 0,8 | 0,7 | 1,7 | 0,7 | 0,8 | 1,7 | 0,7 | 0,6 | 0,7 | 0,4 | | | | | |
| Loader 10tn | | | | | | | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | 1 | 1 | 2,4 | 3,4 | 3 | 2 | | |
| Welding device | | | | | | | 1 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | 1 | 1 | | |
| Drilling hammer | | | | | | | 1 | 1 | 1 | 1 | | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | |
| Perforator | | | | | | | | | | | | | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | | | | | | | | | | | | | | | | | |
| Drilling machine | | | | | | | | 2 | 2 | 4 | 4 | 4 | 4 | 4 | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 1 | | |
| Batching plant | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PE welder | | | | | | | | | | | | | | | | 1 | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | 1 | | | | | | | | | |
| Vibrator | | | | | | | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | 2+1 | 2+2 | 2 | | | |
| Hoist 5t | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1,2 | 1 | | |
| Heavy truck 10$m^3$ | | | | 6 | 18 | 18 | 15 | 18 | 18 | 3 | 3 | 9 | 15 | 15 | 24 | 12 | 3 | 6 | 12 | 18 | 0 | 0 | 3 | 0 | 0 | 18 | | | 3 | 3 | 0 | 15 | 3 | | | 3 | | | | | |
| Heavy truck 10$m^3$ | | | | | | | 6 | | 6 | | | | | 12 | 6 | 15 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 9 | 9 | 15 | 9 | 9 | 9 | 15 | 9 | 9 | 6 | 12 | | | | | |
| Heavy truck 10$m^3$ | | | | 6 | 18 | 18 | 21 | 18 | 24 | 3 | 3 | 9 | 15 | 27 | 30 | 27 | 12 | 21 | 27 | 33 | 15 | 15 | 18 | 15 | 9 | 27 | 15 | 9 | 12 | 12 | 15 | 24 | 12 | 6 | 12 | 3 | | | | | |
| Heavy truck 20$m^3$ | | | | | | | | | | | | | | | | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | | | | | | | |
| Classificator 130$m^3$/hour | | | | | | | 1 | | 1 | | | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | |
| Classificator 45$m^3$/hour | | | | | | | 1 | | 1 | | | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | |

The required number of workers will vary throughout the Project implementation period. According to the construction time schedule (**Figure 2-6**), the maximum workforce will include 66 workers and technicians, 14 managers and engineers, and 19 officers. In total, 99 workers will be required for the construction stage.

The construction workforce will primarily comprise highly skilled professionals, such as welders, concreters and construction machinery operators, alongside unskilled labour recruited mainly from the project-affected settlements. Overall construction management will be carried out by the Site manager and the foremen.

Duration of the construction works was determined based on the volume and labour intensity of the main earth/excavation and concrete works, the rational sequencing of tasks, and a consolidated assessment of operational constraints in line with CN&R №1.04.03-85 "Norms for the duration of construction of facilities, buildings, and structures". The construction period was determined according to the Project's construction time-schedule (**Figure 2-7**) and amounts to 36 months[11].

## 2.7 Associated Facilities

According to the EBRD ESP (2019), facilities or activities that are not financed under the Bank's loan agreement but are, in the EBRD's view, significant for the success of the project or for achieving agreed project outcomes are considered **Associated Facilities**[12].

All components required for the reservoir's operation, including access roads and power supply lines, are included in the project design document. Therefore, there are no components that can be classified as associated facilities for the Project.

## 2.8 Project Justification

The GA has prioritised the management of water resources for agricultural use and plans to construct 17 reservoirs within the EU support initiative 'Recovery, resilience and reform: post 2020 Eastern Partnership priorities' to the Government of Armenia to enhance the water and food security level in the country. The Program for the 17 reservoirs construction was developed by the Ministry of Territorial Development an Infrastructure (MTAI) on 2022 and approved by the GA.

The objective of the Program is to implement large-scale reservoir construction in Armenia to regulate surface water flow, manage water resources effectively, and increase both the availability of usable water and the area of agricultural land to be irrigated. The construction of the planned reservoirs will support the conversion of the existing irrigation system to gravity-based operation, which will help reduce power consumption and, consequently, lower the cost of agricultural production.

[11]Preparation of design and cost estimation documents for construction of Astghadzor reservoir in Gegharkunik Marz of the Republic of Armenia, Explanatory Note, 2024

[12]These are new facilities or activities: (i) without which the project would not be viable, and (ii) would not be constructed, expanded, carried out or planned to be constructed or carried out if the project did not exist

# 3. Project Alternatives

## 3.1 Zero Option

The planned capacity of the Astghadzor reservoir is 1.55 mln. $m^3$ and it is intended to irrigate approximately 740 ha of agricultural land in the rural settlements of Astghadzor, Vaghashen, and Zolaqar during the low-water months. Currently, the agricultural plots in these settlements are mainly irrigated by the Astghadzor, Vaghashen, and Zolaqar pumping stations, which draw water from Lake Sevan and supply it to users, as well as through small canals and ditches that convey water from the Astghadzor River by gravity. Considering that the Astghadzor River is one of 28 rivers that discharge into Lake Sevan, it can be concluded that the irrigation of agricultural land in the aforementioned settlements is ultimately supported by water from Lake Sevan.

According to the Project design document[13], approximately 850 ha out of available 1,000 ha of agricultural land in the Astghadzor community are considered irrigable. It was initially planned to irrigate 800 ha using the existing pumping station in Astghadzor. However, due to deteriorated pumping units and improper functioning, only 450 ha are currently being irrigated. The other pumping stations are also in similarly poor condition.

During the irrigation season, about 8-8.5 mln. kWh of power energy is consumed by pumping stations to supply irrigation water mechanically to the Astghadzor and Zolaqar settlements only. In addition to the high operational costs, the pumping stations also cause significant damage to the fish stocks in Lake Sevan.

The "Zero Option" of the Project, meaning the reservoir is not constructed or operated, and irrigation in the settlements of Astghadzor, Vaghashen, Zolaqar and Martuni continues to rely partly on a gravity system and partly on outdated, ineffective pumping stations, would have the following negative consequences and therefore is not considered as acceptable solution:

1) Annual consumption of approximately 8-8.5 mln. kWh of power energy, which indirectly contributes to Greenhouse Gas (GHG) emissions from power generation facilities,
2) The existing pumping stations in Astghadzor, Vaghashen, and Zolaqar are functionally outdated and ineffective and require significant investment for rehabilitation / reconstruction,
3) The high operational and maintenance costs of the Astghadzor, Vaghashen, and Zolaqar pumping stations make agricultural production in the command area of the planned reservoir economically unfeasible and uncompetitive,
4) Pumping irrigation water from Lake Sevan causes significant harm to the lake's biodiversity, particularly to fish stocks,
5) The continued use of the existing irrigation system, primarily based on pumping stations, cannot support the expansion of irrigated land in the rural settlements of Astghadzor, Vaghashen, and Zolaqar.

## 3.2 Analysis of Alternative Capacities of the Reservoir

The capacity of the reservoir mainly depends on the following parameters:

- Type of crop production,
- Water flow (availability) in the Astghadzor River,
- Precipitation level,

[13]Preparation of design and cost estimation documents for construction of Astghadzor reservoir in Gegharkunik Marz of the Republic of Armenia, Explanatory Note, 2024

- Water losses from the reservoir,
- Water losses from the irrigation system (≈25%).

Considering the types of crops cultivated in the reservoir's command area, and assuming that water losses from the reservoir and irrigation network are manageable and relatively constant, the main parameter determining the reservoir's capacity is the water inflow into the Astghadzor Reservoir.

The analysis of multi-year hydrological data from the Astghadzor River[14] showed that the total flow volume can reach 7.6 mln. $m^3$ in years with a 50% probability of discharge, 6.3 mln. $m^3$ in years with a 75% probability, and 4.7 mln. $m^3$ in minimum-flow years with a 95% probability. According to projected climate change scenarios[15], river flow could decrease by 19.8% (CCSM4 RCP6.0 scenario), 33.7% (CCSM4 RCP8.5 scenario), and 39% (METRAS RCP8.5 scenario).

To irrigate the Project's 740 ha of agricultural land in Astghadzor, Vaghashen, Zolaqar and martuni settlements, 3.13 mln. $m^3$ of water will be needed, including a 25% loss of the existing irrigation network.

Two alternatives of the reservoir capacity were discussed during the Project design study.

**Option 1:** Capacity of the reservoir - 1.55 mln. $m^3$, in case of 75% probability of monthly distribution of the Astghadzor River flow at the dam site.

**Option 2:** Capacity of the reservoir ≈ 1.8 mln. $m^3$, in case of 50% probability of monthly distribution of the Astghadzor River flow at the dam site.

Taking into account the Projected climate change scenarios up to the 2100 year, including the potential reduction of the water flow in the Astgadzor River in case of '50% probability', the Option 2 appears to be unrealistic. Irrigating the Project's 740 ha of agricultural land in the rural settlements of Astghadzor, Vaghashen, and Zolaqar would require approximately 3.13 mln. $m^3$ of water of which 1.42 mln. $m^3$ can be delivered from the reservoir and 1.71 mln. $m^3$ directly from the river. This can be ensured in case of the 1.55 mln. $m^3$ reservoir capacity.

## 3.3 Analysis of Alternative Types of Dam's Construction Materials

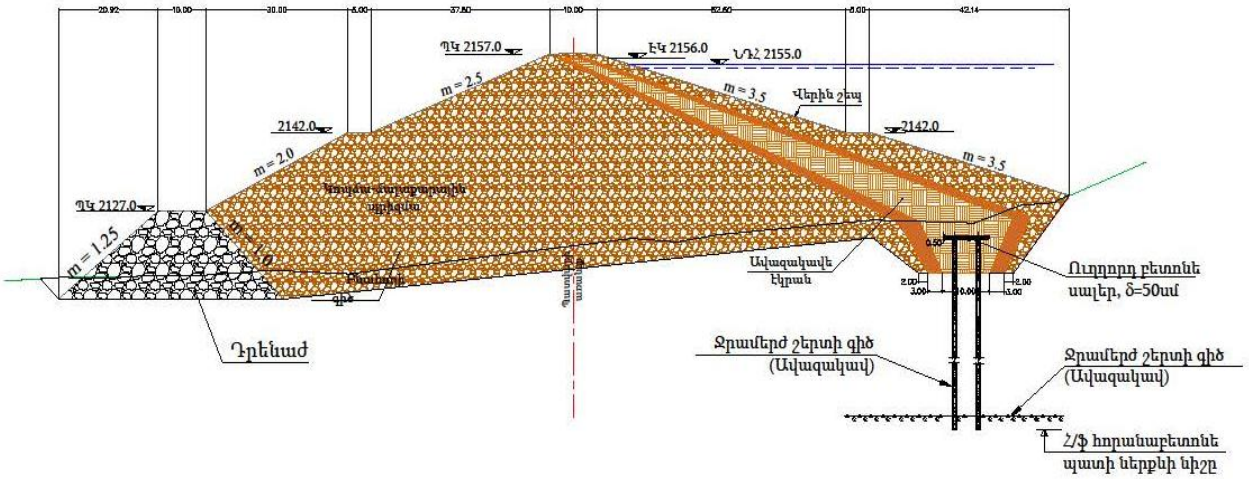
Two types of materials to be used for the construction of the reservoir dam were discussed during the Project design study, including:

**Option 1:** Construction of stone-sand dam (constructed from pebble-cobble soil) with a sand-clay (loam) screen (**Figure 3-1**).

[14]Ibid

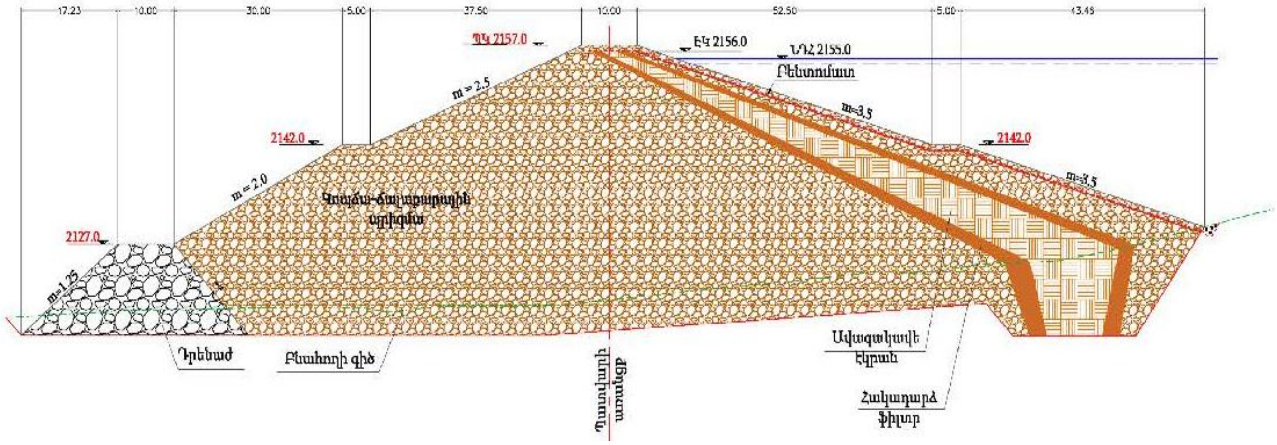
[15]Armenia's Fourth National Communication on Climate Change (2020) (https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf)

**Figure 3-1. Stone-sand dam (constructed from pebble-cobble soil) with a sand-clay (loam) screen**




**Option 2:** Construction of a stone-sand dam with a sand-clay (loam) screen and a bentomat layer, the bottom will be from the bentomat layer (**Figure 3-2**).

**Figure 3-2. A stone-sand dam with a sand-clay (loam) screen and a bentomat layer**




Both options are analyzed in terms of the availability of construction materials in the vicinity of the project site, as well as in light of the estimated budget. For both options, the backfill materials will primarily be sourced from two borrow pits located within the construction site (see **Section 2.6**). Based on the estimated budget (**Table 3-1**), the second option (3,761,037.6 AMD) is approximately 2.5 times less expensive than the first option (9,460,641.1 AMD) and is therefore selected as the Project solution.

**Table 3-1. Estimated budgets for both options (dam's construction materials)**

| № | Items | Cost, mln. AMD | |
|---|---|---|---|
| | | Option 1 | Option 2 |
| 1 | Dam and Reservoir | 5,440,842.1 | 1,482,784.1 |
| 2 | Spillway | 338,323.0 | 338,323.0 |
| 3 | Construction-irrigation tunnel | 734,525.9 | 734,525.9 |
| 4 | Access road, 2,0 km | 10,620.0 | 10,620.0 |
| 5 | Instrumentations | 3,089.2 | 3,089.2 |
| 6 | Guard house | 10,000.0 | 10,000.0 |
| 7 | Power supply | 32,489.4 | 32,489.4 |

| № | Items | Cost, mln. AMD | |
|---|---|---|---|
| | | Option 1 | Option 2 |
| Sub-Total | | 6,569,889.6 | 2,611,831.6 |
| Contingencies, 20% | | 1,313,977.9 | 522,366.3 |
| Total | | 7,883,867.6 | 3,134,198.0 |
| VAT 20% | | 1,576,773.5 | 626,839.6 |
| **Grand Total** | | **9,460,641.1** | **3,761,037.6** |

## 3.4 Analysis of Alternative Locations of the Reservoir Dam

### 3.4.1 Proposed Locations

As part of the Project design study, several potential locations for the construction of the reservoir dam (axis) were investigated. A number of field and desktop studies were carried out, including topographical and geological surveys for these sites. One option involved constructing the dam further downstream along the Astghadzor River. However, it was determined that this location would result in reduced water storage capacity and would require modifications to the alignment of several engineering infrastructures, thereby increasing the overall project budget.

Another alternative for the dam construction is presented in **Figure 3-3**. In this option, the dam is proposed to be constructed upstream along the Astghadzor River. During the field surveys, a significant landslide body was identified within the study area, on the left slope of the Astghadzor River. This landslide spans approximately 80 m upslope and 50 m in width, with a maximum depth of around 15 m, as determined through engineering-geological profiling. The vertical elevation difference between the landslide's head and toe is approximately 50 m, and the total estimated volume of unstable soil mass is about 40,000 $m^3$ (**Figure 3-4**). This option has high seismic risk.

**Figure 3-3. Alternative locations for the reservoir dam upstream the Astghadzor River**

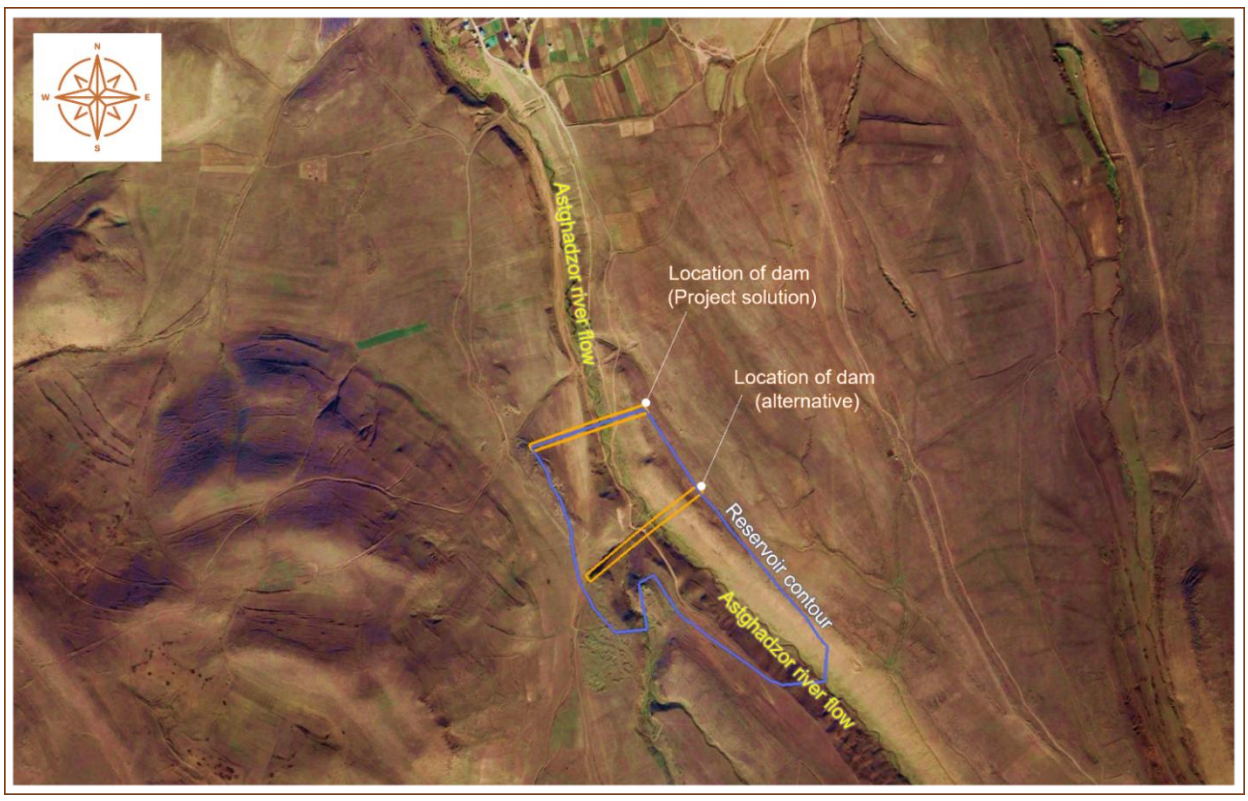


**Figure 3-4. Primary and secondary scarps of the landslide zones**


### 3.4.2 Methodology for the Multi-Criteria Analysis of the Project Alternatives

A step-by-step methodology for the Multi-Criteria Analysis (MCA) of project alternatives, commonly used for reservoir construction projects, was applied during the analysis of the alternative options considered in the Astghadzor Reservoir design study. The following common criteria for water reservoir construction projects were applied during the MCA:

- Environmental Impact
- Economic feasibility
- Social Impact
- Technical feasibility
- Water supply reliability
- Flood control and drought mitigation
- Cultural heritage.

All criteria should be measurable, relevant, and aligned with the project's goals and objectives. Each criterion should be assigned a weight that reflects its importance relative to the overall objectives of the project. Weights are typically determined based on expert input or stakeholder consultations and should total 100% (or 1.0 if using decimal values).

Each alternative option should be assessed and rated against the above-mentioned criteria using a consistent scale (e.g., a scale of 1 to 5, where 1 represents the poorest performance and 5 the best). Ratings should be based on available data, as well as expert and/or stakeholder input.

### 3.4.3 MCA

The alternative locations for dam construction considered above were analysed using the MCA methodology outlined in the above **Section 3.4.2**. The following alternative dam locations were discussed and assessed:

- **Alternative A** - Location of dam as proposed in the project design document,
- **Alternative B** - Construction of the dam downstream the project dam location,
- **Alternative C** - Construction of the dam upstream of the project dam location.

**Table 3-2. Scoring/Rating results of the Project alternative options**

| № | Criteria | Scale (0-5) | | |
|---|---|---|---|---|
| | | Alternative A | Alternative B | Alternative C |
| **1** | **Environmental impact** | **3.33** | **2.67** | **3.33** |
| 1.1 | Proximity to protected or internationally recognized natural areas | 4 | 3 | 5 |
| | | Alternative B is the closest site to the 'Sevan' National Park; therefore, its impact on the protected area is expected to be relatively higher compared to Alternatives A and C. | | |
| 1.2 | Impact on biodiversity, availability and loss of critical habitats | 3 | 3 | 3 |
| | | The impact of all alternative options on the biodiversity and loss of critical habitats will be the same. | | |
| 1.3 | Environmental impacts during the construction activities (air emissions, contamination of water and soil, waste generation, noise and vibration, etc.) | 3 | 2 | 2 |
| | | The impact of Alternative A on air pollution as well as water and soil contamination is expected to be lower than that of the other two options. This is due to the shorter length and narrower cross-sectional area of the dam to be constructed. | | |
| **2** | **Economic feasibility** | **3.0** | **2.33** | **3.0** |
| 2.1 | Potential capital and operational costs | 3 | 2 | 3 |
| | | Alternative B require modifications to the alignment of several engineering infrastructures, thereby increasing the overall project budget. | | |
| 2.2 | Land acquisition costs | 3 | 2 | 3 |
| | | There are more private and cultivated land plots located downstream of the planned reservoir site. | | |
| 2.3 | Proximity to the sources and providers of construction materials (borrow pits, suppliers, etc.) | 3 | 3 | 3 |
| | | For all alternatives, this criterion is assessed as the same. | | |
| **3** | **Social impact** | **3.33** | **2.0** | **3.0** |
| 3.1 | Proximity to the settlements / communities | 3 | 2 | 3 |
| | | Alternative B is the closest site to the Astghadzor, Vaghashen, Zolaqar and Martuni settlements. | | |
| 3.2 | Impact on affected settlements (e.g., displacement, resettlement, access to water) | 3 | 2 | 4 |
| | | The closer the dam and reservoir is to the settlements, the greater the potential for economic and physical displacement. | | |
| 3.3 | Public opinion, community involvement, and acceptance of the project | 4 | 2 | 2 |
| | | The dam and reservoir location proposed in the design document is the most acceptable for the affected settlements and population. | | |
| **4** | **Technical feasibility** | **3.67** | **3.0** | **3.0** |
| 4.1 | | 4 | 4 | 2 |

| № | Criteria | Scale (0-5) | | |
|---|---|---|---|---|
| | | Alternative A | Alternative B | Alternative C |
| | Topographic and geological settings of the site. Seismic, landslide, flood and other risks | A significant landslide body was identified in the area proposed for the dam construction within Alternative C. | | |
| 4.2 | Proximity to water feeding and irrigation infrastructure | 4 | 2 | 4 |
| | | In the case of Alternative B, modifications to the alignment of several engineering infrastructures will be required. | | |
| 4.3 | Risks associated with the construction and long-term maintenance | 3 | 3 | 3 |
| | | Will be the same for all alternative options. | | |
| **5** | **Water supply reliability** | **3.0** | **2.5** | **3.0** |
| 5.1 | The volume of water that can be reliably stored and supplied | 3 | 2 | 3 |
| | | In the case of Alternative B, the water storage capacity of the planned reservoir will be reduced. | | |
| 5.2 | The capacity to adapt to climate change and changing demand patterns | 3 | 3 | 3 |
| | | Will be the same for all alternative options. | | |
| **6** | **Flood control and Drought mitigation** | **3.0** | **3.0** | **3.0** |
| 6.1 | The ability of the reservoir to reduce flood risks and store water during dry periods | 3 | 3 | 3 |
| | | Will be the same for all alternative options. | | |
| 6.2 | Management of peak flow events and water scarcity | 3 | 3 | 3 |
| | | Will be the same for all alternative options. | | |
| **7** | **Cultural heritage** | **3.0** | **3.0** | **2.5** |
| 7.1 | Availability of cultural heritage units within the project direct impact area | 3 | 3 | 3 |
| | | Will be the same for all alternative options. | | |
| 7.2 | Loss of cultural heritage units as a result of the project implementation | 3 | 3 | 2 |
| | | The Vanqi Berd archaeological complex is located near the planned reservoir basin. Therefore, in the case of Alternative C, the project's potential direct impact on Vanqi Berd, due to the upstream location of the dam, is expected to be high. | | |

For each alternative options, the weighted scores from all criteria to get the total score are calculated in **Table 3-3**.

**Table 3-3. Calculation of Weighted Scores**

| № | Criteria | Weight | Alternative A (Score) | Weighted A | Alternative B (Score) | Weighted B | Alternative C (Score) | Weighted C |
|---|---|---|---|---|---|---|---|---|
| 1 | Environmental impact | 0.25 | 3.33 | 0.833 | 2.67 | 0.668 | 3.33 | 0.833 |
| 2 | Economic feasibility | 0.20 | 3.0 | 0.6 | 2.33 | 0.466 | 3.0 | 0.6 |
| 3 | Social impact | 0.15 | 3.33 | 0.5 | 2.0 | 0.3 | 3.0 | 0.45 |
| 4 | Technical feasibility | 0.15 | 3.67 | 0.551 | 3.0 | 0.45 | 3.0 | 0.45 |
| 5 | Water supply reliability | 0.10 | 3.0 | 0.3 | 2.5 | 0.25 | 3.0 | 0.3 |

| № | Criteria | Weight | Alternative A (Score) | Weighted A | Alternative B (Score) | Weighted B | Alternative C (Score) | Weighted C |
|---|---|---|---|---|---|---|---|---|
| 6 | Flood control and drought mitigation | 0.10 | 3.0 | 0.3 | 3.0 | 0.3 | 3.0 | 0.3 |
| 7 | Cultural heritage | 0.05 | 3.0 | 0.15 | 3.0 | 0.15 | 2.5 | 0.125 |
| **Sum** | | | | **3.234** | | **2.584** | | **3.058** |

### 3.4.4 Conclusion

The MCA was conducted to evaluate and compare the three proposed alternatives (A, B, and C) for the construction of the Astghadzor Reservoir. Each alternative was assessed based on a set of predefined criteria, including environmental and social impacts, economic and technical feasibility, water supply and flood control related issues and impact on cultural heritage.

As a result of the MCA, the reservoir dam location proposed in the project design (Alternative A) received the highest score of 3.234, indicating that it is the most preferable option for dam construction in terms of lower environmental and social impacts, as well as technical and economic feasibility.

The construction of the dam upstream along the Astghadzor River (Alternative C, score: 3.058) can also be considered a strong option, offering a balanced outcome across environmental and social criteria. However, the presence of a landslide-prone area and the proximity of the 'Vanqi Berd' archaeological complex make this alternative less favourable.

The least preferable option (Alternative B) involves constructing the dam downstream along the river. This option scored the lowest due to the need for additional costs related to modifying engineering infrastructure and its reduced water storage capacity.

# 4. Legal, Regulatory and institutional framework

## 4.1 Applicable Legal and Regulatory Framework

According to the ***Law on Environmental Impact Assessment and Expert Examination (2014, re-edited in 2023)***[16], there are two types of documents, which are subject to environmental impact assessment and expert examination. These documents are:

(i) Framework Document - a policy, strategy, concept, scheme of utilization of natural resources, program, master plan, urban development document, which are likely to affect the environment; and

(ii) (ii) Design Document - technical report, feasibility study and construction-engineering design of intended activity.

The Law establishes the general legal and organizational principles for conducting mandatory EIA of various types of activities and concept documents of sectoral development. According to the Article 12 of the Law, the types of activities, which should undergo EIA are divided into "A" and "B" categories depending on their expected environmental impact.

As per the Article 12 the Law, the reservoirs or artificial lakes with 500,000 $m^3$ and more capacities are subject of national EIA and State expert examination. The roles and authorities of parties engaged in EIA and expert examination processes are set in Chapter 2 of the Law. The procedure for public notification and public discussions is outlined in the ***RA Government Decree №1325-N*** dated 19.11.2014[17].

The ***Water Code (2002)***[18] provides the legal basis for protection of water resources, the provision of water for people and economic sectors through effective management of water resources and ensuring the protection of water resources for future generations. The Water Code includes the following: responsibilities of state/local authorities and public, development of the national water policy and national water program, water cadastre and monitoring system, public access to relevant information, water use and water system use permitting systems, trans-boundary water resources use, water quality standards, safe operation of hydraulic facilities, protection of water resources and state supervision. The quality of surface water in Armenia is monitored as per the principles of EU Water Framework Directive adopted by the ***RA Government Decree №75-N*** dated 27.01.2011[19].

Article 1 of the Water Code among others defines:

- 'Water protection zone' as an area designated to prevent the pollution and depletion of water resources, and to maintain a favourable water regime; such areas are not subject to privatization or confiscation.
- 'Sanitary protection areas of water ecosystems' as an area designated to protect water resources used for drinking, healthcare, domestic services, medical facilities, resorts, and other health-related purposes.

The Criteria for the definition of areas for sanitary protection of water ecosystems, flow formation, groundwater protection, water protection, ecotone and unalienable zones are approved by the ***RA Government Decree №64-N*** dated 20.01.2005[20].

The criteria for defining sanitary protection areas of water ecosystems are:

[16] https://www.arlis.am/documentview.aspx?docid=178468
[17] https://www.arlis.am/documentview.aspx?docid=188071
[18] https://www.arlis.am/DocumentView.aspx?docid=148955
[19] https://www.arlis.am/documentview.aspx?docid=200962
[20] https://www.arlis.am/DocumentView.aspx?DocID=13388

a) areas that are protected for the conservation of biological, hydrological and recreational values of water resources,
b) areas where the quality and quantity of surface and groundwater may be required for human health and well-being, including drinking water and water used for therapeutic and ecological integrity purposes,
c) sanitary protection areas of water ecosystems may include river or lake sections, humid areas, ponds and lakes, as well as adjacent areas that are subject to conservation taking into account their natural conditions as acting healthy environmental systems and areas where a restoration need (in the context of supervision over the contamination, erosion and other adverse impacts caused by floods effect on water quality and quantity) of human activity or natural environment will be raised,
d) sanitary protection areas of water ecosystems are defined with a radius of up to 90 m.

The criteria for defining areas of water protection zones are:

a) areas where the prevention of littering, pollution, suffocation and depletion of water resources, as well as favourable conditions for the water regime, are ensured,
b) the areas of water protection zones include all areas intended for the conservation of water resources,
c) the areas of water protection zones are defined in the form of a strip up to 32 m long.

The Regulation for reservoirs water protection zones (strips) in the Armenian Soviet Socialist Republic (SSR) approved by the Decision №648 of the Council of Ministers of the Armenian SSR[21] applies to all reservoirs located within the borders of the Armenia, regardless their ownership.

The boundaries of the Water Protection Zone (WPZ) are defined for each reservoir by a **water protection design document,** taking into account the local conditions and methodological recommendations set for the determination of water protection zones (strips) of reservoirs. For new reservoirs the water protection design documents are drafted during the project design stage and included into the environmental measurements section. The commissioning of the newly constructed reservoirs shall be done within the water protection boundaries after implementation of all designed water protection measures.

Design document for the water protection zone of operating reservoirs is drawn up separately. Before drawing up the design of the water protection zone, it is determined by the minimum allowable sizes as follows:

- for the water protection zone - 500 m above the normal elevated water level[22],
- for the riparian water protection strip - 50-100 m above the normal elevated level.

The Riparian Water Protection Strips (RWPS) include islands, peninsulas, islets, etc., regardless of their size.

To prevent the pollution and depletion of the water object and to appropriately use its adjacent areas, the regime of economic activity and land use within the water protection zone of the reservoir is defined by the relevant design document.

Before the establishment of the WPZs, the national economic facilities[23] constructed within their boundaries continue to operate provided that the requirements and conditions set by this regulation as well as water protection measures envisioned by the design document are followed. The sizes of

[21] https://www.arlis.am/DocumentView.aspx?docid=4965
[22] The term 'normal elevated water level' is not defined in the legal act; however, the Consultant assumes that it corresponds to the 'full supply level'
[23] national economic facility is a term used in the former Soviet Union time, now it means commercial units

water protection zones, the procedure of land use within the WPZ, water protection and other measures are determined by specialized design companies in accordance with this regulation and agreed with water use and protection authorities and involved ministries and State bodies.

The objective of the ***Law on RA water national program (2006)***[24] is to meet the needs of the population and the economy through the effective management of usable water resources, ensure ecological stability, establish and use strategic water reserves, protect national water resources, and define measures aimed at addressing the issues outlined in the RA Water Code and the RA Law on the fundamentals of national water policy.

The objective of the ***Law on the fundamentals of national water policy (2005)***[25] is to ensure the availability of water resources in the quantity, regime, and quality necessary to meet human well-being, support the development of the republic's socio-economic system, and address both current and future economic and ecological needs.

The ***Law on lake Sevan (2001)***[26] regulates the relations related to the preservation, restoration, reproduction, natural development and use of the ecosystems of Lake Sevan, its catchment area and economic activity zone.

The ***Land Code (2001)***[27] defines the key provisions for land-use in Armenia. Land is classified as per designated purposes (categories) into: 1) agricultural land, 2) settlement land, 3) industrial, mining and other production designation land, 4) land for energy, transport, communication, utility infrastructure facilities, 5) land for specially protected areas, (6) special designation land, 7) forest land, 8) water land[28], and 9) reserve land. The Land Code also specifies soil preservation principles, objectives and regulations via the following RA Government decrees:

- The procedure for topsoil use, approved by the RA Government Decree №1396-N dated 08.09.2011[29],
- The requirements for determination of topsoil stripping norms and for stripped topsoil preservation and use, approved by the RA Government Decree №1404-N dated 02.11.2017[30],
- The procedure for soil excavation, approved by the RA Government Decree №572-N dated 10.05.2019[31].

The ***Law on surveillance over the land use and land conservation (2008)***[32] provides objectives and types of effective use and conservation of RA lands, inspection related to enforcement of land legislation and institutions, procedures of control, rights and responsibilities of entities controlling land use and protection. The Law applies to all lands of the RA Land Fund, irrespective of purpose, ownership and/or right to use.

The ***Law on waste (2004)***[33] provides the legal and economic basis for collection, transportation, disposal, treatment, re-use of wastes as well as prevention of negative impacts of waste on natural resources, human life and health. It defines the roles and responsibilities of state authorities as well as of waste generator organizations in waste management activities.

[24] https://www.arlis.am/documentview.aspx?docid=166250
[25] https://www.arlis.am/DocumentView.aspx?docid=166244
[26] https://www.arlis.am/documentview.aspx?docid=200928
[27] https://www.arlis.am/documentview.aspx?docid=150513
[28] Water lands - areas occupied by water bodies such as rivers, natural and artificial reservoirs, and lakes, as well as areas designated for hydraulic, water management, and other facilities necessary for the use and protection of these water bodies
[29] https://www.arlis.am/documentview.aspx?docID=71439
[30] https://www.arlis.am/DocumentView.aspx?docID=117360
[31] https://www.arlis.am/documentview.aspx?docid=130889
[32] https://www.arlis.am/DocumentView.aspx?docid=144520
[33] https://www.arlis.am/documentview.aspx?docid=140521

The ***Law on alienation of property for overriding interests of the public (2006)***[34] defines procedures for determining the overriding public interest, for alienating property in order to ensure public interest and for compensation for the alienated property. This law applies to all land ownership (real or movable estate, property rights, equities, etc.) located and registered in Armenia and belonging to physical persons, legal entities and communities. The constitutional conditions for the alienation of property in order to ensure overriding interests of the public are: (i) the alienation must be carried out in exceptional cases defined by the law and in accordance with the procedure established by the law; and (ii) adequate compensation must be paid for the alienated property.

The ***Law on atmospheric air protection (1994, revised in 2022)***[35] regulates air quality as well as public relations in the field of prevention and reduction of adverse chemical, physical and biological impacts on air. The Law also regulates emission permits and provides permissible limits/concentrations for atmospheric air emissions. The RA Government Decree №160-N dated 02.02.2006 defines maximum permissible concentrations of ambient air pollution in residential areas.

The ***Law on flora (1999)***[36] and ***Law on fauna (2000)***[37] outline Armenia's policies for the conservation, protection, use, regeneration and management of natural populations of plants and animals as well as the impact of human activities on biodiversity. These laws are aimed at the sustainable preservation and use of flora/fauna and the conservation of biodiversity. The laws also contain provisions for assessing and monitoring flora and fauna, especially rare and threatened species. The RA Government Decree №71-N and №72-N on approval of the ***RA Red Book of animals***[38] and ***RA Red Book of plants***[39] respectively define the biology of threatened (rare, threatened, endangered, vulnerable) species of flora and fauna as well as their quantity, habitats and variety.

The ***Law on special protected areas of nature (2006)***[40] regulates special protected areas of the RA and eco-systems that have environmental, economic, social, scientific, educational, historical, cultural, healthcare and recreation value. It also outlines the legal basis for state policies regarding sustainable development, restoration, protection, reproduction and use of natural objects and complexes. The Law defines four categories of protected areas in Armenia: (i) State Reserves; (ii) National Parks; (iii) Sanctuaries; and (iv) Nature Monuments. The list of the nature monuments is approved by the RA Government Decree №967-N dated 14.08.2008[41].

The ***Law on protection and use of immovable cultural and historic monuments and historic environment (1998)***[42] provides the legal and policy basis for the protection and use of such monuments in Armenia. Article 15 of the Law describes procedures for discovering and registering monuments, establishing protection zones around them and creating historical and cultural reserves. Article 22 stipulates that the land plots located in historically sensitive areas can be allocated for construction, agricultural and other activities only upon approval of the authorized state body (Department of Historic and Cultural Monuments Preservation). The Law also sets the roles and responsibilities of State bodies engaged in management of cultural and historic monuments through the Procedure for State registration, study, conservation, strengthen, repair, reconstruction and use of immovable historic and cultural monuments, approved by the RA Government Decree №438

[34] https://www.arlis.am/documentview.aspx?docid=153844
[35] https://www.arlis.am/documentview.aspx?docid=146626
[36] https://www.arlis.am/documentview.aspx?docid=120784
[37] https://www.arlis.am/documentview.aspx?docid=120790
[38] https://www.arlis.am/DocumentView.aspx?DocID=56347
[39] https://www.arlis.am/DocumentView.aspx?DocID=56348
[40] https://www.arlis.am/documentview.aspx?docid=140513
[41] https://www.arlis.am/documentview.aspx?docid=157090
[42] https://www.arlis.am/DocumentView.aspx?docid=107521

dated 20.04.2002[43]. The RA Government Decree №2322-N[44], №754-N[45], №80-N[46], №628[47] and №1270-N[48] define the State lists of immovable historical and cultural monuments in the RA Syunik, Gegharkunik, Vayots Dzor, Aragatsotn and Shirak regions respectively, while the Government Decree №385-N approves the list of State owned immovable historical and cultural monuments that are not subject of alienation/acquisition[49].

The ***Law on intangible cultural heritage (2009)***[50] regulates the legal relations arising from the processes of preservation, safeguarding, and development of intangible cultural heritage, including identification, documentation, research, application, recreation, teaching, and dissemination of intangible cultural values, protection of the property rights over such values, maintenance of intangible cultural heritage of Armenia, international cultural cooperation, cultural communication between peoples of foreign countries and those of the RA. Several legal acts have been adopted by the RA to promote the administration of the legal framework of the sector which enables to regulate relations pertaining to preservation, safeguarding, and development of intangible cultural heritage; the activities of communities that create, preserve and transmit intangible cultural values; international cultural cooperation, including: (i) Government Decree №310-A "On Defining the Criteria for Preparing the Lists of Intangible Cultural Values and Approving the List of Intangible Cultural Heritage Values"[51], (ii) Government Decree №36-N "On the Criteria for Preparing the Lists of Intangible Cultural Heritage in Need of Urgent Safeguarding, and the List of Intangible Cultural Heritage Values Based thereon"[52], (iii) Government Decree №241-N "On approving the criteria for defining cultural spaces and published the list of cultural spaces"[53], etc.

The ***Code on subsoil resources (2011)***[54] contains the main provisions in the area of use and protection of mineral resources and underground water, including sanitary protection zones for underground water resources.

The ***Forest Code (2005)***[55] regulates sustainable management of forests: guarding, preserving, rehabilitation, afforestation and rational use of forests and forest lands in Armenia as well as with forest stock-taking, monitoring and control.

The ***Law on environmental oversight (2005)***[56] regulates the organization and enforcement of oversight of national environmental legislation and defines the legal and economic basis underlying the specifics of oversight over the fulfilment of environmental requirements and relations between the parties. The existing legal framework relating to natural resources and environmental includes a range of legal tools. Government decrees are the key legal instruments for implementing environmental laws. The other tools are Presidential orders, Prime-Minister's resolutions, and ministerial decrees.

The RA ***Law on public health (2024)***[57] regulates the organization and implementation of preventive and anti-epidemic measures, immunoprophylaxis of diseases, prevention of the impact of harmful

[43] https://www.arlis.am/documentview.aspx?docid=137204
[44] https://www.arlis.am/DocumentView.aspx?DocID=36406
[45] https://www.arlis.am/DocumentView.aspx?DocID=38081
[46] https://www.arlis.am/DocumentView.aspx?DocID=37837
[47] https://www.arlis.am/DocumentView.aspx?DocID=36898
[48] https://www.arlis.am/DocumentView.aspx?docid=12877
[49] https://www.arlis.am/DocumentView.aspx?docid=55737
[50] https://www.arlis.am/DocumentView.aspx?docid=121003
[51] https://www.arlis.am/DocumentView.aspx?docid=151791
[52] https://www.arlis.am/DocumentView.aspx?docID=157499
[53] https://www.arlis.am/DocumentView.aspx?docID=134827
[54] https://www.arlis.am/documentview.aspx?docid=146898
[55] https://www.arlis.am/DocumentView.aspx?docid=121312
[56] https://www.arlis.am/documentview.aspx?docid=146636
[57] https://www.arlis.am/hy/acts/191172

and dangerous environmental factors on the human body (environmental hygiene), epidemiological surveillance, production control, public awareness, dissemination of medical and public health knowledge and promotion of a healthy lifestyle, teaching public health knowledge, sanitary-epidemiological control in the Republic of Armenia and registration of products (goods) subject to state registration (except for those regulated by the technical regulations of the Eurasian Economic Union), occupational hygiene services and public health expertise, as well as public relations related to the powers of the Government, state administration bodies in the field of public health, the rights and obligations of individuals and legal entities, individual entrepreneurs, the features of population protection in the event of establishing quarantine due to an epidemic that is the basis for a state of emergency, the mechanisms and procedure for exercising the right to health protection.

In addition, there are sanitary-hygienic norms and standards approved by the RA Minister of Health and regulating the sanitary hygienic conditions in public and residential areas viz.:

- Sanitary Norms ("SN") №2-III-11.3. Noise in workplace, residential and public buildings and in the residential construction areas,
- Hygienic Norms ("HN") №2.2.4-009-06. The hygienic norms of the vibration in the workplace, residential and public buildings.

The ***Labour Code (2004)***[58] regulates collective and individual employment relationship; defines the basis and procedure of implementation for the establishment, revision and cessation of that relationship; assigns duties, authorities and responsibilities of the parties of employment relationship, as well as defines conditions for OHS. The Labour Code also recognizes workers' rights to form and to join workers' organizations of their choice, contains provisions for enabling collective bargaining, and prohibits any type of forced labour. Key principles related to ensuring the equal rights and opportunities for men and women are set out in the ***Law №HO-57-N (2013) On ensuring of equal rights and equal opportunities for men and women***[59]. As per Article 6 of this Law, gender discrimination is prohibited, *inter alia*, via setting different levels of wages, changing wages as well as worsening working conditions conditioned by gender. Armenia has ratified 29 Conventions of the International Labor Organization, including eight fundamental ones.

The ***Law on fire safety (2001)***[60] regulates the relations of the state bodies and local self-governing bodies of Armenia, organizations/companies and people in fire safety-ensuring sphere. It defines the basic ways of shaping the state fire safety policies, as well as legal mechanisms of their implementation, such as provision of the populations with effective and reliable fire protection systems. The Law is supplemented by the Fire Safety Rules (Order №595-N of the RA Minister of Territorial Administration and Emergency Situations (2015)[61]).

## 4.2 Ratified International Agreements

Armenia is a signatory/party to a number of **international agreements and conventions** related to the protection and management of the natural environment, communities, cultural heritage and labour issues.

[58] https://www.arlis.am/documentview.aspx?docid=152137
[59] https://www.arlis.am/DocumentView.aspx?docid=138982
[60] https://www.arlis.am/documentview.aspx?docid=144513
[61] https://www.arlis.am/documentview.aspx?docID=99397

**Table 4.1. List of ratified by the RA international agreements applicable for the project**

| International agreements (convention or protocol) | Description |
|---|---|
| Convention on Wetlands of International Importance - (Ramsar 1971) | The Ramsar Convention is an intergovernmental treaty to maintain the ecological character and plan the sustainable use of Wetlands of International Importance.<br>The Convention entered into force in Armenia in 1993. |
| Paris Convention for the Protection of the World Cultural and Natural Heritage (1972) | The Convention establishes the need to preserve natural and cultural heritage and the balance between the two.<br>Armenia became a State party in 1993. |
| The Convention on the Conservation of Migratory Species of Wild Animals (1979) (Bonn Convention) | The objective of the Bonn Convention, which was adopted in 1979, is to ensure the conservation of land, marine and air migratory species over the whole of their area of distribution.<br>Armenia is a State party since 2011 |
| Convention on the Conservation of European Wildlife and Natural Habitats, Bern (1979) | The Bern Convention is a binding international legal instrument in the field of nature conservation, covering most of the natural heritage of the European continent and extending to some States of Africa.<br>Ratified by Armenia in 2008. |
| The Convention on Biological Diversity (1992) | The three main objectives of the Convention are: the conservation of biological diversity; the sustainable use of the components of biological diversity; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.<br>Signed by Armenia in 1993. |
| European Landscape Convention, Florence (2000) | The European Landscape Convention of the Council of Europe promotes the protection, management and planning of the landscapes and organises international co-operation on landscape issues. |
| United Nation Framework Convention on Climate Change (UNFCCC) (1992) | The UNFCCC is one of the «Rio Conventions» adopted at the Rio Earth Summit in 1992. The principal objective is to prevent «dangerous» human interference with the climate system. The UNFCCC entered into force in March 1994 and the first Conference of the Parties of the Convention took place in Berlin, 1995.<br>Armenia became a state party in 2002. |
| Paris Agreement under the United Nations Framework Convention on Climate Change | The aim of the agreement is to decrease global warming through:<br>(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;<br>(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;<br>(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.<br>Ratified by Armenia in 2017. |
| UN Convention to Combat Desertification, Paris (1994) | This Convention is the sole legally binding international agreement linking environment and development to sustainable land management. The Convention addresses specifically the arid, semi-arid and dry sub- |

| International agreements (convention or protocol) | Description |
|---|---|
| | humid areas, known as the drylands, where some of the most vulnerable ecosystems and peoples can be found.<br>Ratified by Armenia in 1997. |
| UNESCO Convention for the Safeguarding of the Intangible Cultural Heritage (2003) | The purposes of this Convention are: (a) to safeguard the intangible cultural heritage; (b) to ensure respect for the intangible cultural heritage of the communities, groups and individuals concerned; (c) to raise awareness at the local, national and international levels of the importance of the intangible cultural heritage, and of ensuring mutual appreciation thereof; (d) to provide for international cooperation and assistance.<br>Ratified by Armenia in 2006. |
| Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, Aurhus Convention (1998) | The Aarhus Convention is a multilateral environmental agreement through which the opportunities for citizens to access environmental information are increased and transparent and reliable regulation procedure is secured.<br>Armenia became a State-party in 2001. |
| Convention on Environmental Impact Assessment in a Transboundary Context, Espoo Convention (1991) | The Convention sets out the obligations of the Parties to carry out an environmental impact assessment of certain activities at an early stage of planning. Before permitting an industrial project, the country to decide on the project («country of origin») must notify any countries which could be affected by the transboundary impacts of a project located in another country («affected parties»).<br>The affected party and the public in the affected area must be able to express their views and comments about the proposed project. This is a separate procedure which is additional to any relevant national permitting process.<br>The permitting state must take these comments into account in its final decision and communicate it to the affected country and the public.<br>The projects subject to consultations under the Convention are those listed in Appendix I including 'large dams and reservoirs'.<br>Ratified by Armenia in 1997. |
| International Labour Organization (ILO) Conventions | Armenia has ratified 29 ILO conventions including the following fundamental ones:<br>- Forced Labour Convention, 1930 (Ratified 17.12.2004),<br>- Freedom of Association and Protection of the Right to Organize Convention, 1948 (Ratified 02.01.2006),<br>- Right to Organize and Collective Bargaining Convention, 1949 (Ratified 12.11.2003),<br>- Equal Remuneration Convention, 1951 (Ratified 29.07.1994),<br>- Abolition of Forced Labour Convention, 1957 (Ratified 17.12.2004)<br>- Discrimination (Employment and Occupation) Convention, 1958 (Ratified 29.07.1994),<br>- Minimum Age Convention, 1973 (Ratified 27.01.2006),<br>- Worst Forms of Child Labour Convention, 1999 (Ratified 02.01.2006). |

## 4.3 EBRD Requirements

The main requirements of the EBRD for its own activities are formulated in the Bank's ESP (2019), and the requirements for the E&S aspects of the Client-borrower's activities are set out in the PRs[62]. The ESP sets E&S requirements for the EBRD clients' activities to achieve sustainable results. The PRs applicable to this Project are listed below:

**PR1: Assessment and Management of Environmental and Social Risks and Impacts** requires the EBRD client (borrower) to conduct an E&S assessment and / or audit. Assessment is carried out for all stages of the project (construction, operation, decommissioning). Based on the assessment and audit, an ESAP, an Environmental and Social Management Plan (ESMP), and other plans are developed. An important feature of the EBRD's requirements is the concept of associated facilities that are not financed by the Bank, and therefore are not part of the project, but which are significant in determining the success of the project[63]. These associated facilities may be carried out by both the client of the Bank and other parties. However, they should be part of the E&S assessment. PR1 is also applicable to contractors involved in project implementation. EBRD also requires borrowers to implement an E&S Management System (ESMS) appropriate to the nature of the project, as well as reporting to EBRD on the project's E&S performance, including compliance with the relevant PRs and the approved ESMP, ESAP, SEP and other documents or commitments.

**PR2: Labour and Working Conditions** establishes requirements in terms of labour and working conditions, including the prohibition of forced and child labour in the project. The PR2 requirements are based on the conventions of the ILO.

**PR3: Resource Efficiency and Pollution Prevention and Control** requires efficient use of energy, water and resources, and minimisation of waste, as well as compliance with good international practice (GIP), and application of a mitigation hierarchy. This PR is based on the principles of the EU Industrial Emissions Directive (Integrated Pollution Prevention and Control)[64] and calls for the implementation of EU requirements on the use of BATs and related standards for emissions and discharges.

**PR4: Health, Safety and Security** requires the client (borrower) to identify and assess community and occupational health and safety risks and implement preventive measures. The focus is on preventing and eliminating risks rather than reducing and minimising them.

**PR5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement** defines requirements related to project-induced land acquisition, including restrictions on land use and access to assets and natural resources, which may cause physical displacement (relocation, loss of land or shelter), and/or economic displacement (loss of land, assets or restrictions on land use, assets and natural resources leading to loss of income sources or other means of livelihood). The key requirement of PR5 is to avoid or, when unavoidable, minimise, involuntary resettlement via feasible alternative project designs/sites. A resettlement framework (RF), including livelihood restoration where needed, is developed in an early stage of the project to detail resettlement principles and organisational arrangements.

**PR6: Biodiversity Conservation and Sustainable Management of Living Natural Resources** determines the requirements for the conservation of biological and landscape diversity in the development area. PR6 requires the borrower to characterise the state of biodiversity, identifying sensitive species and habitats, and developing measures to avoid / reduce impacts. PR6 defines

[62]EBRD. 2019. ESP. https://www.ebrd.com/news/publications/policies/environmental-and-social-policy-esp.html.
[63]'These are new facilities or activities: i) without which the project would not be viable, and ii) would not be constructed, expanded, carried out or planned to be constructed or carried out' (EBRD ESP. 2019. Section II. Definitions).
[64]Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on Industrial Emissions (Integrated Pollution Prevention and Control). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010L0075.

criteria for critical habitat screening and requires developing a Biodiversity Action Plan (BAP) where significant adverse impacts on biodiversity are expected.

**PR8: Cultural Heritage** defines the requirements for the preservation of both tangible and intangible cultural heritage. PR 8 requires exploring the presence / possibility of the presence of objects of cultural heritage in the project's area of influence. Where the assessment identifies that the project may have material risks and impacts on cultural heritage, the client is required to develop a cultural heritage management plan.

**PR10: Information Disclosure and Stakeholder Engagement.** The EBRD requires careful and systematic stakeholder identification, including communities that may be affected by project impacts (affected groups) and groups whose vital interests may be affected by projects (vulnerable groups). The EBRD requirements for organising stakeholder engagement are also set out in its Access to Information Directive65. Meaningful stakeholder consultations are viewed by the EBRD as an ongoing process throughout the project lifecycle. The EBRD's stakeholder engagement requirements are detailed in the draft SEP for the Project.

## 4.4 Applicable EU Directives

The EBRD PRs require projects to comply with the relevant European Union (EU) environmental requirements in addition to the applicable national laws and regulations. The list of EU Directives that are relevant to the Project is given below.

**Directive 2011/92/EU, as amended by Directive 2014/52/EU, on assessment of the effects of certain public and private projects on the environment (the EIA Directive)[66]**

The Directive defines the environmental impact assessment (EIA process for certain public and private projects in the Member States to integrate environmental considerations into project preparation and authorisation. It applies to a wide range of projects listed in Annexes I and II. The projects listed in Annex I are considered to have a significant environmental impact (incl. inter alia 'dams and other installations designed for the holding back or permanent storage of water, where a new or additional amount of water held back or stored exceeds 10 million $m^3$'). For projects listed in Annex II, national authorities should determine the need for an EIA using a 'screening procedure'.

The key features of the EIA process are as follows:

- the project developer may request the competent authority to specify what should be covered by the EIA information to be provided (scoping stage);
- the developer must provide information on the environmental impact (in the form of an EIA report drafted in accordance with Annex IV of the Directive);
- the environmental authorities and the public, as well as local and regional authorities (as well as any EU countries that are affected) must be informed and consulted;
- the competent authority decides taking into consideration the results of consultations; this decision also includes a reasoned conclusion on the significant effects of the project;
- the authority informs the public of its decision.

[65]EBRD. 2019. Access to Information Directive. www.ebrd.com/documents/strategy-and-policy-coordination/access-to-information-policy-directive.pdf?blobnocache=true

[66]Directive 2014/52/EU of the European Parliament and of the Council of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment. https://eur-lex.europa.eu/eli/dir/2014/52/oj. Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment (codification). https://eur-lex.europa.eu/eli/dir/2011/92/oj

**Directive 2010/75/EU on industrial emissions (integrated pollution prevention and control) (the Industrial Emissions Directive)[67]**

The Directive is the main EU instrument regulating the emission of pollutants from industrial facilities. It aims to protect human health and the environment in general by reducing harmful industrial emissions in the EU, in particular through the use of Best Available Techniques (BAT). It is noted that production facilities carrying out the activities listed in Annex I to the Directive *(including inter alia cement production for dam construction)* require a special permit (issued by the authorities in the EU Member States).

**Directive 2009/147/EC on the conservation of wild birds (the Birds Directive)[68]**

The Directive requires the Member States to protect wild bird species and protect and restore their habitats. Annex I lists wild bird species that shall be the subject to special conservation measures concerning their habitats. It is required to designate special 'protection areas' to avoid significant pollution or deterioration of habitats or any disturbances affecting the birds including birds associated with floodplain habitats to be affected by the Project. Outside these protection areas, it is also required avoid pollution or deterioration of habitats.

**Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive)[69]**

The Directive requires the Member States to specify areas that are expected to ensure the conservation of flora and fauna species. It is stipulated the need for designating 'special areas of conservation' which, together with the existing special 'protection areas' established per the Birds Directive, to form a became a coherent European ecological network for protecting species and habitats (Natura 2000).

**Directive 2000/60/EC establishing a framework for Community action in the field of water policy (the Water Framework Directive)[70]**

The Directive aims to ensure an integrated approach to water management by establishing a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. It envisions water management by river basin approach.

**Directive 2008/98/EC on waste (Waste Framework Directive[71])**

The Directive defines the priorities and principles of waste management and the basic concepts and requirements for waste recycling, reuse and disposal in a way that does not have a negative impact on the environment or human health. The principle of waste management hierarchy integrated in the Directive envisions the following sequence of priority in selection of waste management methods:

- waste prevention (prevention at the of waste generation at source);
- waste reduction;
- waste reuse;
- application of other methods of waste recovery, e.g. energy recovery;

[67]Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (recast). https://eur-lex.europa.eu/eli/dir/2010/75/oj

[68]Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version). https://eur-lex.europa.eu/eli/dir/2009/147/oj

[69]Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. https://eur-lex.europa.eu/eli/dir/1992/43/oj

[70]Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. https://eur-lex.europa.eu/eli/dir/2000/60/oj

[71]Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. https://eur-lex.europa.eu/eli/dir/2008/98/oj

- final disposal at landfills.

**Directive 2003/10/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise)[72]**

The Directive defines the physical parameters that serve as risk predictors, such as peak sound pressure, daily noise exposure level and weekly noise exposure level. It sets exposure limit values and exposure action values in respect to the daily and weekly noise exposure level as well as peak sound pressure. These exposure limits are to be available for Project construction workers.

**Directive 2002/44/EC on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration)[73]**

The Directive aims at ensuring health and safety of each worker and at creating a minimum basis of protection for all Community workers by timely detection of adverse health effects arising or likely to arise from exposure to mechanical vibration, especially muscle-skeletal disorders. These exposure limits are to be available for Project construction workers.

## 4.5 Good Industry Practice (GIP) Guidance

Specific E&S requirements applicable to the Project are set out in the EBRD's Sub-sectoral Environmental and Social Guidelines: Building and Construction Activities (2010)[74]. They elaborate on typical E&S risks related to construction, operation, maintenance and decommissioning of facilities. Other relevant EBRD guiding documents used in the ESIA relate to resettlement; forced labour; gender issues, non-discrimination and equal opportunity; workers' accommodation; and other E&S topics.

The International Finance Corporation (IFC) ***General Environmental, Health and Safety Guidelines (2007)[75]*** (General EHS Guidelines) are technical reference documents with general and industry-specific examples of GIIP. The General EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in facilities by existing technology at reasonable costs.

**ICOLD Bulletin 173** (2021) - Integrated Operation of Hydropower Stations and Reservoirs. *This bulletin gives an overview of the main functional and operational aspects relating to cascade hydropower stations and reservoirs, it was formed by reviewing of all the related aspects proposed and case studies provided by committee members.*

**ICOLD Bulletin 96** (1994) - Dams and environment - Water quality and climate. *This Bulletin gives an overview of effects of reservoirs on water quality and climate.*

**ICOLD Bulletin 86** (1992) - Dams and Environment - Socio-economic impacts. *The present bulletin gives an overview of social and economic problems which may arise before, during or after the construction of a large dam.*

*The International Commission on Large Dams (ICOLD) is the leading international professional and academic organization in the field of hydraulic engineering. Its mission is to develop the art and*

[72]Directive 2003/10/EC of the European Parliament and of the Council of 6 February 2003 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (noise). https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:042:0038:0044:EN:PDF

[73]Directive 2002/44/EC of the European Parliament and of the Council of 25 June 2002 on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (vibration). https://eur-lex.europa.eu/resource.html?uri=cellar:546a09c0-3ad1-4c07-bcd5-9c3dae6b1668.0004.02/DOC_1&format=PDF%20

[74]https://www.ebrd.com/downloads/about/sustainability/Building_Construction_Activities.pdf

[75]https://www.ifc.org/content/dam/ifc/doc/2000/2007-general-ehs-guidelines-en.pdf

*science of dam engineering, and to promote the sustainable development and management of the world's water and hydropower resources. ICOLD has 100 member countries.*

## 4.6 Institutional framework

Several state bodies and their subordinate structures or units are involved in water management in Armenia. The main roles and responsibilities of these bodies in the field of irrigation water management are outlined below:

- **The Ministry of Environment (ME)** is the authorized body responsible for water resources management and protection in Armenia. It is tasked with developing and implementing the National Water Policy, National Water Program, and river basin management plans; protecting natural water bodies; preparing annual water balances; and overseeing their implementation.
- **The Environmental Impact Expert Examination Center (EIEEC)**, acting on behalf of the Ministry of Environment (ME), is responsible for organizing and implementing the expert examination and related processes for framework and design documents (projects) initiated by state and private entities, as well as individuals. Among other functions, the EIEEC ensures stakeholder participation in public discussions, facilitates the notification and involvement of interested parties in the expert examination process, and issues environmental impact expert examination conclusions.
- **The Water Resources Management Department**, under the ME, is responsible for regulating water resources management issues, including approving surface and groundwater extraction volumes, issuing water use permits, maintaining the State Water Cadastre, and managing water use related data. It also prepares documents for the suspension, amendment, or cancellation of water use permits.
- **The Hydrometeorology and Monitoring Centre** State Non-Commercial Organization (SNCO), under the ME, monitors meteorological, hydrological, and geophysical conditions in Armenia and provides disaster warnings. The Centre also supports the implementation of Armenia's international obligations in these areas.
- **The Ministry of Territorial Administration and Infrastructure (MTAI)**, along with its affiliated authorities and organizations, develops policy and regulations for the overall management of water infrastructure systems.
- **The Water Committee**, under the MTAI, is designated by the Water Code as the Water System Management Body. It is responsible for developing and implementing investment programs and submitting proposals to the Regulatory Commission concerning regulated tariffs and water system use permits.
- Irrigation in Armenia is managed by **"JRAR" Closed Joint-Stock Company (CJSC)** and 15 **Water Users Associations (WUAs)**. JRAR CJSC, a 100% state-owned enterprise, handles water abstraction and delivery, and is responsible for the maintenance and operation of first- and second-category irrigation systems. The WUAs operate reservoirs and distribute irrigation water to end users.
- **The Environmental Protection and Mining Inspection Body** is responsible for supervising and inspecting compliance with regulations related to the use and protection of water resources.

# 5. ESIA Methodology and Approach

## 5.1 Introduction

The ESIA is an iterative process that involves the prediction and assessment of potential impacts of the Project on the physical, biological, and cultural components (indicators) of the environment, as well as on social and socio-economic resources/receptors. During the ESIA study, recommendations were developed to eliminate, minimize, reduce, mitigate, or compensate for adverse impacts, while also enhancing expected benefits and opportunities. Appropriate management and monitoring measures have also been proposed.

The main stages of the ESIA study are as follows:

- Screening,
- Scoping,
- Baseline Study,
- Impact Assessment and Mitigation,
- Management and Monitoring,
- Stakeholder Engagement and Public Consultations.

## 5.2 Screening

Screening is the initial stage of the ESIA that is carried out to determine the level of the impact assessment as well as what legal and other requirements will be applied for the Project.

The construction of the Astghadzor Reservoir, with a capacity of 1.55 mln. $m^3$, is a greenfield project that may trigger significant adverse environmental and/or social impacts. The EBRD has classified this project as Category 'A' under its 2019 Environmental and Social Policy (ESP), which means that a comprehensive ESIA report and associated documents must be prepared and publicly disclosed for a minimum of 120 days.

## 5.3 Scoping

The key task of the E&S scoping process is to determine the content and extent of the matters that should be addressed in the ESIA and its associated documentation. The Scoping process is not intended to provide detailed information about the Project. Rather, it serves as a preliminary overview, aimed at facilitating early engagement with relevant stakeholders and helping to identify potential Project impacts. Scoping is designed to ensure that the ESIA focuses on the most significant impacts, project alternatives, and other key issues.

The scoping process involves a comprehensive analysis of the activities and features associated with each stage of the Project lifecycle, and their potential to positively or negatively interact with environmental (including physical and biological receptors), social, and socio-economic resources and receptors.

## 5.4 Baseline Study

To provide a context within which the impacts of the Project can be assessed, a description of the physical, biological, and socio-economic (including social, economic, and health and safety) environment expected to prevail in the absence of the Project must be presented. In this regard, it is

essential to collect comprehensive baseline data on environmental, social, and socio-economic conditions through the collection of both primary and secondary information.

Secondary baseline data were gathered from documents prepared during the Project design phase and the national EIA study provided by the Water Committee and the National EIA Consultant, as well as from the gap analysis study conducted by the ESIA Consultant. In addition, baseline information related to the Project region, components, and associated facilities was collected by the Consultant from publicly available sources, reports, online databases, and interactions with Project stakeholders. The list of documents and information used during the secondary baseline data collection process is provided in **Section 1.4** of this ESIA report.

Where necessary, or where information is lacking, secondary baseline data should be supplemented with primary data collected during field surveys and investigations. The following field surveys were initially conducted by the National EIA Consultant and subsequently enhanced by the ESIA Consultant to describe the baseline conditions within the Project's footprint and to supplement the baseline chapter (**Chapter 6**) of this ESIA report:

| **Surveys conducted by the National EIA Consultant** |
|---|
| • Biodiversity (flora and fauna) field investigation<br>• Background air quality survey (determination of $SO_2$, $NO_2$, CO and dust actual concentration in the atmospheric air within the area of Project influence)<br>• Water and soil quality survey<br>• Ambient noise study (determination of actual noise levels within the Project's area of influence)<br>• Socio-economic data collection and interviews<br>• Archaeological field surveys |
| **Supplementary studies conducted by the ESIA Consultant** |
| • Cumulative impact assessment,<br>• Assessment of impacts of the associated facilities,<br>• Water infiltration and loss study, water and soil quality survey,<br>• Assessment of Greenhouse Gas (GHG) emissions and climate change mitigation measures,<br>• Spring season field biodiversity surveys and Critical Habitat Assessment,<br>• Conduct Appropriate Assessment procedure,<br>• Cultural Heritage studies and intangible Cultural Heritage survey |

The results of the field surveys are provided in the annexes and summarised in the relevant sections of **Chapter 6**, and are further discussed in **Chapter 8** of this ESIA report.

The baseline outlines the existing E&S conditions and provides the context against which potential impacts will be identified and assessed. Specifically, the baseline aims to provide information to support the following:

1. Identify the key conditions and sensitivities within the zone potentially affected by the Project,
2. Provide baseline data for subsequent prediction and assessment of potential impacts to be generated in the course of Project implementation,
3. Understand stakeholders' concerns and analysis of their perceptions and expectations,
4. Ensure a benchmark to assess future changes resulting from the Project implementation and monitor the effectiveness of mitigation measures.

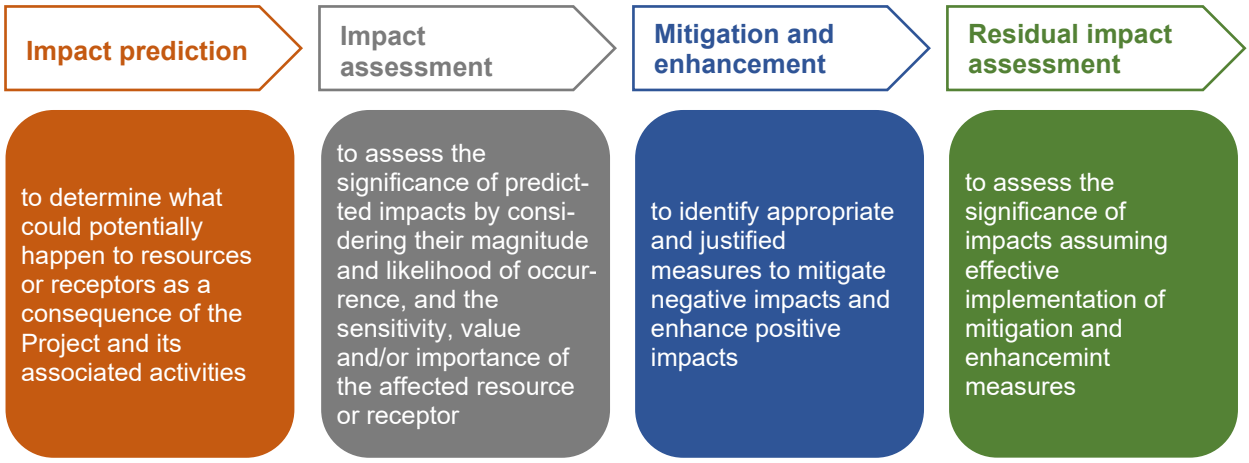
## 5.5 Impact Assessment and Mitigation

The potentially significant impacts identified during the scoping stage are subject to a full-scale appraisal in the course of the ESIA study. The impact assessment follows a consistent process for the consideration of the following four aspects:

- Impact prediction,
- Impact evaluation,
- Mitigation and enhancement,
- Residual impact evaluation.

The scheme of impact assessment and evaluation process is presented in **Figure 5-1**.

**Figure 5-1. Schematic view of impact assessment process**




*Impact Prediction*

Impact prediction is an expert-driven process used to determine the likely consequences of the Project and its associated activities or features on the environment. Impacts on various resources and receptors are identified and assessed based on the potentially significant interactions determined during the scoping phase. Given the diverse range of potential impacts considered in the assessment process, a variety of prediction methods are typically employed, including quantitative, semi-quantitative, and qualitative techniques.

*Impact Assessment*

E&S impacts arise as a result of Project activities or features interacting directly with receptors, or causing indirect changes to the existing environment. Impacts can be described and quantified in various ways. In the course of this study, impacts on different components of the physical, biological, human, and social environment are assessed throughout the Project's lifecycle in terms of:

- Direction: positive or negative,
- Type: direct, indirect, residual,
- Magnitude: high, medium, low, negligible,
- Likelihood: high, medium, low,
- Duration of the Impact: temporary, short-term, long-term, permanent,
- Reversibility,
- Significance degree: significant, moderate, low, negligible.

The key characteristics of the impacts are defined in Table 5-1.

**Table 5-1. Impact Characteristics**

| Impact Characteristics | Description |
|---|---|
| **Type** | **Direct impact** resulting from the direct interaction between a project activity and the resource / receptor.<br>**Indirect impact** between the proposed activity and the environment/ receptor as a result of subsequent interactions within it.<br>**Residual impacts** are defined as those impacts that remain following the implementation of the mitigation measures proposed. |
| **Duration of impact** | **Temporary (very low duration)** impacts would last for a short duration of six months of less and are reversible and intermittent or occasional in nature. The resource or receptor would return to the previous state when the effect ceases or after a short period of recovery.<br>**Short-term (low duration)**, when impact is likely to be restricted for a duration of up to three years.<br>**Long-term (medium duration**), when impacts would continue for an extended period of time; this is based on the understanding that there will be recovery of the effected environmental component to its best achievable pre-project state over time.<br>**Permanent (high duration)**, when impacts would occur during the lifetime of the Project and cause a permanent change in the affected receptor or resource. |
| **Magnitude** | **Negligible**, when the impact having almost no influence on baseline conditions.<br>**Low**, when resulting in slight changes of prevailing baseline conditions.<br>**Medium**, when resulting in changes which are within the benchmark norms or shows some signs of stress on any of the components of environment.<br>**High**, when resulting in changes which affects larger extent or shows signs of stress on receptors in larger extent. |
| **Likelihood** | **Low**, when event is unlikely, but may occur at some time during normal operating conditions.<br>**Medium**, when event is likely to occur at some time during normal operating conditions.<br>**High**, when event will occur during normal operating conditions. |

Once the magnitude and likelihood of the impact has been characterized, the impact significance degree is assigned using the matrix in Figure 5-2.

**Figure 5-2. Impact Significance Matrix**

| | | ***Likelihood / Duration*** | | |
|---|---|---|---|---|
| | | Low | Medium | High |
| ***Magnitude*** | Negligible | Negligible | Negligible | Negligible |
| | Low | Negligible | Low | Moderate |
| | Medium | Low | Moderate | Significant |
| | High | Moderate | Significant | Significant |

If the duration of an impact is long-term or permanent, but the likelihood is low or medium, the significance of the impact is evaluated one level higher.

In the case of a positive impact, no magnitude designation, other than 'positive', is assigned. For the purposes of this impact assessment, it is considered sufficient to indicate that the Project is expected to result in a positive impact, without quantifying the exact degree of positive change.

Context of impact significance for E&S resources is provided in **Table 5-2**.

**Table 5-2. Context of impact significance**

| Significance of impacts | Description | |
|---|---|---|
| | **Environmental resources** | **Socio-economic resources** |
| Negligible | Impacts practically do not change the environmental baseline conditions, local in extent and temporary or short-term in duration | No significant changes in baseline conditions are expected, in-site in extent and temporary or short-term in duration impact. No significant inconveniences are caused |
| Low | Site, local and regional impacts which are not accompanied by long-term degradation of sensitive resources; effects are usually reversible and minor (do not require special mitigation measures); usually do not exceed the applicable standards (criteria, i.e. noise, vibration, etc.) in relation to the less sensitive resources | Short-term inconveniences caused by Project implementation to individuals and communities, but with no consequences to long-term change of livelihood or quality of life. Receptors either easily in part adapt to changes brought by the Project or proceed with previous livelihood |
| Moderate | Site and local environmental impacts, mostly long-term; impacts which do not affect critical resources but result in irreversible loss of biodiversity and habitats; impacts with regional effects persisting from 1 to 3 years; require development of cost reasonable impact mitigation measures | Direct and indirect impacts on livelihood and quality of life of the local communities or individuals. Receptors may undergo some difficulties to adapt to changes and they will be able to return to their former livelihood under condition of some support (for instance, compensation) |
| Significant | Significant impacts of regional and of the larger scale; medium-term, long-term and permanent impacts resulting in irreversible changes and degradation of baseline conditions; usually having adverse effects exceeding national environmental standards or associated with transnational environmental issues; involving effects of toxic substances and associated with potential emergencies affecting critical resources and sensitive receptors | Widely spread adverse direct and indirect impacts on both individuals and local communities which are practically cannot be mitigated or compensated. Affected receptors are not able to adapt to changes or proceed with previous livelihood |
| Positive | There will be a beneficial impact to a resource/receptor | There will be a beneficial impact to a resource/receptor |

*Mitigation and Enhancement*

A key component of the ESIA process is to identify practical ways to avoid, reduce, or mitigate the potentially significant impacts identified during the study. These are referred to as mitigation measures and are incorporated into the Project as commitments. The objective of mitigation is to prevent, minimize, or manage significant negative impacts to as low as reasonably practicable, and to optimize and maximize any potential benefits or opportunities of the Project, where applicable.

A hierarchy of mitigation options is considered, with the preferred approach being to avoid the impact at source. The least desirable option is to provide compensation or an offset for residual impacts that cannot be reasonably avoided.

Embedded controls (i.e., physical or procedural controls that are planned as part of the Project design and are not added in response to an impact significance assessment) were considered as part of the Project (i.e., prior to the impact assessment stage of the ESIA process). As such, they are not described as mitigation measures in the individual topic assessment sections.

All mitigation measures outlined in the ESIA are summarized in an Environmental and Social Management Plan (ESMP) for the Project, which provides an overview of how these measures will be implemented during the construction and operation stages.

*Residual Impact Assessment*

Following the identification of potential E&S impacts, their significance is assessed, taking into account the proposed mitigation measures already incorporated into the Project design and, where appropriate, any additional mitigation measures that are considered feasible and justified.

Mitigation measures are applied to reduce impacts to as low as reasonably practicable; however, some impacts may not be eliminated entirely. These remaining impacts are referred to as residual impacts. One objective of the ESIA is to assess the significance of these residual impacts, which will remain after mitigation measures have been incorporated into the Project, and to determine the appropriate monitoring and measurement actions.

## 5.6 Management and Monitoring

At the final stage of the impact assessment process, basic management and monitoring measures are defined to determine whether: a) residual impacts or their associated Project components remain in conformance with applicable standards; and b) mitigation measures are effectively addressing impacts, and compensatory measures and offsets are reducing effects to the extent predicted.

## 5.7 Stakeholder Engagement and Public Consultations

International best practices for the implementation of an ESIA, along with the requirements of the EBRD, provide the basis for conducting active consultations with competent supervisory agencies, experts, affected local communities, and other stakeholders. These consultations aim to understand their views on the Project and its impacts, and to incorporate these perspectives into the prediction and evaluation of impacts, as well as the corresponding mitigation measures. Consultation is also valuable for identifying data and information within the studied area.

As part of this ESIA package, a Stakeholder Engagement Plan (SEP) has been developed, including a grievance mechanism, to serve as a structured and systematic approach for stakeholder engagement throughout all stages of Project implementation.

# 6. Environmental and Social Baseline

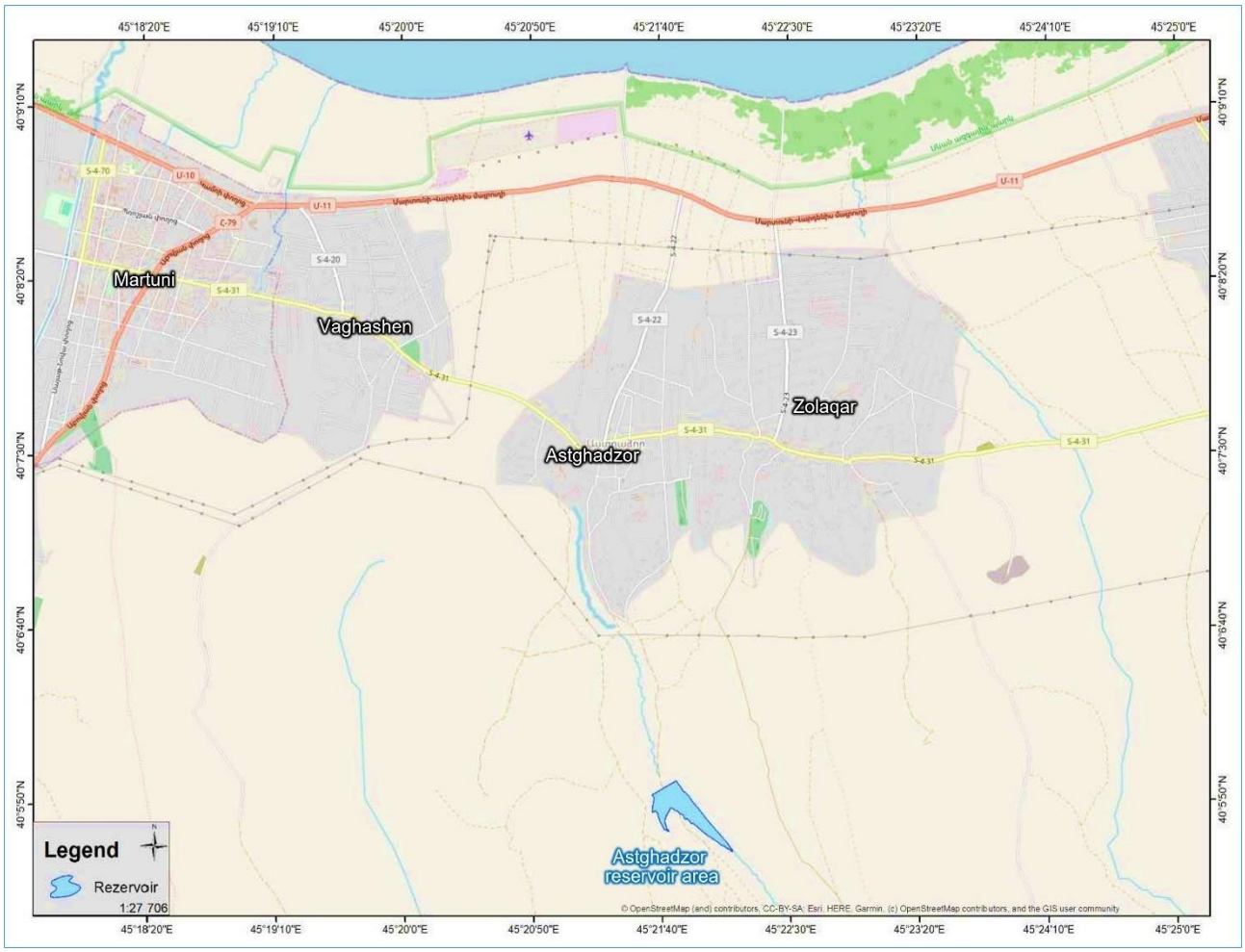
## 6.1 Physical Environment

### 6.1.1 Geography

The Astghadzor Reservoir is planned to be constructed within the administrative boundaries of the Astghadzor and Zolaqar rural settlements. It will be located on the Astghadzor River, at an elevation of 2,100-2,160 masl. The reservoir is intended to ensure sustainable irrigation for agricultural lands Astghadzor, Zolaqar, Vaghashen, and Martuni rural settlements (**Figure 6-1**).

Astghadzor (also known as Khachadzor or Dzor) is located 39 kilometers southeast of the regional center, Gavar town. The settlement lies on a low hill at an elevation of 2,030 masl, approximately two kilometers from Lake Sevan. The road distance between Astghadzor and Yerevan, the capital of Armenia, via the M11, M10, and M4 highways, is approximately 130 kilometers. Zolaqar borders Astghadzor to the east, and the two settlements are connected by an inter-community road.

**Figure 6-1. Situational Plan of the Project region**

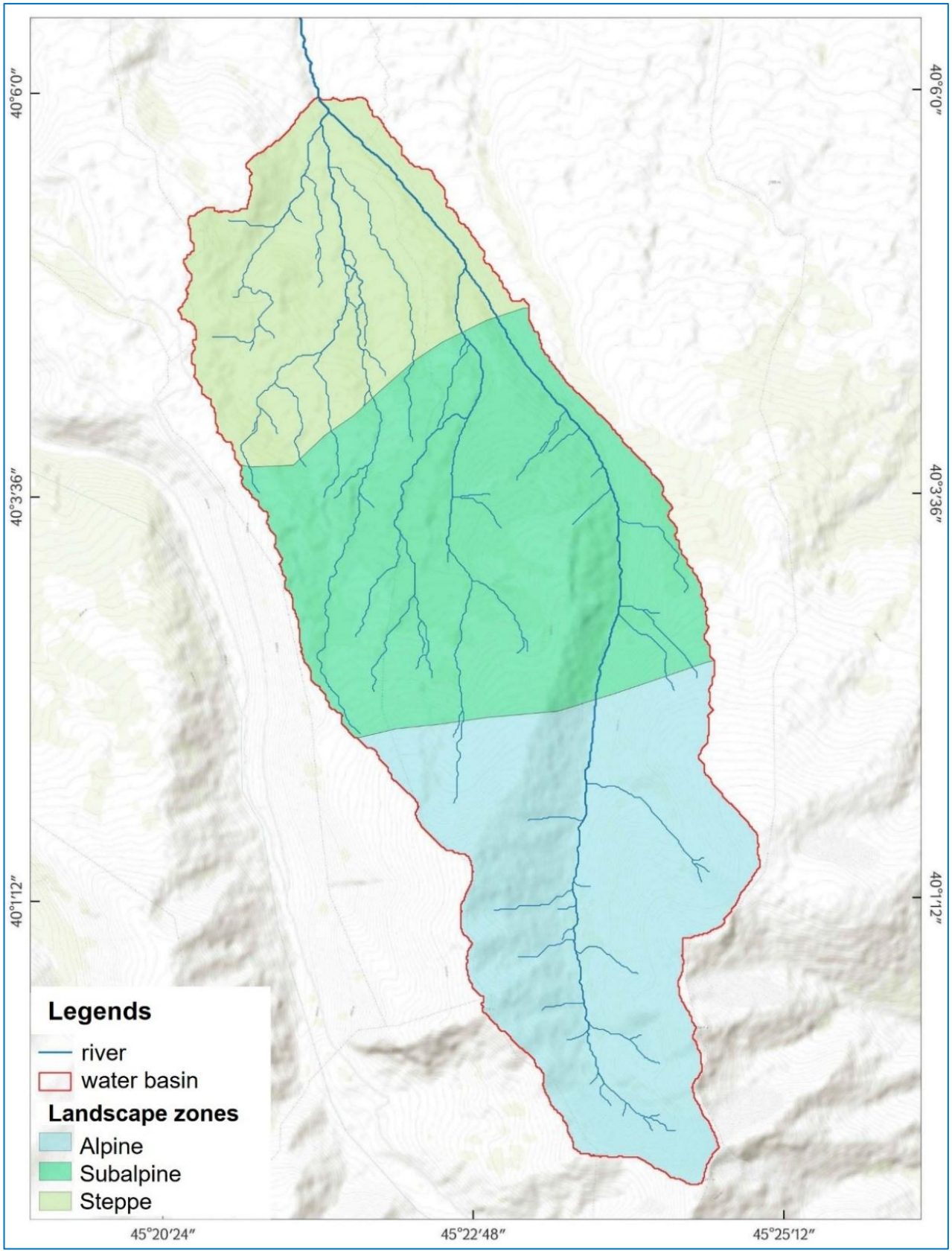



### 6.1.2 Relief, Landscape and Visual Amenity

The landscape zones in the Astghadzor and Vardenis river basins are similar. The mountain steppe zone extends up to 2,400 meters and is primarily found on lava plateaus. This zone is characterized by hot summers and cold winters. Near its northern boundary of the reservoir, in relatively humid

areas, meadow steppes are formed. The subalpine zone lies between 2,400 and 2,800 meters in elevation, while the alpine zone is found at elevations above 2,800 meters (**Figure 6-2**).

**Figure 6-2. Landscape zones of the Project site**



The Astghadzor River basin is primarily oriented to the north. However, its internal slope orientation varies: 42.8% face north, 26.5% east, 1.8% south, and 28.9% west. The inclination of the basin's slopes plays a crucial role in drainage. In the upper reaches of the Astghadzor River, the slopes are steep, exceeding 20 degrees. In contrast, the lower reaches are dominated by left-bank tributaries, where the terrain features gentler slopes, primarily up to 10 degrees, although areas with slopes ranging from 10 to 20 degrees are also present.

The site designated for the planned reservoir remains largely undisturbed, though some areas have been used as natural pastures. The terrain is predominantly rocky and fragmented, with occasional boreholes from geological surveys.

From a geomorphological perspective, the terrain of the study area features a typical mountainous landscape with rugged topography. The lowest point is Lake Sevan, at 1,900 masl, with the relief gradually rising toward the south. The area is bordered to the south by the Vardenis Mountains, which extend from southwest to northeast, spanning approximately 60 km from Gndasar Peak in the Geghama Mountains to the Mets Tsarasar mountain junction. Mount Vardenis is the highest point in this range, reaching an elevation of 3,522 meters, with some sections extending down to the shores of Lake Sevan. To the northeast, the Vardenis Mountains merge with the Geghama Range, where the peak of Azhdahak rises to 3,598 meters.

An aerial view of the planned Astghadzor Reservoir area is presented in **Figure 6-3**. A view of Astghadzor village from the reservoir site is shown in **Figure 6-4**.

**Figure 6-3. Aerial view of the Project site**

**Figure 6-4. View from the reservoir area to Astghadzor village**

### 6.1.3 Geology and Hydrogeology

To assess the geological conditions of the Astghadzor reservoir site, an engineering-geological and geophysical surveys were conducted by "NORGEO" LLC.

Field investigations were carried out between March and June 2023. During this period, 17 boreholes were drilled to depths ranging from 5.0 to 45.0 m using an Atlas Copco CS-14 drilling rig. A total of 67 soil samples, both disturbed and undisturbed, were collected during drilling to evaluate the physico-mechanical properties of the soils and their filtration capacity.

Laboratory analyses were performed in accordance with applicable regulatory standards, specifically GOST 5180-2015 and GOST 12248-2010, at the Geomineral LLC laboratory.

The geological setting of the study area, from the deepest layers to the surface, consists of sedimentary rocks from various geological periods, including the Middle Eocene, Oligocene, Miocene-Pliocene, Pliocene, Quaternary, and Modern periods.

***Middle Eocene***

Middle Eocene rocks have a limited distribution in the area. They are represented by dark gray porphyrites, quartz porphyrites, tuffs, and tuff breccias. The stratigraphic section of this geological unit is as follows:

1. Dark gray porphyrites with interbedded tuffs and tuff breccias, thickness: 250-300 m.
2. Light gray to white quartz porphyrites with associated tuffs and tuff breccias, thickness: 600-700 m.

The total thickness of the Middle Eocene rock sequence reaches up to 1,000 m.

***Oligocene***

Oligocene rocks are found in the central and southwestern parts of the Martuni region. They are represented by volcanic and volcaniclastic formations, including tuff breccias of andesitic composition.

The total thickness of Oligocene-age rocks ranges from 1,300 to 1,500 m.

***Miocene-Pliocene***

A narrow strip of pumice-grained sandstones and sandstones is exposed in the Vardenik River Canyon. Miocene-Pliocene rocks overlie a layer of Oligocene-aged tuff breccias. The total thickness of the Miocene-Pliocene rocks reaches up to 50 m.

***Pliocene***

Pliocene rocks are widespread in the eastern parts of the Martuni region. They are represented by dacites, liparito-dacites, andesites, and andesito-dacites. The total thickness of the Pliocene rock sequence is approximately 500 m.

***Quaternary***

Quaternary rocks are widespread in the Martuni region. They are represented by type A and B basalts, as well as volcanic slags. The basalts in the area exhibit macroscopic differences in color, crystallization, and density. Their color ranges from black to gray, with reddish hues also observed. The total thickness of the Quaternary rock layer is approximately 50 m.

***Modern Sediments***

Modern sediments are represented by river and lake alluvial-diluvial deposits, consisting of gravelly, pebbly, and sandstone-clay formations. These sediments are widely distributed in the areas surrounding the villages of Vardenik and Martuni. The thickness of the Quaternary deposits reaches up to 50 m.

Hydrogeological conditions

From a hydrogeological perspective, groundwater is widespread in the area. It occurs at relatively shallow depths and is primarily associated with the Astghadzor River basin. During the investigation, groundwater was detected in borehole 1.2, borehole 2.2, borehole 3.2, observation point 1 and observation point 2, at depths ranging from 1.2 to 2.2 m.

These groundwater occurrences are associated with modern sediments, particularly gravelly soils. The groundwater horizon is formed as a result of infiltration from the Astghadzor River, and its level may fluctuate depending on the river's flow.

Conclusions

1) From a geological perspective, the study area is composed of sedimentary rock layers ranging from the Middle Eocene at the bottom to the Modern sediments at the top, including the Oligocene, Miocene-Pliocene, Pliocene, and Quaternary periods. In the planned reservoir area, drilling primarily targeted the Modern sedimentary layer. Within this layer, gravel, conglomerate, siltstone, sandy clay, and sand strata were identified and described.
2) The upper horizon of groundwater was detected in borehole 1.2, borehole 2.2, borehole 3.2, observation point 1 and observation point 2, at depths ranging from 1.2 to 2.2 m. They are associated with modern sediments, particularly limestone-rich soils. The groundwater level may fluctuate depending on the river's flow.

   Groundwater was found in borehole 2.4 at depths between 40.5 and 44.5 m. This horizon is deep and is associated with the regional aquifer.
3) The measurements of soil filtration properties indicate that the permeability coefficients range from low to high, reflecting both low-permeability and permeable soils.

4) Chemical laboratory studies were conducted to determine the chemical composition of groundwater and soil. According to laboratory data, the groundwater is classified as non-aggressive.

5) The total annual filtration losses of the Astghadzor reservoir, including the dam foundation and three blocks, amount to 1,800,000 m³/year.

6) Geological processes and phenomena in the study area are manifested primarily as landslides. The landslide measures approximately 80 m in length and 50 m in width. According to engineering-geological data, the maximum thickness of the landslide body reaches up to 15 m. The vertical difference in elevation between the head and the toe of the landslide is about 50 m, and the total volume of the unstable soil mass is estimated at approximately 40,000 $m^3$.

7) According to the RA CN 20.04 "Earthquake-resistant construction, Design norms"[76], the region and the study area are located in the 1st seismic zone. The ground condition coefficient ($K_0$) for the area equals to 1.0. The calculated seismicity of the site, expressed as the expected maximum ground acceleration ($A_{max}$) is calculated through the following formula:

$$A_{max} = 0.3g \times 1.0 = 0.3g$$

8) From an engineering-geological perspective, the soils in the area designated for the construction and operation of the Astghadzor Reservoir are generally considered favourable.

### 6.1.4 Tectonics, Seismic Stability and Landslides

On the northern slope of the Vardenis Mountains, in the upper reaches of the Vardenik and Martuni rivers, a northwest-trending anticlinal structure is observed. This structure extends from the southwestern part of Mount Vardenik to the headwaters of the Martuni and Vardenik rivers. The flanks of the anticline are composed of Eocene-aged porphyrites, quartz porphyrites, tuffs, and tuff breccias.

The northeastern section of the Martuni anticlinal structure transitions into a synclinal structure that extends across the Lake Sevan basin. Southwest of the Martuni region lies the Sevan branch of the Pambak-Sevan-Syunik active fault, which runs from the Artanish settlement along the floor of Lake Sevan and continues southwest toward the settlements of Karchaghbyur and Vardenik.

A significant landslide body has been identified within the study area, on the left slope of the Astghadzor River. This landslide spans approximately 80 m upslope and 50 m in width, with a maximum depth of around 15 m, as determined through engineering-geological profiling. The vertical elevation difference between the landslide's head and toe is approximately 50 m, and the total estimated volume of unstable soil mass is about 40,000 $m^3$. This option has high seismic risk.

Based on field geological mapping, a cross-section of the landslide slope was developed. Drilling was carried out along this section, and slope stability calculations were performed. The stability assessment for the proposed reservoir site was conducted under two scenarios: static and seismic loading. An engineering-geological model was constructed to support the calculations. The results indicated that, under current conditions, the required safety factor condition (K_sf > K_st) is met for the normal load combination. However, for the special load combination, this condition is not satisfied.

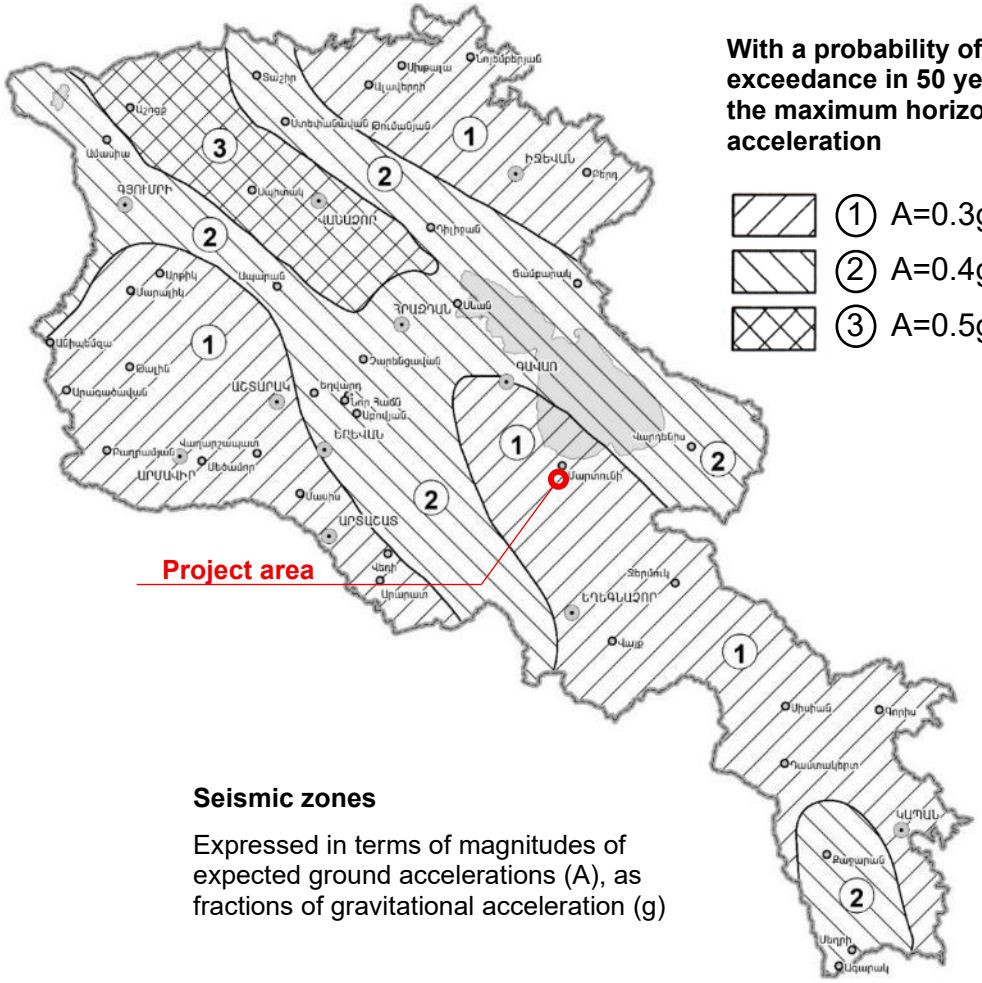
[76] https://www.arlis.am/documentview.aspx?docid=172012

Accoridng to the RA CN 20.04 "Earthquake-resistant construction, Design norms", Armenia is divided into 1st, 2nd and 3rd seismic zones, with the last the most seismically hazardous. The magnitudes of expected ground horizontal accelerations per seismic zones are:

| Seismic zones | 1st | 2nd | 3rd |
|---|---|---|---|
| Ground horizontal accelerations magnitudes a, cm/sec$^2$ | 300 | 400 | 500 |

As concluded in **Section 6.1.3**, the Project site (Astghadzor village) is located in the 1st seismic zone (**Figure 6-5**), where the expected seismic hazard is estimated at Amax = 0.3g. Thus, the Project is situated within the low seismic hazard zones of Armenia.

**Figure 6-5. Map of zoning of probable seismic risks in the RA territory**




The Probabilistic Seismic Hazard Assessment (PSHA) was performed on the planned Astghadzor Reservoir dam platform by the "Territorial Service of Seismic Protection" SNCO, Armenian Association of Seismology and Geophysics and "Terraform" LLC[77]. The R-CRISIS software was used for the PSHA, allowing consideration of input data uncertainties through the logic tree approach. Two seismotectonic models were used for the calculations.

The PSHA was conducted for the Astghadzor dam site (coordinates: 40.100N and 45.260E), assuming a Vs30 value of 760 m/s, representing the shear wave velocity. According to the RA CN 20.04 "Earthquake-resistant construction, Design norms", the dam belongs to category 2. The PSHA calculations were performed for annual exceedance probabilities of $2.11\times10^{-3}$ and $1.0\times10^{-4}$,

[77]Report on the Probabilistic Assessment of Seismic Hazard of the designed Astghadzor Reservoir Dam Site, 2023

corresponding to return periods of 475 and 10,000 years, respectively. The results of the PSHA are given in **Table 6-1**.

For these parameters, the expected average values of maximum horizontal acceleration at the Astghadzor dam platform are 0.13g for a 475-year return period and 0.39g for a 10,000-year return period. At a confidence level of 84%, the corresponding values are 0.15g and 0.47g, respectively.

**Table 6-1. Deterministic and probabilistic assessment of maximum horizontal acceleration values**

| Risk determination methods | Dam | Average value (g) | 84% |
|---|---|---|---|
| Deterministic | Astghadzor | 0.27 | 0.31 |
| Probabilistic: return period of 475 years (Operating Basis Earthquake, OBE) | Astghadzor | 0.13 | 0.15 |
| Probabilistic: return period of 10,000 years (Safety Evaluation Earthquake, SEE) | Astghadzor | 0.39 | 0.47 |

### 6.1.5 Hydrology (surface and groundwater resources)

Surface water

The planned Astghadzor Reservoir is located within the Lake Sevan basin, home to the largest high-altitude freshwater lake in the South Caucasus. Lake Sevan has a volume of 33.2 $km^3$ and a surface area of 1,238 $km^2$. It is situated at an elevation of 1,900.65 masl and divided into two parts by the Shorzha embankment, which stretches between the Artanish and Noratus capes: the southeastern section, known as Greater Sevan, containing 20.4 $km^3$ of water; and the northeastern section, or Lesser Sevan, holding 12.8 $km^3$. The maximum recorded depth in Lesser Sevan is 79.4 m, while the average depth across the entire lake is 26.2 m. The lake's shoreline extends approximately 230 km.

Lake Sevan, a crucial freshwater resource in the region, is fed by 28 rivers and brooks, including Astghadzor and Vardenis rivers, 4 of which flow into Lesser Sevan and 24 into Greater Sevan. The total area of these river basins is 2,780 $km^2$, with an additional inter-basin area of 696 $km^2$ (**Figure 6-6**).

The Hrazdan River, the only outflow of Lake Sevan, historically had a natural flow of 110 mln. $m^3$ per year before the lake level was lowered. Today, it forms part of a network of canals and aqueducts used to channel water extracted from Lake Sevan for hydropower[78] and irrigation purposes[79].

According to the RA Law on Specially Protected Areas of Nature, Lake Sevan holds the legal status of a national park (see also **Sub-section 6.2.4**). Its main conservation objectives, institutional framework, management measures and monitoring activities are defined in the Management Plan for the Sevan Basin Management Area for 2022-2027.

Astghadzor River is one of the 28 surface watercourses that supply Lake Sevan with water. Astghadzor is a river in the Gegharkunik Marz, located within the Lake Sevan basin. It originates on the western slopes of Mount Batssar in the Vardenis mountain range, at an altitude of 2,599 masl. The river is 16.7 km long, with a catchment area of 43 $km^2$.

The river valley is V-shaped in its upper reaches and trough-shaped in the lower sections. Astghadzor has a mixed feeding regime, and its average annual discharge is 43 $m^3/s$. The river's waters are primarily used for irrigation purposes.

[78]Supply water to the Sevan-Hrazdan Hydropower Cascade, which consists of seven hydropower plants
[79]Management Plan for Sevan Basin Management Area for 2022-2027 (https://www.arlis.am/hy/acts/171479)

**Figure 6-6. Sevan Lake basin**


Vardenis is a river in the Gegharkunik Marz, located within the Lake Sevan basin. It originates on the northern slopes of the central part of the Vardenis mountain range at an altitude of 3,215 masl. The river is 28 kilometers long, and its catchment area is 116 km$^2$.

The river valley is V-shaped in the upper and middle reaches, widening in the lower reaches where it enters a lake-like plain and flows into Lake Sevan north of the village of Vardenik. The river is fed by snow and rain, with peak flows occurring in spring due to snowmelt. The average annual discharge is 1.87 m$^3$/s, with a total annual flow of 55.8 mln. m$^3$. The river forms a floodplain, freezes in winter, and its waters are used for irrigation.

The RA Government Decree №75-N specifies the classification (categories) and environmental norms for surface water bodies (rivers). According to that Decree five water quality categories are defined for the river basins of Armenia: Class 1 - Excellent, Class 2 - Good, Class 3 - Fair, Class 4 - Poor, and Class 5 - Bad. The Astghadzor River belongs to the Sevan River basin. Therefore, the environmental norms established by the Annex 15 of the RA Government Decree №75-N for the Sevan Lake basin were used to assess the water quality of the Astghadzor River.

Two samples were taken from the Astghadzor River in April 2025: Sample N1 (upstream, before the reservoir site) and Sample N2 (downstream, after the reservoir site). The samples were analyzed at the accredited laboratory of the "Hydrometeorology and Monitoring Centre" SNCO. The results of the water quality analysis and the corresponding water quality categories determined based on the analyzed parameters are summarized in **Table 6-2**.

**Table 6-2. Results of water quality analysis and water determined water quality categories**

| № | Analysed indicators | Unit | N1 | | N2 | |
|---|---|---|---|---|---|---|
| | | | Result of analysis | Category | Result of analysis | Category |
| 1 | Colour | rank | 30 | 4 | 30 | 4 |
| 2 | Transparency | cm | 31 | * | 31 | * |
| 3 | Suspended solids | mg/l | 59.2 | 3 | 56 | 3 |
| 4 | pH (Hydrogen index) | - | 7.41 | 1 | 7.55 | 1 |
| 5 | Mineralization | mg/l | 53 | * | 54 | * |
| 6 | El.conductivity | µs/cm | 81 | 2 | 82 | 2 |
| 7 | Alkalinity | mg/l | 45 | * | 40 | * |
| 8 | COD (Chemical Oxygen Demand) | mgO/l | 20 | 2 | 15 | 2 |
| 9 | Fluoride ion | mg/l | 0.111 | * | 0.091 | * |
| 10 | Sulphate ion | mg/l | 7.328 | 3 | 7.178 | 3 |
| 11 | Chloride ion | mg/l | 1.437 | 1 | 1.368 | 1 |
| 12 | Nitrate ion | mg/l | 1.254 | 2 | 1.118 | 2 |
| 13 | Nitrite ion | mg/l | <0.013 | 2 | <0.013 | 2 |
| 14 | Ammonium ion | mg/l | 0.151 | 2 | 0.156 | 2 |
| 15 | Total inorganic nitrogen | mgN/l | 0.401 | 2 | 0.373 | 2 |

*the environmental norm for this water quality indicator has not been specified

The results of chemical analyses of water samples from the Astghadzor River indicate that the water quality generally meets the criteria for Class 1 (Excellent) and Class 2 (Good). However, concentrations of suspended solids and sulfate ions correspond to Class 3 (Fair), while the water quality in terms of color falls under Class 4 (Poor).

Groundwater Resources

According to the map of the groundwater observation network of the Lake Sevan catchment basin[80], as well as *Report on Monitoring of the National Groundwater Network of the RA for 2024*, there are 15 groundwater monitoring (observation) points installed along the watercourses within the Lake Sevan catchment basin. The nearest groundwater monitoring locations to the Project site are observation points 1809, 1810, 1811, and 1812 in Vardenis town, and observation point 2090 in Vaghashen village (**Figure 6-6**). The later is located around 5.5 km downstream the planned reservoir area.

The Hydrometeorology and Monitoring Centre under the Ministry of Environment (ME), as the state environmental monitoring body, conducts regular groundwater monitoring in Armenia. According to the *Report on Monitoring of the National Groundwater Network of the RA for 2024*, which also summarizes groundwater monitoring data from 2010 to 2024, the groundwater flow at the fountain wells of the Vardenis observation points 1809, 1810, 1811 and Vaghashen observation point 2090 decreased compared to 2023. Consumption at the fountain well 1812 in Vardenis town remained stable.

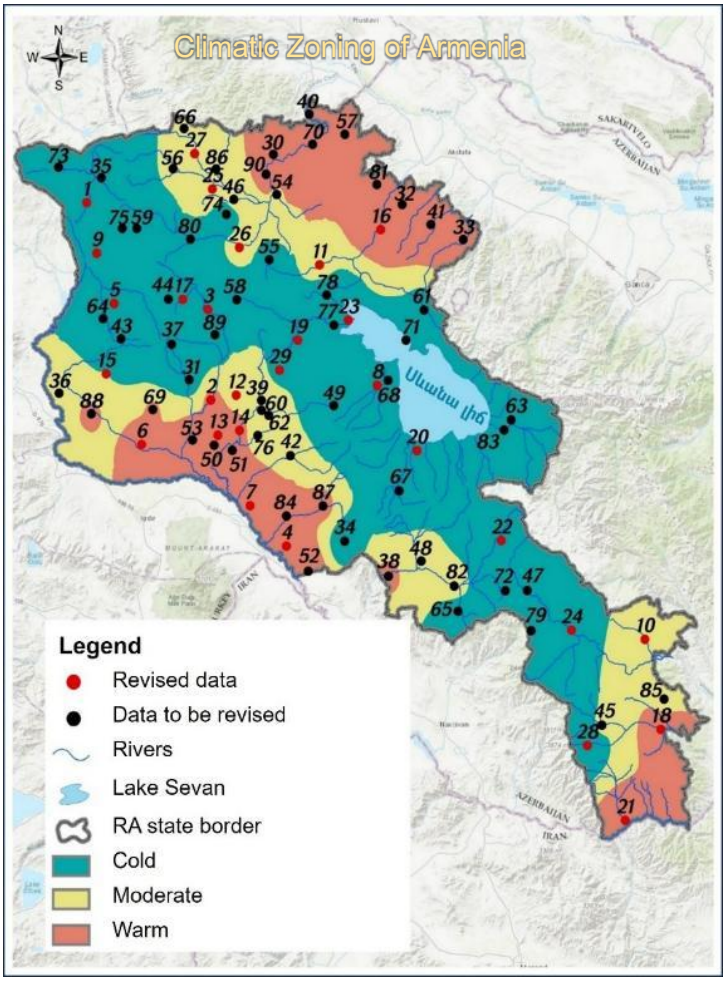
During the geotechnical field surveys (see also **Sub-section 6.1.3**), the groundwater table was detected in boreholes 1.2, 2.2, 3.2 and observation points 1 and 2, at depths ranging from 1.2 to 2.2

[80] https://armmonitoring.am/page/63

m. Groundwater also was found in borehole 2.4 at depths between 40.5 and 44.5 m. This horizon is deep and is associated with the regional aquifer.

### 6.1.6 Climate and Meteorology

According to the RA Construction Norms CN 22-01-2024 "Construction Climatology"[81] the Project site (№20, in Martuni town) is located within the cold climatic zone (see map of climatic zoning of Armenia).




The nearest meteorological station is located in the town of Martuni, approximately 6.5 km northwest of the Project site. Based on data from the Martuni meteorological station, the average annual air temperature in the Project region is 5.9°C, with January averaging -5.2°C and August 16.4°C. The annual temperature range is approximately 21.6°C. The absolute minimum temperature of -31.7°C was recorded in January, while the absolute maximum of 33.6°C was observed in July.

The average annual relative humidity is 68% and total annual precipitation amounts to 522 mm. The highest monthly rainfall occurs in November, reaching up to 84 mm. The maximum recorded soil freezing depth is 114 mm, while the maximum ten-day snow height is 75 mm.

The prevailing wind direction from June to August is southern, while from December to February it is southwestern. The average monthly wind speed is 2.9 m/s in April and 2.5 m/s in October.

The average temperature, relative humidity, precipitation, and snow cover data observed at the Martuni meteorological station, derived from CN 22-01-2024 "Construction Climatology", are summarized in **Tables 6-3** to **6-7**, respectively.

**Table 6-3. Average air temperature**

| Meteorological station | Average temperature by month, °C | | | | | | | | | | | | Average annual, °C | Absolute minimum, °C | Absolute maximum, °C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | | | |
| Martuni | -5.2 | -4.9 | -1.3 | 5.0 | 9.8 | 13.4 | 16.4 | 16.3 | 13.2 | 8.4 | 2.5 | -2.6 | 5.9 | -31.7 | 33.6 |

**Table 6-4. Relative humidity**

[81] https://www.arlis.am/DocumentView.aspx?DocID=188846

| Meteorological station | Air relative humidity by month, % | | | | | | | | | | | | Average annual | Humidity of the coldest month, % | | Humidity of the hottest month, % | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Average monthly | Average monthly at 3 p.m. | Average monthly | Average monthly at 3 p.m. |
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | | | | | |
| Martuni | 68 | 69 | 68 | 66 | 67 | 70 | 73 | 71 | 66 | 64 | 65 | 66 | 68 | 68 | 61 | 73 | 54 |

**Table 6-5. Precipitation**

| Meteoro-logical station | Amount of precipitation by month, mm<br>average monthly<br>daily maximum | | | | | | | | | | | | Yearly | November-March, mm | April-October, mm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | | | |
| Martuni | 27 | 31 | 47 | 59 | 74 | 69 | 46 | 31 | 32 | 43 | 38 | 25 | 522 | 168 | 354 |
| | 51 | 34 | 40 | 46 | 41 | 69 | 65 | 43 | 59 | 49 | 84 | 41 | 84 | | |

**Table 6-6. Snow cover**

| Meteoro-logical station | Snow cover | | | |
|---|---|---|---|---|
| | Maximum ten-day height, mm | The number of days with snow cover in a year | Maximum amount of water in snow, mm | Maximum depth of soil freezing, mm |
| Martuni | 75 | 103 | 151 | 114 |

**Table 6-7. Wind**

| Monitoring station | Months | Repeatability, %<br>Average velocity, m/s, in directions | | | | | | | | Tranquility repeatability, % | Average monthly velocity, m/s | Prevailing direction in June-August | Minimum average velocity among the directions in July, m/s | The prevailing direction in December-February | Minimum average velocity among the directions in January, m/s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Northern | North-Eastern | Eastern | South-Eastern | Eastern | South-Western | Western | North-Western | | | | | | |
| Martuni | January | 5 | 1 | 1 | 2 | 49 | 37 | 3 | 2 | 85 | 3.7 | Southern | 1.7 | South-Western | 4.0 |
| | | 1.7 | 1.7 | 1.6 | 2.2 | 3.6 | 4.0 | 2.4 | 2.2 | | | | | | |
| | April | 11 | 5 | 3 | 2 | 40 | 30 | 5 | 4 | 78 | 2.9 | | | | |
| | | 1.9 | 2.0 | 1.7 | 2.2 | 3.4 | 3.8 | 2.4 | 2.0 | | | | | | |
| | July | 30 | 12 | 4 | 1 | 20 | 17 | 5 | 11 | 71 | 1.6 | | | | |
| | | 2.0 | 2.1 | 1.8 | 1.5 | 1.7 | 1.9 | 1.8 | 2.0 | | | | | | |
| | October | 9 | 5 | 2 | 2 | 40 | 35 | 4 | 3 | 83 | 2.5 | | | | |
| | | 1.8 | 1.7 | 1.6 | 1.7 | 2.6 | 3.1 | 2.3 | 1.9 | | | | | | |

### 6.1.7 Climate Risk Profile

Background

According to the Armenia's Fourth National Communication on Climate Change (2020)[82] over the past decades a significant increase in temperature has been observed in Armenia. Particularly, over

[82] https://unfccc.int/sites/default/files/resource/NC4_Armenia_.pdf

the period of 1929-1996, the annual mean temperature increased by 0.4ºC, during 1929-2007 - by 0.85ºC, during 1929-2012 - by 1.03ºC, and during 1929-2016 - by 1.23ºC. The ambient air temperature change has had different trends in different seasons. During the period of 1966-2016, the average summer temperature increased by about 1.3ºC; moreover, extremely hot summers were observed in Armenia within the last 20 years of the last century.

During the period of 1935-1996, the average annual precipitation decreased by 6% and in 1935-2016 - by about 9%. The spatial distribution of precipitation is quite irregular. During the period of 1935-2016 the climate in the north, south and central regions of the country has become more arid, while precipitations have increased in the Shirak plain, in the Lake Sevan basin and in Aparan-Hrazdan regions.

The frequency and intensity of natural disasters has increased significantly. Over the period of 1975-2016, the total number of observed hazardous phenomena increased by about 40 cases, as compared to the average of 1961-1990 (168 cases). The highest number of hailstorms was observed in the Shirak plain, the maximum number of cases with heavy rainfall occurred in Tashir and Ijevan regions, and frosts - in the Ararat valley and foothill regions. According to drought indices, the number of days with strong and very strong droughts during the period of 2000-2017 increased by 33 days, as compared to the 1961-1990 average (87). In recent years, the upper boundary of the drought zone has expanded and includes mountainous areas, with an earlier timed start of drought.

Climate change scenarios for Armenia

The results of the CCSM4[83] Global Climate Model used and reported in the NC3[84] were reviewed for the projection of changes in air temperature and atmospheric precipitation, as well as high resolution METRAS (12×12 km) regional climate model was applied.

The average annual temperature across the territory of Armenia is projected to increase by up to 1.6ºC by 2040, by 3.3ºC - by 2070 and by 4.7ºC - by 2100, relative to the baseline annual average (5.5ºC) for 1961-1990. As for atmospheric precipitations, these are projected to decline by up to 2.7% by 2040, 5.4% - by 2070 and 8.3% - by 2100, relative to the baseline annual average (592 mm) for 1961-1990.

The projected climate change is expected to have negative effects on the country's water resources, energy, agriculture, ecosystems, human health, settlements and infra structures, as well as a number of other climate-sensitive sectors, including tourism.

Water resources

**River flow.** Analysis of water resources vulnerability in Armenia was carried out using the CCSM4 model data with the emission scenarios of RCP8.5[85] and RCP6.0, as well as the METRAS model with the RCP8.5 scenario. The vulnerability of the river flow to climate change varies across different river basins, due to the differences in natural and climatic conditions of the basins, and the various factors that impact on the flow formation. The vulnerability of the annual river flow assessed with the above-mentioned climate models and scenarios for 2040, 2070 and 2100 are summarized in **Table 6-8**.

[83]CCSM4 - Community Climate System Model, version 4
[84]NC3 - Third National Communication
[85]RCP - Representative Concentration Pathway

**Table 6-8. Vulnerability of the river flow to climate change in Armenia**

| Scenario | Time period | River flow studied, mln. $m^3$ | Change in flow | |
|---|---|---|---|---|
| | | | mln. $m^3$ | % |
| CCSM4 RCP6.0 | 1961-1990 | 6,279.9 | 0 | 0 |
| | 2011-2040 | 5,760.4 | -519.5 | -8.27 |
| | 2041-2070 | 5,450.5 | -829.4 | -13.2 |
| | 2071-2100 | 5,037.9 | -1,242.0 | -19.8 |
| CCSM4 RCP8.5 | 2011-2040 | 5,513.5 | -766.4 | -12.2 |
| | 2041-2070 | 5,148.2 | -1,131.7 | -18.0 |
| | 2071-2100 | 4,165.1 | -2,114.8 | -33.7 |
| METRAS RCP8.5 | 2011-2040 | 5,433.4 | -846.5 | -13.5 |
| | 2041-2070 | 4,547.9 | -1,732.0 | -27.6 |
| | 2071-2100 | 3,832.0 | -2,447.9 | -39.0 |

**Lake Sevan.** The assessment of the water balance of Lake Sevan under the predicted climate change scenarios was implemented through a multifactor correlation analysis of the annual inflow into the Lake and multi annual observation data of atmospheric precipitation and air temperature at the meteorological stations of the basin. Based on the RCP8.5 and RCP6.0 emission scenarios used with the CCSM4 climate model and the RCP8.5 scenario used with the METRAS model, changes in the river inflow into the Lake Sevan for 2040, 2070 and 2100 were projected (**Table 6-9**).

**Table 6-9. Projection of the Lake Sevan water balance elements**

| Scenario | Time period | River flow, mln. $m^3$ | Precipitation, mln. $m^3$ | Evaporation, mln. $m^3$ |
|---|---|---|---|---|
| CCSM4 RCP6.0 | 1961-1990 | 783.8 | 503.9 | 1074.5 |
| | 2011-2040 | 712.6 | 519.0 | 1194.9 |
| | 2041-2070 | 681.6 | 513.9 | 1246.2 |
| | 2071-2100 | 646.4 | 524.0 | 1316.9 |
| CCSM4 RCP8.5 | 2011-2040 | 693.7 | 508.9 | 1203.3 |
| | 2041-2070 | 648.0 | 529.1 | 1326.0 |
| | 2071-2100 | 552.8 | 513.9 | 1467.1 |
| METRAS RCP8.5 | 2011-2040 | 687.5 | 488.7 | 1186.1 |
| | 2041-2070 | 597.0 | 478.7 | 1335.4 |
| | 2071-2100 | 519.0 | 463.6 | 1467.1 |

The analysis of climate change scenarios shows a negative impact for the Lake's habitat; and under the pessimistic scenario a decrease in the total river inflow into Lake Sevan by about 34% (265 mln. $m^3$) by 2100 is projected. In addition to the anthropogenic impact, the quality of the Lake water is significantly affected by climate change. Along with the air and water temperature increase, the biomass of phytoplankton in the Lake is increasing, which leads to an abrupt deterioration of the Lake's water quality and the acceleration of eutrophication processes.

**Reservoirs.** The vulnerability of the river inflow during spring (April-June) months was estimated for the strategically significant reservoirs - Akhuryan, Aparan, Azat and Marmarik, for 2040, 2070, and 2100. The impact of climate change on the river inflow into the reservoirs during spring will be particularly significant for the Akhuryan and Marmarik reservoirs. Based on the assessment by the METRAS model and the RCP8.5 scenario, a decrease of around 60% can be projected for the river inflow during the spring months in 2100.

Agriculture

The vulnerability of the agriculture sector to natural hazards is relatively high, and it considerably varies across land zones and specific crops. It is more evident in low-lying and medium-altitude zones in the country. About 80% of the territory of Armenia is exposed to various degrees of desertification, which is not only the consequence of anthropogenic activity, but is also affected by natural factors, such as water and wind erosion of soils, hot dry spells, drought, lack of humidity, landslides, natural salinization, alkalization, etc. Climate change, along with various anthropogenic phenomena, contributes to the vulnerability of organic carbon reserves in soils. According to climate change forecasts for Armenia over the next 100 years, the following changes are expected in the field of agriculture:

- Decrease in the level of soil moisture by 10-30%, decrease in soil moisture provision for various agricultural crops by 7-13%,
- Shortage of water for irrigation, increase of soil water deficit by 25-30%,
- Reduced productivity of irrigated land by about 24%,
- Degradation of lands and natural pastures; decrease in overall pasture area and productivity by 4-10% by 2030, decrease in pasture yield by 7-10%, decrease in fodder production volumes,
- Crop yield decline by 8-14% by 2030.

Hailstorms, frosts, heat waves, and drought have a particularly significant impact on the loss of agricultural crop yields due to hazardous hydrometeorological phenomena. In recent years, annual damage caused to agriculture by drought, hail, floods, spring frosts and mudflows has been estimated at about 15-30 billion AMD. In particular, the largest share in the damage caused is attributable to hailstorms. According to climate change scenarios, the frequency of thunderstorms and weather fluctuations accompanied by hailstorms is likely to increase in spring and summer.

### 6.1.8 Soil

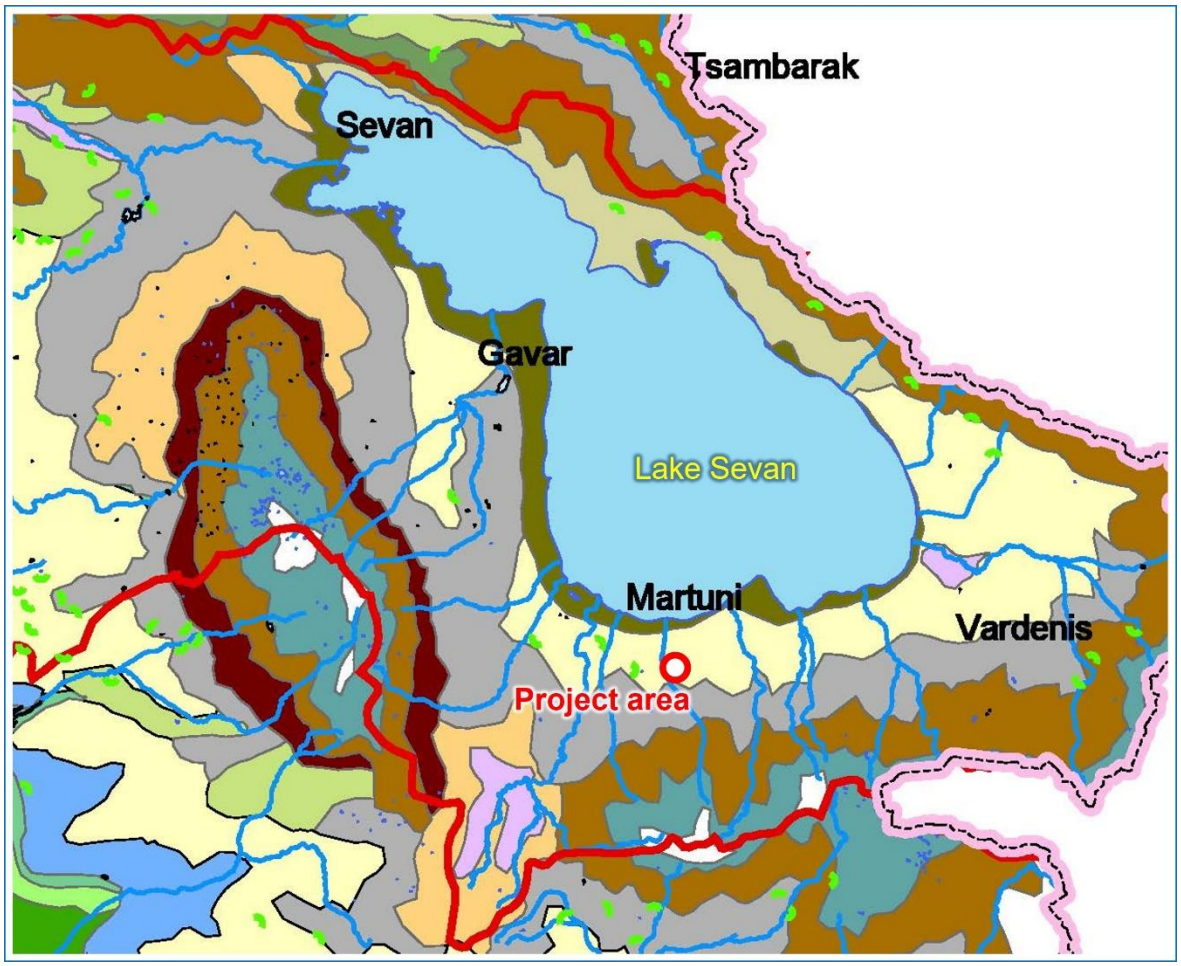
The Project region has the following soil types (**Figure 6-7**), as per the Water Resources Atlas of Armenia:

- Lake Sevan's outcropped bottomlands (form a narrow belt contouring the lake),
- Mountain-fulvous soils of dry steppes,
- Mountainous carbonated and black soils of moderately humid steppes.

During the national EIA study, samples of soil were taken from the area of planned Astghadzor reservoir in May 2024. Soil samples were analysed using the ISO 17294-2:2016 standard method at the accredited laboratory of the "Hydrometeorology and Monitoring Centre" SNCO. Results of the soil analyses compared to the Admissible Concentration Limits (ACL) for chemical elements in soil set out in the Sanitary Rules and Norms №2.1.7.003-10 "Hygienic requirements for soil quality"[86] are given in **Table 6-10**.

[86] https://www.arlis.am/DocumentView.aspx?docid=146741

**Figure 6-7. Map of soil types in the Project region**




Source: Water Resources Atlas of Armenia, Yerevan, 2008

Շագանակագույն լեռնա-անտառային հողեր չոր անտառներով և թփուտներով / Brown mountainous-forest soils of dry forests and bushes
Շագանակագույն լեռնա-անտառային հողեր չափավոր խոնավ անտառներով / Brown mountainous-forest soils of moderately humid forests
Տեղ-տեղ անալիացված լեռնային սևահողեր խոնավ տափաստաններով / Desalinated here and there fat mountainous black soils of humid steppes
Գորշ անտառային տեղ-տեղ գիպս պարունակող հողեր և աղուտներ / Gray mountainous here and there gypsiferous & saline soils
Գիպս պարունակող և տեղ-տեղ գունավորված աղուտներ / Gypsiferous and here and there saline colored soils
Սևանա լճի բուսազուրկ հատակային հողեր / Lake Sevan's outcropped bottomlands
Մարգագետնային աղուտներ և ալկալի հողեր / Meadow saline lands and alkali soils
Մարգագետնային – ճահճային հողեր / Meadow-marshy soils
Լեռնային գորշադեղնավուն հողեր չոր տափաստաններով / Mountain-fulvous soils of dry steppes
Լեռնային ածխածնային և սևահողեր չափավոր խոնավ տափաստաններով / Mountainous carbonated and black soils of moderately humid steppes

**Table 6-10. Concentrations of chemical elements in soil samples taken from the Project site compared with the Armenian ACLs**

| № | Chemical elements | Unit | Results of analysis | ACL of chemicals in soil |
|---|---|---|---|---|
| 1 | Lithium | mg/kg | 0.0219 | - |
| 2 | Beryllium | mg/kg | 0.00317 | - |
| 3 | Boron | mg/kg | 0.0468 | - |
| 4 | Sodium | mg/kg | 21.3 | - |
| 5 | Magnesium | mg/kg | 2.97 | - |
| 6 | Aluminium | mg/kg | 39.5 | - |
| 7 | Total phosphorus | mg/kg | 1.96 | - |

| № | Chemical elements | Unit | Results of analysis | ACL of chemicals in soil |
|---|---|---|---|---|
| 8 | Potassium | mg/kg | 15.5 | - |
| 9 | Calcium | mg/kg | 16.3 | - |
| 10 | Titanium | mg/kg | 5.11 | - |
| 11 | Vanadium | mg/kg | 0.117 | 150 |
| 12 | Chrome | mg/kg | 0.0677 | 6 |
| 13 | Iron | mg/kg | 32.9 | - |
| 14 | Manganese | mg/kg | 0.571 | 1500 |
| 15 | Cobalt | mg/kg | 0.0223 | 5 |
| 16 | Nickel | mg/kg | 0.0584 | 4 |
| 17 | Copper | mg/kg | 0.0583 | 3 |
| 18 | Zinc | mg/kg | 0.0939 | 23 |
| 19 | Arsenic | mg/kg | 0.00802 | 2 |
| 20 | Selenium | mg/kg | 0.00813 | - |
| 21 | Strontium | mg/kg | 0.271 | - |
| 22 | Molybdenum | mg/kg | 0.000974 | - |
| 23 | Cadmium | mg/kg | 0.000315 | - |
| 24 | Tin | mg/kg | 0.000523 | - |
| 25 | Antimony | mg/kg | 0.0004 | 4. 5 |
| 26 | Barium | mg/kg | 0.259 | - |
| 27 | Lead | mg/kg | 0.0101 | 32 |
| 28 | Bismuth | mg/kg | 0.000117 | |
| 29 | Uranium | mg/kg | 0.00087 | |

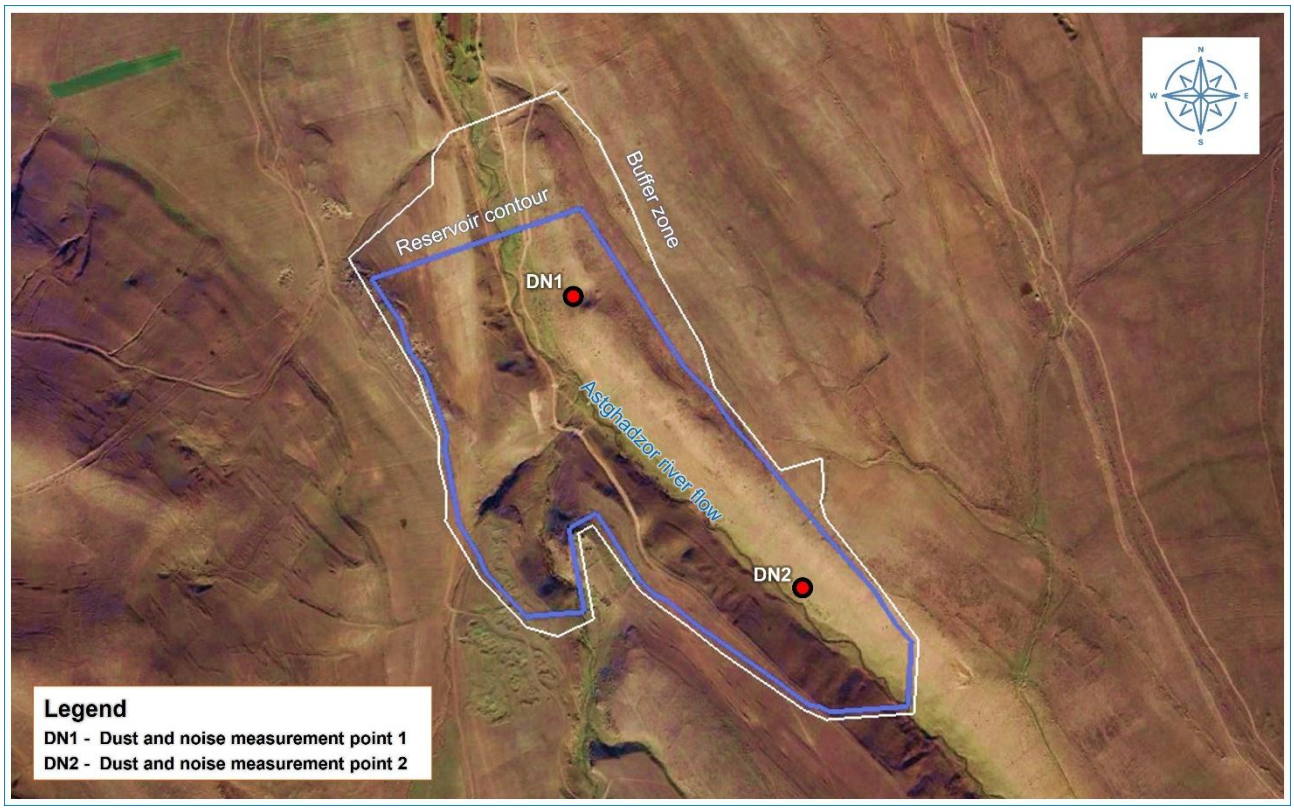
The concentrations of none of the chemical elements in the soil sample exceed the ACLs set by national sanitary rules and norms.

### 6.1.9 Ambient Air Quality

There are no industrial facilities operating in the Project region. Consequently, the Hydrometeorology and Monitoring Centre does not monitor air quality in the rural settlements of Astghadzor and Zolaqar or their surrounding areas. The main sources of gaseous emissions are agricultural machinery and occasional vehicle traffic; however, their impact on air quality is not considered significant. Dust emissions (PM2.5 and PM10) may occur during land cultivation and as a result of vehicle movement. Currently, dust concentrations are negligible, but are expected to increase significantly during earthworks (excavation activities).

During the national EIA study, instrumental measurements of dust (PM2.5 and PM10) concentrations as well as eqivalent and maximum noise levels were performed. The map indicating dust and noise measurement points is presented in **Figure 6-8**.

**Figure 6-8. Dust (PM2.5 and PM10) and noise measurement points**




PM2.5 and PM10 instrumental measurements are carried out during the daytime. Duration of each measurement was 20 minutes. The results of the PM2.5 and PM10 are provided in **Table 6-11**. Ambient air quality standards for residential areas in Armenia are set by RA Government Decree №160-N and the World Health Organization's (WHO) Air Quality Guidelines - Global Update 2021.

**Table 6-11. The results of PM2.5 and PM10 instrumental measurements**

| Point | | Dust actual concentrations, mg/m³ | Maximum permissible concentration (MPC) for dust, mg/m³ | | |
|---|---|---|---|---|---|
| | | | Daily average | Maximum value | IFC/WHO[87] (24 hours) |
| Point: DN1 | PM2.5 | 0.008 | 0.035 | 0.16 | 0.025 |
| | PM10 | 0.009 | 0.06 | 0.3 | 0.05 |
| Point: DN2 | PM2.5 | 0.006 | 0.035 | 0.16 | 0.025 |
| | PM10 | 0.009 | 0.06 | 0.3 | 0.05 |

The conclusion is that the actual concentrations of PM2.5 and PM10 within the Project area are below the MPC established by both national standards and IFC/WHO guidelines.

[87]IFC refers to the World Health Organization (WHO). Air Quality Guidelines Global Update, 2021

### 6.1.10 Noise and Vibration

Threshold Limit Values (TLVs) for equivalent (average) and maximum noise/sound levels set by the RA Sanitary Norms №2-III-11.3 "Noise in the workplaces, in residential and public buildings and housing in construction areas"[88] are comparable with the IFC Environmental, Health, and Safety General Guidelines (2007)[89] and WHO Guidelines for Community Noise (1999). The national TLVs and IFC/WHO guidelines for noise are presented in **Table 6-12**.

**Table 6-12. Threshold limit values (TLV) for noise**

| № | Premises and territories, receptors | | TLV, dBA | | |
|---|---|---|---|---|---|
| | | | National | | IFC/WHO |
| | | | Equivalent to sound level | Maximum sound level | One hour equivalent sound level |
| 1 | Workplace | | 80 | | 85 |
| 2 | Shops, trading halls, airport and railway stations waiting rooms, drop-off points of public service providers | | 60 | 75 | |
| | Industrial, commercial | | | | 70 |
| 3 | Territories adjacent to residential buildings, clinics, ambulatories, rest houses, care homes, disabled persons homes, libraries, kinder gardens, schools and other educational facilities | day-time[90] | 55 | 70 | 55 |
| | | night-time[91] | 45 | 60 | 45 |

No man-made sources of noise or vibration were observed in the Project area. Equivalent and maximum noise levels were measured during the national EIA study. The results of the noise measurements are compared with the TLVs established by Sanitary Norms №2-III-11.3; and are summarized in **Table 6-13**.

**Table 6-13. Equivalent and maximum noise measurement results (baseline)**

| Noise № | Sound levels, dB(A) | | Threshold limit value, dB(A) | | |
|---|---|---|---|---|---|
| | | | National | | IFC standards night-time/day-time |
| | Equivalent to sound level, Leq | Maximum sound level, Lmax | Equivalent to sound level | Maximum sound level | |
| DN1 | 52.5 | 56.9 | * | * | * |
| DN2 | 50.8 | 55.6 | * | * | * |

**there are no sensitive receptors near the locations where the noise measurements were conducted; therefore, the TLVs are not presented in the table above*

Before the commencement of construction works, the construction contractor will conduct instrumental noise and vibration measurements, at a minimum in the settlements of Astghadzor and Zolaqar, to establish a baseline against which the impact of project implementation on sensitive receptors will be regularly assessed and mitigated, if necessary (see **Sub-section 8.2.10**). Increased traffic along the communal roads of Astghadzor and Zolaqar villages is also expected to cause some nuisance to residents.

[88] https://www.arlis.am/hy/acts/163246
[89] https://www.ifc.org/content/dam/ifc/doc/2000/2007-general-ehs-guidelines-en.pdf
[90] between 07:00 and 23:00
[91] between 23:00 and 07:00

### 6.1.11 Natural Hazards

Armenia is prone to several natural hazards due to its geological, topographical, and climatic conditions. Here are the main natural hazards typical to Armenia:

1. **Earthquakes**
   - Armenia is located in a seismically active zone (part of the Alpine-Himalayan seismic belt).
   - Strong earthquakes have historically caused significant damage (e.g., the 1988 Spitak earthquake).
   - Earthquake risk is high in northern and central parts of the country.
2. **Landslides**
   - Common in mountainous and hilly areas, especially where there is deforestation, road construction, or heavy rainfall.
   - Southern and northeastern regions are particularly vulnerable.
3. **Floods and Flash Floods**
   - Caused by intense rainfall, rapid snowmelt, or dam breaches.
   - More frequent in spring and early summer.
   - Rivers like the Arpa, Debed, and Vorotan can flood surrounding areas.
4. **Mudflows (Debris flows)**
   - Occur in mountainous river valleys, especially during heavy rains.
   - Common in the Lori, Tavush, Syunik, and Vayots Dzor regions.
5. **Droughts**
   - Particularly affect the Ararat Valley and other agricultural regions.
   - Reduced water availability impacts farming and hydropower.
6. **Hailstorms**
   - Can occur during spring and summer, causing severe damage to crops.
   - Agriculture in regions like Armavir, Ararat, and Shirak is often affected.

## 6.2 Biological Environment

### 6.2.1 Biodiversity

The biodiversity baseline presented in this section is based on key findings of the national EIA report for the Astghadzor Reservoir, including data from field surveys conducted in April-May 2024. These findings are further supplemented by the results of additional studies, including field surveys carried out in spring-summer 2025.

### 6.2.2 Vegetation and Flora

*Methods*

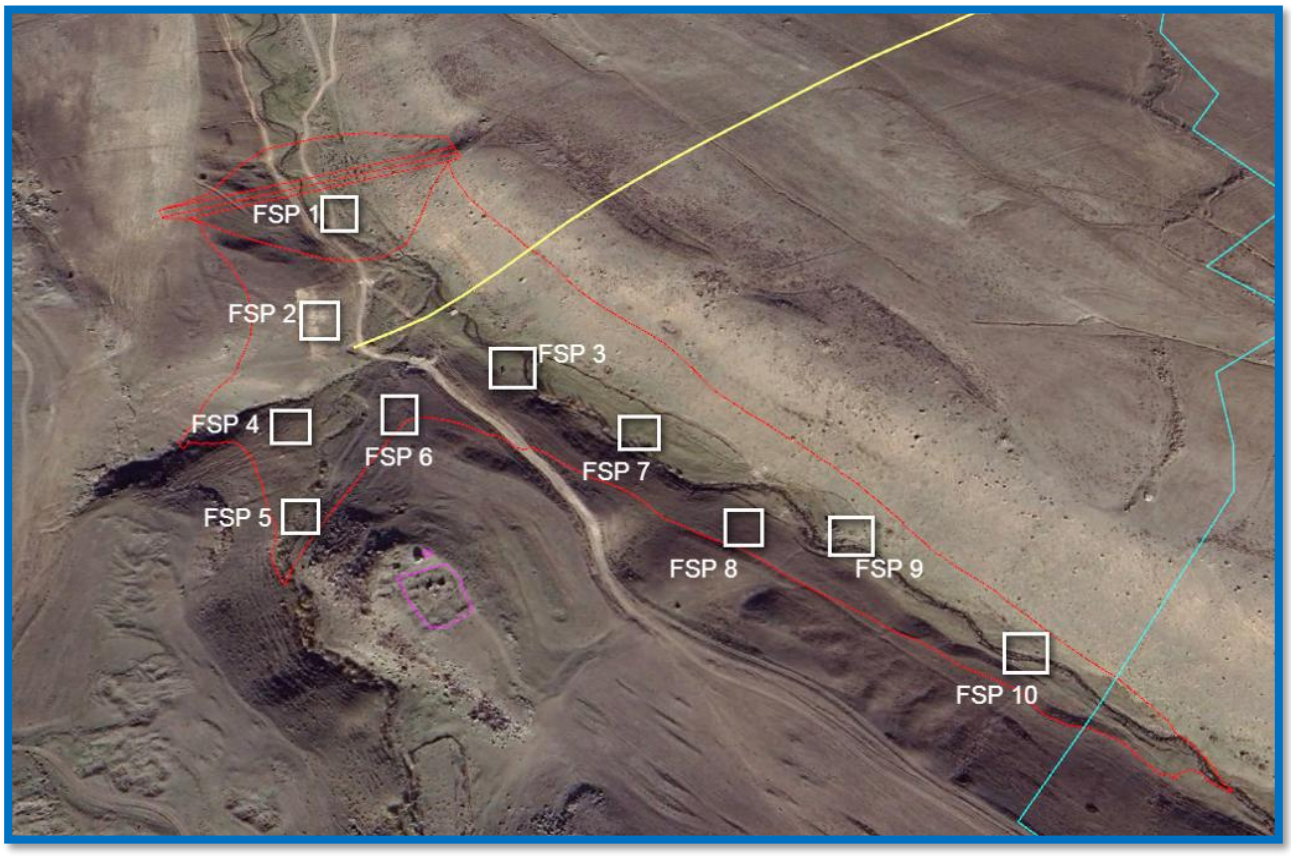
The types of vegetation within the Project-affected area were determined and categorized based on the results of field surveys conducted under the national EIA.

The surveys employed itinerary and semi-stationary geospatial research methods. The study area was divided into sampling plots based on the main biotopes, taking into account the site's terrain and landscape features. A total of 10 flora sampling plots (FSPs), each measuring 100 × 100 meters, were established (see **Figure 6-9**). A complete inventory of plant species was carried out in each FSP, with all habitats and plant species documented and digitally photographed.

Most plant species were identified visually during field surveys. Species requiring laboratory identification were collected, preserved in herbariums, and subsequently analyzed. Vegetation descriptions were developed based on these surveys.

The flora study focused on identifying the diversity of higher vascular plants. Species identification was guided by the Flora of Armenia book (11 volumes, 1954-2009). Scientific plant names are presented in accordance with S. Tcherepanov's manual (Tcherepanov, 1995).

**Figure 6-9. Flora sampling areas**




*Vegetation types*

Based on the floristic divisions by A.L. Takhtajyan (1954), the proposed site for the Astghadzor reservoir falls within the Sevan floristic region. The site is situated in the concave valley of the Astghadzor River, in the Gegharkunik Marz, at an elevation ranging from about 2,100 to 2,165 meters above sea level (asl).

The vegetation primarily consists of meadow-steppe with a prevalence of sedges and grasses (**Figure 6-10**). Intrazonal vegetation includes riparian, and limited instances of dendroflora (**Figure 6-11**). The canyon slopes, being stony in parts, host petrophilic vegetation **(Figure 6-12**). Additionally, the area features scrubs of meadowsweets and burnet roses.

**Figure 6-10. The view of the Astghadzor River valley: grassy, meadow-grassy grasslands and subalpine vegetation**

**Figure 6-11. The view of the Astghadzor River valley: intrazonal riparian vegetation**

**Figure 6-12. The view of the Astghadzor River valley: petrofilic vegetation**

*Flora*

Species of the higher vascular plants found in the Project area are listed in **Table 6-14**. The flora is presented by 87 species of 27 families.

**Table 6-14. List of plant species registered in the study area**

| Family (in brackets - number of species) | Field sampling plots | Latin name of species |
|---|---|---|
| Asteraceae (14) | FSP 1;5;7 | Artemisia absinthium L. |
| | FSP 4;6;8 | Erigeron acer L. |
| | FSP 1;7 | Anthemis triumfettii (L.) All. |
| | FSP 2;3 | Achillea millefolium L. |
| | FSP 1;2;9 | Serratula radiata (Waldst. et Kit.) |
| | FSP 3 | Tanacetum vulgare L. |
| | FSP3 | Solidago virgaurea L. |
| | FSP3;6 | Leucanthemum vulgare L. |
| | FSP6;8 | Cirsium cosmelii (Adam) Fisch. ex Hohen. |
| | FSP 6 | Cirsium ciliatum (Murray) Moench) |
| | FSP4;8 | Cirsium incanum (S.G. Gmel.) Fisch. ex Bieb. |

| Family (in brackets - number of species) | Field sampling plots | Latin name of species |
|---|---|---|
| | FSP 1; 6 | Hieracium umbellatum L. |
| | FSP 2; 9 | Hieracium murorum L. |
| | FSP 4; 7 | Cichorium intybus L. |
| Fabaceae (6) | FSP 3 | Coronilla varia L. |
| | FSP 3; 10 | Trifolium pretense L. |
| | FSP 8 | Trifolium trichocephalum M.Bieb. |
| | FSP 6; 8 | Lotus caucasicus Kupr. |
| | FSP 1; 7; 8 | Medicago sativa L. |
| | FSP 7 | Medicago corulea Less. |
| Lamiaceae (10) | FSP 2; 9 | Sideritis montana L. |
| | FSP 2; 9 | Teucrium polium L. |
| | FSP 10 | Salvia nemorosa L. |
| | FSP 1 | Salvia verticillata L. |
| | FSP 2; 9 | Tymus rariflorus K.Koch |
| | FSP 9; 10 | Stachys iberica M. Bieb. |
| | FSP 8; 9 | Origanum vulgare L. |
| | FSP 1 | Ziziphota clinopodioides Lam. |
| | FSP 1; 4 | Nepeta mussinii Spreng. |
| | FSP 3; 10 | Mentha longifolia (L.) L. |
| Poaceae (13) | FSP 1; 4; 8 | Bromus japonicus subsp. anatolicus ( Boiss. & Heldr.) Penzes) |
| | FSP 6 | Trisetum flavescens (L.) P. Beayv |
| | FSP 1; 6 | Poa pratensis L. |
| | FSP 4 | Poa trivialis L. |
| | FSP 4; 5 | Phleum phleoides (L.) Karst |
| | FSP 5; 8 | Phleum alpinum L. |
| | FSP 8 | (M.Bieb.) P. Beauv. |
| | FSP 1; 7 | Festuca pratensis Huds. |
| | FSP 1 | Dactylis glomerata L. |
| | FSP 3 | Calamagrostis arundinacea (L.) Roth |
| | FSP 9 | Secale montanum Guss. |
| | FSP 6; 9 | Koeleria kurdica Ujhelyi |
| | FSP 10 | Phragmites australis (Cav.) Trin. |
| Rosaceae (7) | FSP 5 | Rosa spinosissima L. |
| | FSP 5; 9 | Poterium polygamum Waldst. Et Kit. |
| | FSP 6 | Sanguisorba officinalis L. |
| | FSP 8 | Alchemilla caucasica Buser. |
| | FSP 8 | Potentilla crantzii (Crantz) G. Beck ex Fritsch |
| | FSP 5 | Cotoneaster integerrima Medik. |

| Family (in brackets - number of species) | Field sampling plots | Latin name of species |
|---|---|---|
| | FSP 5 | Spiraea crenata L. |
| Dipsacaceae (3) | FSP 5; 8 | Scabiosa bipinnata K.Koch |
| | FSP 8 | Scabiosa caucasica M.Bieb. |
| | FSP 10 | Cephalaria gigantea (Ledeb.) Bobr. |
| Polygonaceae (1) | FSP 3 | Rumex crispus L. |
| Boraginaceae (1) | FSP 4 | Cerinthe minor L. |
| Euphorbiaceae (1) | FSP 6 | Euphorbia iberica Boiss. |
| Brassicaceae (3) | FSP 7 | Sisimbrium loeselii L. |
| | FSP 1; 5 | Rorippa islandica (Oeder) Borbas |
| | FSP 5 | Alyssum tortuosum Willd. |
| Primulaceae (2) | FSP 4; 6 | Primula veris subsp. macrocalyx (Bunge) Ludi |
| | FSP 7 | Androsace villosa L. |
| Hypericaceae (1) | FSP 8 | Hypericum scabrum L. |
| Caryiphyllaceae (2) | FSP 6; 8 | Arenaria dianthoides Smith |
| | FSP 1 | Silene multifida (Ad.) Rohrb. |
| Apiaceae (2) | FSP 1; 4 | Eryngium billardieri Delar. |
| | FSP 5; 8 | Chaeriphyllum macrospermum (Willd. ex Spreng.) Fisch. et C.A. Meyer |
| Scrophulariaceae (3) | FSP 5 | Veronica hispidula Boiss. et Huet |
| | FSP 6; 8 | Verbascum flavidum (Boiss.) Freyn et Bornm. |
| | FSP 8 | Euphrasia pectinata Ten. |
| Convolvulaceae (1) | FSP 6 | Convolvulus arvensis L. |
| Rubiaceae (2) | FSP 5 | Galium verum L. |
| | FSP 1; 5 | Asperula prostrata (Adams) K.Koch |
| Ranunculaceae (1) | FSP 7 | Thalictrum minus L. |
| Gentianaceae (1) | FSP 8 | Gentiana gelida M.Bieb. |
| Papaveraceae (1) | FSP 7 | Papaver fugax Poir. |
| Plantaginaceae (2) | FSP 3; 10 | Plantago major L. |
| | FSP 3 | Plantago media L. |
| Campanulaceae (2) | FSP 4 | Asyneuma campanuloides Bieb. ex Sims |
| | FSP 7 | Campanula stevenii Bieb. |
| Juncaceae (1) | FSP 3; 10 | Juncus inflexus L. |
| Salicaceae (2) | FSP 10 | Salix caprea L. |
| | FSP 3; 10 | Populus nigra var italica Duroi. |
| Onagraceae (2) | FSP 3 | Epilobium nervosum Boiss. et Buhse |
| | FSP 3 | Epilobium hirsutum L. |
| Cyperaceae (1) | FSP 10 | Carex acutiformis Ehrh. |
| Crassulaceae (2) | FSP 2; 9 | Sedum oppositifolium Sims |
| | FSP 9 | Sedum gracile |

In the Sevan floristic region, a total of 48 plant species listed in the RA Red Book[92] have been registered. Among these, the vicinity of the proposed Astghadzor reservoir hosts significant biodiversity species such as Caryophyllaceae, *Dianthus grosheimii* Schischk. - classified as Endangered (EN) and Greenland dense (Potomagetonaceae, *Groenlandia densa* (L.) Fourr. - also classified as Endangered (EN).

*Dianthus grosheimii*, commonly known as Clove Grosheim, is typically found in the upper mountain zones. It thrives on rocky slopes, mountain steppes, and meadows. According to the records from the A.L. Takhtajyan Institute of Botany's archives, the *Dianthus grossheimii* plant species was collected from the Vardenants Mountain Pass, near the Orbelyans' lodge, as well as from the Airija (Argichi) area.

*Groenlandia densa* or Greenland dense, primarily grows in the upper mountain and subalpine zones. It is adapted to the freshwater environments of lakes and slow-flowing rivers. According to archival data from the A.L. Takhtajyan Institute of Botany, Greenland dense flora (*Groenlandia densa*) has historically been collected from several locations, including the area approximately 25 km from the city of Martuni towards the Vardenants Pass, the Argichi River basin, and the vicinities of Madina and Lichk settlements.

Neither of these plant species was observed in the immediate area or vicinity of the planned Astghadzor Reservoir during recent field surveys. This confirms, based on a comparison of available literature and herbarium specimens, that no plant species requiring special protection or classified as endangered, vulnerable, or critically endangered in the national Red Book or the IUCN Red List are currently present within the area designated for the reservoir construction.

### 6.2.3 Fauna

#### Terrestrial mammals

*Methods*

The data from the previous studies conducted in the area, and the available scientific information related to the region was used during the desktop research, and included articles, reports, and collections of the Armenian Institute of Zoology. Namely, it covered the literature materials at our disposal (Dal 1954, Geptner et al. 1967, Martirosyan & Papanian 1983, Bibikov 1985, Agadzhanyan 1986,1993, Kasabyan 1986, 2001,2014, Popov 2003, Avagyan 2010, RA Red Book (1987, 2010), and the preliminary data for the Emerald network in the RA (2016)).

During the national EIA field trips to the Project site, all signs of the animals presence were registered (including footprints, holes, visually seen excrements etc.); in addition some mammals were observed by chance.

*Results*

Based on the abovementioned sets of data, the list of mammalian species that are found or expected to be found in the area is provided below (**Table 6-15**).

**Table 6-15. Mammalian species of the study area**

| № | Latin name | Armenian name | English name | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| Erinacedae | | | | | | | | |

[92]The Red Book (second edition of 2010) includes the Red Book of Animals and Red Book of Plants, are together called the Red Book in this ESIA

| № | Latin name | Armenian name | English name | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| 1 | *Erinaceus concolor* | Սպիտակափորն ոզնի | Southern white-breasted hedgehog | + | - | | | |
| | | | Soricidae | | | | | |
| 2 | *Crocidura leucodon* | Սպիտակապօր սպիտակատամ | Bicolored shrew | + | + | | | |
| | | | Leporidae | | | | | |
| 3 | *Lepus europaeus* | Նապաստակ | European hare | + | + | | | |
| | | | Mustelidae | | | | | |
| 4 | *Martes foina* | Քարակզաքիս | Beech marten | + | + | | | |
| 5 | *Mustela nivalis* | Աքիս | Least weasel | + | + | | | |
| 6 | *Meles meles* | Գորշուկ | Badger | + | + | | | |
| | | | Canidae | | | | | |
| 7 | *Canis lupus (LC)* | Գայլ | Gray wolf | + | + | + | + | + |
| 8 | *Vulpes vulpes* | Սովորական աղվես | Red fox | + | + | | | |
| | | | Allactagidae | | | | | |
| 9 | *Allactaga euphratica* | Լեռնային | Williams's jerboa | + | - | | | |
| | | | Cricetidae | | | | | |
| 10 | *Cricetulus migratorius* | Մոխրագույն համստերիկ | Gray dwarf hamster | + | - | | | |
| 11 | *Microtus arvalis* | Սովորական դաշտամուկ | Common vole | + | + | | | |
| 12 | *Chionomys nivalis* | Ձնային դաշտամուկ | Snow Vole | + | + | | | |
| | | | Gerbillidae | | | | | |
| 13 | *Meriones sp.* | ավազամուկ ? | Jird, species unknown | + | - | | | |
| | | | Muridae | | | | | |
| 14 | *Sylvaemus uralensis* | Փոքր անտառային մուկ | Ural field mouse | + | + | | | |

**Keys to Table 6-16**

**Column titles:**
1- Information from various sources
2 - Data from field studies
3 - Resolution 6 of Bern Convention
4 - Annex II of the Habitats Directive
5- Annex IV of the Habitats Directive

**Signs:**
+ listed or registered
- not registered
no sign - not listed

**Conservation status** (in - IUCN Red List):
LC - Least Concern

As shown in **Table 6-15**, the area is home to 14 mammal species belonging to 9 families. During the field studies, presence of 10 species was confirmed through animal visual observations or traces of vital activity. These were mainly representatives of the predator group. Red fox and Gray wolf footprints were found at the reservoir site and around; they used the area as a transit route or entered it for a short time, apparently in search of food. Small species such as Stone Marten and Least Weasel were directly observed in the reservoir area. Hares were encountered both in the reservoir area and around.

No species are listed in the RA Red Book; Grey wolf is listed in the IUCN Red list, Category "Least Concern".

Of the 14 identified species, one (Gray wolf) is classified as Priority Biodiversity Features under EBRD PR6, Criterion 12(i), as this is listed in Resolution 6 of the Bern Convention, and Annex II of

the EU Habitats Directive (see **Table 6-15**). This species is also qualified as Critical Habitat under EBRD PR6, Criterion 14(ii), as the species is listed in Annex IV of the EU Habitats Directive.

**Birds**

*Methods*

Data collection included the methods of transect count and count of breeding pairs.

Transect counts were conducted along routes that were 200 m long and 200 m wide (extending 100 m on each side of the central line). The counts were carried out from 6:00 to 11:00, during which most uniformly distributed species are active.

The count of breeding pairs of large-ranged and colonial species was implemented opportunistically when such species appeared. In such cases, the breeding behaviour of the species was observed to identify the highest possible breeding code (Voříšek et al. 2008).

Data processing included visualization of the bird community in the form of a table that also shows priority species and estimation of their abundance. The priority species are those listed either in the RA Red Book, in the IUCN Red List, in the Resolution 6 of the Bern Convention, in the Annex I of EU Birds Directive, or are considered Restricted Range species[93].

Estimation of the abundance of uniformly distributed species was done through computation of their density per one ha and multiplication of the density on the area of typical habitat. The estimation of abundance of large-ranged and colonial species was done through the direct count of breeding pairs (pairs with high breeding codes).

*Results*

The bird's diversity of the study area is presented in **Table 6-16** below and includes 95 species. Among those, there are 32 bird species, which breed in the area, 9 species, which breed in proximity to the site and use the area as a part of their foraging range, and 54 species which pass the area during the seasonal migration.

Among breeding birds, one species is listed in the RA Red Book (2010), and three species are included in the Resolution No.6 of the Bern Convention, and in Annex 1 of the EU Birds Directive

Among large-ranged birds, which use the area as a part of their foraging range in the breeding season, there are three species listed in the RA Red Book and one species included in the Resolution No. 6 of the Bern Convention, and in Annex 1 of the EU Birds Directive.

Among migratory and wintering birds, which use the area for stopover (to get a rest) or foraging in non-breeding period, there are 19 species listed in the RA Red Book, and 22 species included in the Resolution No. 6 of the Bern Convention, and in Annex 1 of the EU Birds Directive.

From the 95 identified species, 33 species are assessed as the Priority Biodiversity Features (PBF) according to the EBRD PR6 criterion 12: namely, 29 species are listed in the Resolution No. 6 of Bern Convention and Annex I of the EU Birds Directive, three species are considered "significant biodiversity features" by a broad set of stakeholders or governments (and listed in the RA Red Book, category "Vulnerable"), and one species, *Phylloscopus sindianus*, as regularly occurring range-restricted species (**Table 6-16**).

[93]For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an extent of occurrence (EoO) of less than 50,000 km$^2$. Source: Guidance Notes to the EBRD PR 6 (March, 2023)

**Table 6-16. Bird species of the Astghadzor site area**

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ardeidae** | | | | | | | | | | | | |
| 1 | Սպիտակ փոքր տառեղ | Little Egret | *Egretta garzetta* | B - regular | Migratory | ind | 10-30 | LC | | + | + | |
| 2 | Եգիպտական տառեղ | Cattle Egret | *Bubulcus ibis* | B - regular | Migratory | ind | 20-50 | LC | | | | |
| **Ciconiidae** | | | | | | | | | | | | |
| 3 | Սև արագիլ | Black Stork | *Ciconia nigra* | B - regular | Migratory | ind | 3-7 | LC | EN | + | + | |
| **Anatidae** | | | | | | | | | | | | |
| 4 | Կարմիր բադ | Ruddy Shelduck | *Tadorna ferruginea* | B - regular | Migratory | ind | 5-15 | LC | VU | + | + | |
| 5 | Մոխրագույն բադ | Gadwall | *Mareca strepera* | Yr - regular | Migratory | ind | 3-10 | | | | | |
| 6 | Կռնչան բադ | Mallard | *Anas platyrhynchos* | Yr - regular | Migratory | ind | 10-30 | | | | | |
| **Accipitridae** | | | | | | | | | | | | |
| 7 | Կրետակեր | European Honey-buzzard | *Pernis apivorus* | B - regular | Migratory | ind | 3000-7000 | LC | | + | + | |
| 8 | Սև ցին | Black Kite | *Milvus migrans* | Yr - regular | Migratory | ind | 1000-3000 | LC | | + | + | |
| 9 | Օձակեր արծիվ | Short-toed Snake-eagle | *Circaetus gallicus* | B - regular | Migratory | ind | 10-50 | LC | VU | + | + | |
| 10 | Դաշտային մկնաճուռակ | Hen Harrier | *Circus cyaneus* | W - regular | Migratory | ind | 20-70 | LC | | + | + | |
| 11 | Մարգագետնային մկնաճուռակ | Montagu's Harrier | *Circus pygargus* | B - regular | Migratory | ind | 300-900 | LC | VU | + | + | |
| 12 | Տափաստանային մկնաճուռակ | Pallid Harrier | *Circus macrourus* | M - regular | Migratory | ind | 60-100 | NT | VU | + | + | |
| 13 | Ճահճային մկնաճուռակ | Marsh Harrier | *Circus aeruginosus* | Yr - regular | Migratory | ind | 200-600 | LC | | + | + | |
| 14 | Մորուքավոր անգղ | Lammergeier | *Gypaetus barbatus* | Yr - regular | Foraging | ind | 1-2 | NT | VU | + | + | |
| 15 | Սպիտակագլուխ անգղ | Griffon Vulture | *Gyps fulvus* | Yr - regular | Foraging | ind | 3-30 | LC | VU | + | + | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | Գիշանգղ | Egyptian Vulture | *Neophron percnopterus* | B - regular | Migratory | ind | 10-20 | EN | EN | + | + | |
| 17 | Տափաստանային արծիվ | Steppe Eagle | *Aquila nipalensis* | M - regular | Migratory | ind | 1000-2000 | EN | VU | + | + | |
| 18 | Գերեզմանարծիվ | Imperial Eagle | *Aquila heliaca* | M - regular | Migratory | ind | 5-20 | VU | EN | + | + | |
| 19 | Քարարծիվ | Golden Eagle | *Aquila chrysaetos* | Yr - regular | Foraging | ind | 1-2 | LC | VU | + | + | |
| 20 | Փոքր ենթաարծիվ | Lesser Spotted Eagle | *Clanga pomarina* | B - regular | Migratory | ind | 2000-3000 | LC | VU | + | + | |
| 21 | Գաճաճ արծիվ | Booted Eagle | *Hieraaetus pennatus* | B - regular | Migratory | ind | 600-1000 | LC | VU | + | + | |
| 22 | Լորաճուռակ | Eurasian Sparrowhawk | *Accipiter nisus* | Yr - regular | Migratory | ind | 200-300 | LC | | | | |
| 23 | Եվրոպական ճնճղաճուռակ | Levant Sparrowhawk | *Tachyspiza brevipes* | B - regular | Migratory | ind | 100-200 | LC | VU | + | + | |
| 24 | Մեծ ճուռակ | Eurasian Buzzard | *Buteo buteo* | B - regular | Migratory | ind | 5000-8000 | LC | | | | |
| 25 | Տափաստանային ճուռակ | Long-legged Buzzard | *Buteo rufinus* | Yr - regular | Foraging | ind | 700-1500 | LC | | + | + | |
| **Falconidae** | | | | | | | | | | | | |
| 26 | Սովորական հողմավար բազե | Common Kestrel | *Falco tinnunculus* | Yr - regular | Foraging | ind | 20-30 | LC | | | | |
| 27 | Տափաստանային հողմավար բազե | Lesser Kestrel | *Falco naumanni* | B - regular | Migratory | ind | 500-1300 | LC | VU | + | + | |
| 28 | Արտույտաբազե | Hobby | *Falco subbuteo* | B - regular | Migratory | ind | 30-70 | LC | | | | |
| 29 | Սապսան | Peregrine Falcon | *Falco peregrinus* | Yr - regular | Migratory | ind | 5-15 | LC | VU | + | + | |
| **Phasianidae** | | | | | | | | | | | | |
| 30 | Լոր | Common Quail | *Coturnix coturnix* | B - regular | Breeding | | | | | | | |
| 31 | Մոխրագույն կաքավ | Grey Partridge | *Perdix perdix* | Yr - regular | Breeding | | | | | | | |
| **Rallidae** | | | | | | | | | | | | |
| 32 | Մարգահավ | Corncrake | *Crex crex* | B - regular | Breeding | pair | 1-2 | LC | VU | + | + | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gruidae** | | | | | | | | | | | | |
| 33 | Մոխրագույն կռունկ | Common Crane | *Grus grus* | M - regular | Migratory | ind | 200-500 | LC | | + | + | |
| 34 | Գեղանի կռունկ | Demoiselle Crane | *Anthropoides virgo* | M - regular | Migratory | ind | 3000-6000 | LC | VU | + | + | |
| **Charadriidae** | | | | | | | | | | | | |
| 35 | Փոքր քարադր | Little Ringed Plover | *Charadrius dubius* | B - regular | Migratory | | | | | | | |
| **Tringidae** | | | | | | | | | | | | |
| 36 | Սպիտակավիզ կտցար | Common Sandpiper | *Actitis hypoleucos* | B - regular | Breeding | | | | | | | |
| **Laridae** | | | | | | | | | | | | |
| 37 | Հայկական որոր | Armenian Gull | *Larus armenicus* | B - regular | Migratory | ind | 20-50 | LC | VU | | | |
| **Columbidae** | | | | | | | | | | | | |
| 38 | Թխակապույտ աղավնի | Rock Pigeon | *Columba livia* | Yr - regular | Foraging | | | | | | | |
| 39 | Անտառային աղավնի | Common Woodpigeon | *Columba palumbus* | Yr - regular | Foraging | | | | | | | |
| **Strigidae** | | | | | | | | | | | | |
| 40 | Տնային բվիկ | Little Owl | *Athene noctua* | Yr - regular | Breeding | | | | | | | |
| **Apodidae** | | | | | | | | | | | | |
| 41 | Սև մանգաղաթև | Common Swift | *Apus apus* | B - regular | Breeding | | | | | | | |
| **Meropidae** | | | | | | | | | | | | |
| 42 | Ոսկեգույն մեղվակեր | European Bee-eater | *Merops apiaster* | B - regular | Breeding | | | | | | | |
| 43 | Ներկարար | European Roller | *Coracias garrulus* | B - regular | Breeding | ind | 10-20 | LC | VU | + | + | |
| **Upupidae** | | | | | | | | | | | | |
| 44 | Հոպոպ | Eurasian Hoopoe | *Upupa epops* | B - regular | Breeding | | | | | | | |
| **Alaudidae** | | | | | | | | | | | | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | Դաշտային արտույտ | Eurasian Skylark | *Alauda arvensis* | B - regular | Breeding | | | | | | | |
| 46 | Եղջրավոր արտույտ | Horned Lark | *Eremophila alpestris* | Yr - regular | Breeding | | | | | | | |
| **Hirundinidae** | | | | | | | | | | | | |
| 47 | Ժայռային ծիծեռնակ | Eurasian Crag-martin | *Hirundo rupestris* | B - regular | Migratory | | | | | | | |
| 48 | Առափնյա ծիծեռնակ | Sand Martin | *Riparia riparia* | B - regular | Migratory | | | | | | | |
| 49 | Գյուղական ծիծեռնակ | Barn Swallow | *Hirundo rustica* | B - regular | Foraging | | | | | | | |
| 50 | Քաղաքային ծիծեռնակ | House Martin | *Delichon urbica* | B - regular | Migratory | | | | | | | |
| **Motacillidae** | | | | | | | | | | | | |
| 51 | Դեղին խաղտտնիկ | Yellow Wagtail | *Motacilla flava* | B - regular | Migratory | | | | | | | |
| 52 | Դեղնագլուխ խաղտտնիկ | Citrine Wagtail | *Motacilla citreola* | B - regular | Migratory | ind | 5-30 | LC | VU | | | |
| 53 | Լեռնային խաղտտնիկ | Grey Wagtail | *Motacilla cinerea* | Yr - regular | Breeding | | | | | | | |
| 54 | Սպիտակ խաղտտնիկ | White Wagtail | *Motacilla alba* | Yr - regular | Breeding | | | | | | | |
| 55 | Անտառային ձիաթռչնակ | Tree Pipit | *Anthus trivialis* | B - regular | Migratory | | | | | | | |
| 56 | Լեռնային ձիուկ | Water Pipit | *Anthus spinoletta* | B - regular | Breeding | | | | | | | |
| **Muscicapidae** | | | | | | | | | | | | |
| 57 | Մոխրագույն ճանճորս | Spotted Flycatcher | *Muscicapa striata* | B - regular | Migratory | | | | | | | |
| 58 | Սևուկ կարմրատուտ | Black Redstart | *Phoenicurus ochruros* | B - regular | Breeding | | | | | | | |
| 59 | Մարգագետնային չքչքան | Whinchat | *Saxicola rubetra* | B - regular | Breeding | | | | | | | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 60 | Սիբիրյան սևագլուխ չքչքան | Siberian Stonechat | *Saxicola maurus* | B - regular | Migratory | | | | | | | |
| 61 | Եվրոպական սևագլուխ չքչքան | European Stonechat | *Saxicola rubicola* | B - regular | Migratory | | | | | | | |
| 62 | Սովորական քարաթռչնակ | Northern Wheatear | *Oenanthe oenanthe* | B - regular | Breeding | | | | | | | |
| 63 | Խայտաբղետ քարակեռնեխ | Rufous-tailed Rock-thrush | *Monticola saxatilis* | B - regular | Breeding | | | | | | | |
| **Turdidae** | | | | | | | | | | | | |
| 64 | Սև կեռնեխ | Eurasian Blackbird | *Turdus merula* | Yr - regular | Breeding | | | | | | | |
| 65 | Սոսնձակեռնեխ | Mistle Thrush | *Turdus viscivorus* | Yr - regular | Migratory | | | | | | | |
| 66 | Սպիտակախածի կեռնեխ | Ring Ouzel | *Turdus torquatus* | Yr - regular | Breeding | | | | | | | |
| **Scotocercidae** | | | | | | | | | | | | |
| 67 | Լայնապոչ եղեգնաթռչնակ | Cetti's Warbler | *Cettia cetti* | Yr - regular | Migratory | | | | | | | |
| **Acrocephalidae** | | | | | | | | | | | | |
| 68 | Ճահճային եղեգնաթռչնակ | Marsh Warbler | *Acrocephalus pallustris* | B - regular | Breeding | | | | | | | |
| **Sylviidae** | | | | | | | | | | | | |
| 69 | Մոխրագույն շահրիկ | Greater Whitethroat | *Curruca communis* | B - regular | Breeding | | | | | | | |
| **Phylloscopidae** | | | | | | | | | | | | |
| 70 | Կովկասյան գեղգեղիկ | Mountain Chiffchaff | *Phylloscopus sindianus* | B - regular | Migratory | ind | 5-15 | LC | | | | + |
| 71 | Ծնկլտան գեղգեղիկ | Common Chiffchaff | *Phylloscopus collybita* | B - regular | Migratory | | | | | | | |
| 72 | Գարնանային գեղգեղիկ | Willow Warbler | *Phylloscopus trochilus* | M - regular | Migratory | | | | | | | |
| **Paridae** | | | | | | | | | | | | |
| 73 | Մեծ երաշտահավ | Great Tit | *Parus major* | Yr - regular | Migratory | | | | | | | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74 | Մեծ երաշտահավ | Great Tit | *Parus major* | Yr - regular | Migratory | | | | | | | |
| **Laniidae** | | | | | | | | | | | | |
| 75 | Ժուլան | Red-backed Shrike | *Lanius collurio* | B - regular | Breeding | pair | 2-3 | LC | | + | + | |
| 76 | Սևաճակատ շամփրուկ | Lesser Grey Shrike | *Lanius minor* | B - regular | Migratory | ind | 300-800 | LC | | + | + | |
| **Corvidae** | | | | | | | | | | | | |
| 77 | Անտառային կաչաղակ | Eurasian Jay | *Garrulus glandarius* | Yr - regular | Migratory | | | | | | | |
| 78 | Սովորական կաչաղակ | Black-billed Magpie | *Pica pica* | Yr - regular | Breeding | | | | | | | |
| 79 | Սերմնաքաղ | Rook | *Corvus frugilegus* | Yr - regular | Breeding | | | | | | | |
| 80 | Մոխրագույն ագռավ | Hooded Crow | *Corvus corone* | Yr - regular | Breeding | | | | | | | |
| 81 | Սև ագռավ | Common Raven | *Corvus corax* | Yr - regular | Breeding | | | | | | | |
| **Sturnidae** | | | | | | | | | | | | |
| 82 | Սովորական սարյակ | Common Starling | *Sturnus vulgaris* | Yr - regular | Migratory | | | | | | | |
| **Passeridae** | | | | | | | | | | | | |
| 83 | Տնային ճնճղուկ | House Sparrow | *Passer domesticus* | Yr - regular | Migratory | | | | | | | |
| 84 | Ձյան ճնճղուկ | White-winged Snowfinch | *Montifringilla nivalis* | Yr - regular | Migratory | | | | | | | |
| 85 | Ժայռային ճնճղուկ | Rock Sparrow | *Petronia petronia* | Yr - regular | Breeding | | | | | | | |
| **Fringillidae** | | | | | | | | | | | | |
| 86 | Ամուրիկ | Eurasian Chaffinch | *Fringilla coelebs* | Yr - regular | Migratory | | | | | | | |
| 87 | Կարմրակատար | European Goldfinch | *Carduelis carduelis* | Yr - regular | Migratory | | | | | | | |
| 88 | Ազնվասարեկ | Eurasian Siskin | *Carduelis spinus* | Yr - regular | Migratory | | | | | | | |
| 89 | Կանեփնուկ | Eurasian Linnet | *Carduelis cannabina* | Yr - regular | Breeding | | | | | | | |
| 90 | Լեռնային վշասարեկ | Twite | *Carduelis flavirostris* | Yr - regular | Breeding | | | | | | | |

| № | Armenian names | English names | Scientific names | Occurrence Status in Armenia | Occurrence Status in Project site | Unit | Number | IUCN | RDB RA | Bern Res6 | BD Annex 1 | RR species |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 91 | Սովորական ոսպնուկ | Common Rosefinch | *Carpodacus erythrinus* | Yr - regular | Breeding | | | | | | | |
| 92 | Կարմրաթև ոսպնուկ | Crimson-winged Finch | *Rhodopechys sanguineus* | Yr - regular | Migratory | ind | 60-150 | LC | VU | | | |
| **Emberizidae** | | | | | | | | | | | | |
| 93 | Լեռնային դրախտապան | Rock Bunting | *Emberiza cia* | Yr - regular | Breeding | | | | | | | |
| 94 | Այգու դրախտապան | Ortolan Bunting | *Emberiza hortulana* | B - regular | Breeding | pair | 2-3 | LC | | + | + | |
| 95 | Կորեկնուկ | Corn Bunting | *Emberiza calandra* | Yr - regular | Breeding | | | | | | | |

***Keys to the Table 6-16:***

**Column titles**

- IUCN - status in IUCN Red List
- RDB RA - status in the RA Red Book
- Bern Res6 - presence in Resolution 6 of Bern Convention
- BD Annex 1 - presence in Annex 1 of the EU Bird Directive
- RR - Restricted Range species

**Occurrence status**

- Yr - regular - year-round resident
- B - regular - resident in breeding season
- M - regular - regular migrant

**Conservation status**

- EN - Endangered
- VU - Vulnerable
- NT - Near Threatened
- LC - Least Concern
- DD - Data Deficient

**Units**

- ind - number of individuals
- pair - number of breeding pairs

**Signs**

"+" listed

no sign - no data or not listed

### Amphibians and Reptiles

*Methods*

Data from previous studies conducted in the area, along with other available scientific information related to the region, were used during the desktop research. This included articles, reports, and collections from the Armenian Institute of Zoology. Additionally, data from the national EIA report (including field survey results) were also considered. During the field survey, reptiles and amphibians were observed visually. Reptiles were also searched for under stones, while amphibians were additionally surveyed using acoustic methods.

*Results*

The list of reptiles and amphibians presented in **Table 6-17**.

**Table 6-17. Reptiles and Amphibians of the study area**

| № | Latin name | Armenian name | English name | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|---|
| **Reptilia** | | | | | | | | |
| **Lacertidae** | | | | | | | | |
| 1 | *Darevskia valentini* | Վալենտինի մողես | Valentin's lizard | + | + | | | |
| 2 | *Darevskia nairensis* | Նաիրյան մողես | Darevskia nairensis | + | - | | | |
| 3 | *Lacerta strigata* | Բծավոր մողես | Caucasus emerald lizard | + | + | | | |
| **Colubridae** | | | | | | | | |
| 4 | *Natrix natrix* | Սովորական լորտու | Grass snake | + | - | | | |
| 5 | *Natrix tessellata* | Ջրային լորտու | Dice snake | + | + | | + | |
| **Viperidae** | | | | | | | | |
| 6 | *Vipera(Pelias) eriwanensis* | Հայկական լեռնատափաստանային իժ | Armenian steppe viper | + | + | NT/ VU | | + |
| **Amphibia** | | | | | | | | |
| **Bufonidae** | | | | | | | | |
| 7 | *Bufo viridis* | Կանաչ դոդոշ | European green toad | + | + | | + | + |
| 8 | *Rana ridibunda* | Լճագորտ | Marsh frog | + | + | | | |
| **Ranidae** | | | | | | | | |
| 9 | *Rana macrocnemis* | Փոքրասիական գորտ | Long-legged wood frog | + | + | | | |

**Keys to the Table 6-17**

**Column titles:**
1 - Information from various sources
2 - Data from field studies
3 - IUCN Red List/Red Book of the RA
4 - Annex IV of the EU Habitats Directive
5 - Range-restricted species

**Signs:**
+ listed or registered
- not registered
no sign - not listed

**Conservation status** (in - IUCN Red List, column 3, in the RA Red Book):
NT - near threatened
VU - vulnerable

Based on the above, six species of reptiles (including three species of lizards and three species of snakes) and three species of amphibians can potentially inhabit the area. All species presented in the literary sources, except for the Grass Snake, were recorded during the fieldwork. The Green Toad is noted in the left, drier part of the area, and the Marsh Frog and the Long-legged wood frog in the wetlands immediately adjacent to the river. All species of lizard found in the area were observed in small rock formations and crevices along the slopes of the river gorge and its small tributary.

Armenian Steppe Viper (*Vipera (Pelias) eriwanensis*) is an endemic species of the Armenian Highland. It was recorded once in the ruins of an old building in the upper part of the study area. Apparently, its habitats are located above the designated area, in flatter terrain.

Of the six identified reptilian species, one species (Armenian Steppe Viper) and its habitats is qualified as the Priority Biodiversity Features (PBF) according to the EBRD PR6 criterion 12 - as regularly occurring range-restricted species; this species is also listed in the RA Red Book under the category "Vulnerable".

One repitilian species (Dice snake) and one amphibian species (European green toad) are assessed as Critical Habitat according to the EBRD PR 6 criterion 14-ii as they are listed in Annex IV of the EU Habitats Directive (**Table 6-17**).

**Ichthyofauna**

Originally, the ichthyofauna of Lake Sevan was dominated by three main species: Sevan Trout presented by four sub-species (Sevan Bream, Sevan Bullfish, Salmo ischchan aestivalis, Salmo ischchan gegarkuni), Capoeta sevangi, and Sevan barbel.

Between 1924 and 1927, *Coregonus* larvae and juveniles from Russia's Lake Chud and Lake Ladoga were introduced into Lake Sevan as part of an effort to acclimatize these species and enhance local fish production. Over the years, other fish species have also been introduced or have found their way into the Lake Sevan.

Based on historical data and recent investigations, the ichthyofauna of the Astghadzor River, particularly near the area designated for the Astghadzor Reservoir, is minimal. To verify this, surveys were conducted, involving people engaged in recreational fishing as well as specialists from the "Sevan" National Park. Reports from about 10-12 years ago indicated the presence of Sevan sturgeon (listed in the Red Book of RA) and Trout species in the river, though only in very small numbers near the Astghadzor village area, located downstream of the proposed reservoir site. However, a more recent survey conducted in April, 2024 recorded no fish species in the sections of the Astghadzor River and its tributaries that fall within the planned reservoir construction zone.

Based on these findings, it can be concluded that the construction of the Astghadzor Reservoir is unlikely to have a significant impact on fish populations in the upper reaches of the Astghadzor River. Therefore, the inclusion of fishway structures for migration in the reservoir design may not be necessary. However, it remains crucial to determine and maintain an appropriate ecological flow from the reservoir. This flow should be sufficient to support any breeding migrations of fish that enter the river from Lake Sevan up to the areas adjacent to Astghadzor village.

**Terrestrial invertebrates**

*Methods*

*Data collection* included a Pollard Walk for butterflies and an active search for visual sightings of beetles in the grass, on the ground, and under stones.

*Data processing* included visualization of the insects' community in the table form that also shows priority species. The priority species are those listed either in the RA Red Book, in the IUCN Red List, in the Resolution 6 of the Bern Convention, or are considered Restricted Range species.

*Results*

Results of the invertebrates' diversity survey are presented in **Table 6-18** and include 42 species.

**Table 6-18. Terrestrial invertebrates of the study area**

| № | Latin names | RDB AM | Regional endemic | Bern Res 6 |
|---|---|---|---|---|
| **Hesperiidae** | | | | |
| 1 | Erynnis tages | | | |
| 2 | Pyrgus melotis | | | |
| **Pieridae** | | | | |
| 3 | Anthocharis cardamines | | | |
| 4 | Pontia edusa | | | |
| 5 | Pieris pseudorapae | | | |
| 6 | Pieris brassicae | | | |
| 7 | Colias crocea | | | |
| **Lycaenidae** | | | | |
| 8 | Lycaena phlaeas | | | |
| 9 | Lycaena alciphron | | | |
| 10 | Lycaena thersamon | | | |
| 11 | Cupido osiris | | | |
| 12 | Pseudophilotes vicrama | | | |
| 13 | Aricia agestis | | | |
| 14 | Lysandra bellargus | | | |
| 15 | Lysandra corydonius | | | |
| 16 | Meleageria daphnis | | | |
| 17 | Polyommatus (icarus) icarus | | | |
| 18 | Polyommatus (Agrodiaetus) ripartii | | | |
| 19 | Polyommatus (icarus) icarus | | | |
| **Nymphalidae** | | | | |
| 20 | Lasiommata megera | | | |
| 21 | Coenonympha pamphilus | | | |
| 22 | Erebia medusa | | | |
| 23 | Coenonympha leander | | | |
| 24 | Hyponephele lycaon | | | |
| 25 | Maniola jurtina | | | |
| 26 | Hipparchia statilinus | | | |
| 27 | Arethusana arethusa | | | |
| 28 | Chazara briseis | | | |
| 29 | Vanessa atalanta | | | |
| 30 | Vanessa cardui | | | |
| 31 | Aglais urticae | | | |
| 32 | Issoria lathonia | | | |
| 33 | Argynnis aglaja | | | |
| 34 | Brenthis hecate | | | |
| 35 | Melitaea didyma | | | |
| 36 | Melitaea cinxia | | | |

| № | Latin names | RDB AM | Regional endemic | Bern Res 6 |
|---|---|---|---|---|
| **Carabidae** | | | | |
| 37 | Carabus adamsi | | | |
| 38 | Carabus maurus | | | |
| 39 | Carabus cribratus | | X | |
| 40 | Calosoma (Callisthenes) breviusculum | | | |
| 41 | Cicindela campestris | | | |
| **Cerambicidae** | | | | |
| 42 | Dorcadion scabricolle | | | |

**Keys to the Table 6-18**

**Column titles:**
RDB AM - Red Book of the RA
Regional endemic - endemic of Caucasus region
Bern Res 6 - Resolution 6 of the Bern Convention

**Signs:**
X regional endemic of listed in Resolution 6 list of the Bern Convention
no sign - not endemic or not listed

From the 42 identified species, one species is assessed as the Priority Biodiversity Feature (PBF) according to the EBRD PR6 criterion 12 (ii) - as range-restricted species of the Caucasian region.

### Habitats

Habitats identified at the Astghadzor water reservoir site are listed in **Table 6-19**. They are presented according to the habitat classification for Armenia, developed based on the EUNIS classification system. The identified habitats are assessed for overlap with those listed in Resolution No. 4 of the Bern Convention and Annex I of the EU Habitats Directive, in order to identify any Priority Biodiversity Features and Critical Habitats.

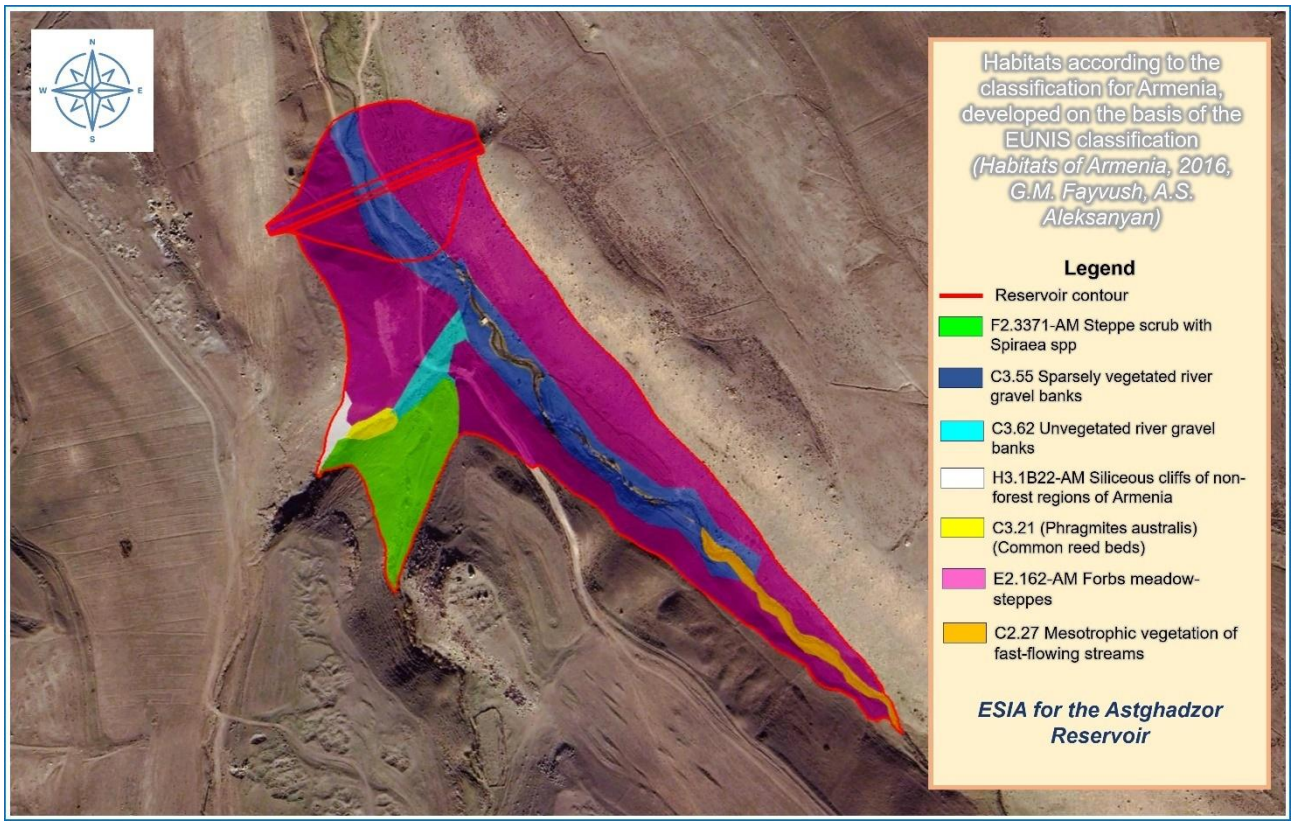
Seven habitats are identified according to the habitat classification for Armenia (**Table 6-19**).

Of the seven identified habitats, four habitats are assessed as the Priority Biodiveristy Features according to the EBRD PR 6 criterion 12-i as they are listed in Resolution No. 4 of the Bern Convention. They are following (the code and name according the Armenain classification is indicated first, but the code and name according Resolution No. 4 of the Bern Convention is indicated second, lost area is indicated in brackets):

- C2.27 Mesotrophic vegetation of fast-flowing streams = C2.27 Mesotrophic vegetation of fast-flowing streams (0.31 ha),
- C3.21 Common reed beds (Phragmites australis) = C3.2 Water fringing reedbeds and tall helophytes other than canes (0.1 ha),
- C.3.55 Sparsely vegetated river gravel banks = C3.55 Sparsely vegetated river gravel banks (1.87 ha),
- C3.62 Unvegetated river gravel banks = C3.62 Unvegetated river gravel banks (0.25 ha).

Map of the seven identified habitats in the footrpint area is shown in the **Figure 6.13**. Map of the habitat listed in Resolution No.4 of the Bern Convention is shown in the **Figure 6.14**. No habitats are listed in Annex I of the EU Habitats Directive

**Figure 6-13. Map of the habitats identified in the reservoir footprint area**




**Figer 6-14. Map of the habitats in the footrpint area listed in Resolution No.4 of the Bern Convention and Annex I of the EU Habitat Directive**

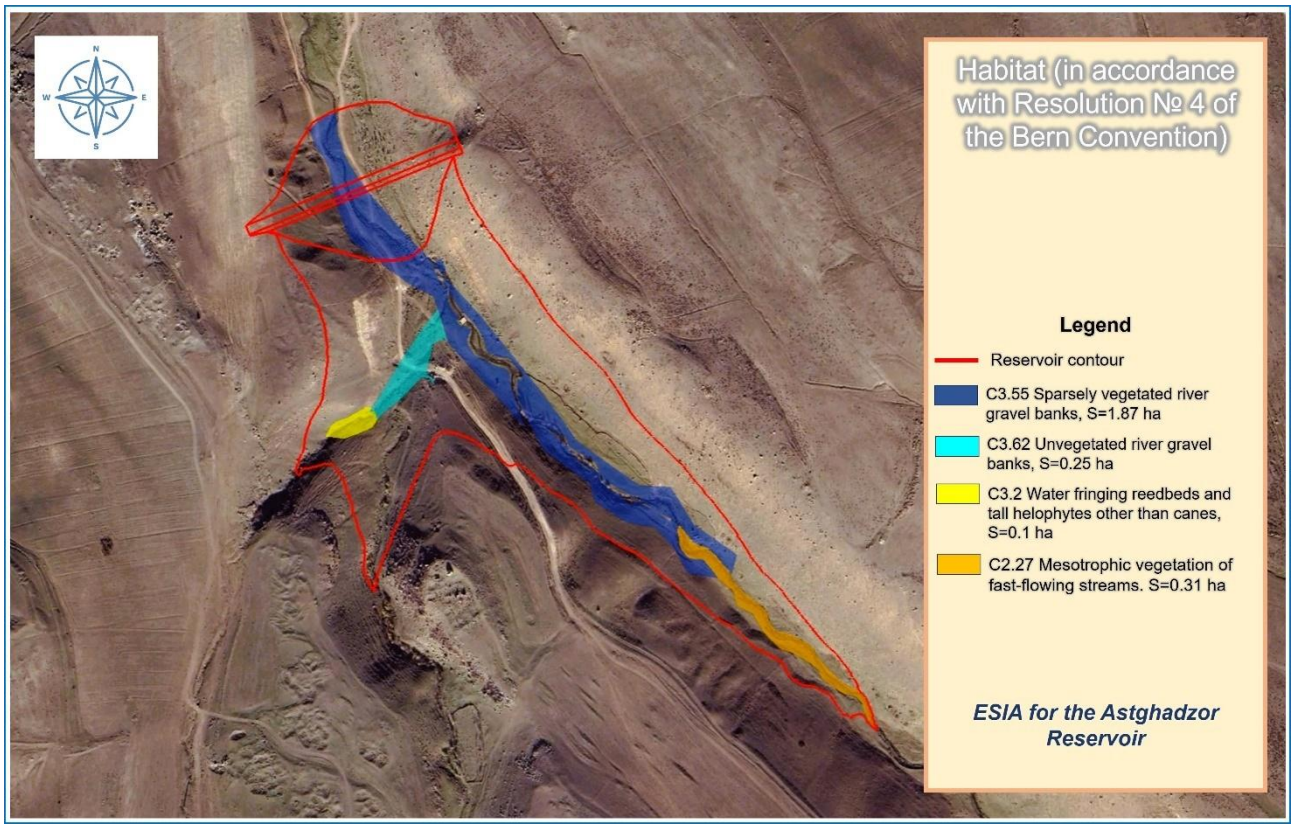


**Table 6-19. Habitats identified in the Astghadzor site area**

| Habitat according to the classification for Armenia, developed on the basis of the EUNIS classification (Habitats of Armenia, 2016, G.M. Fayvush, A.S. Aleksanyan) | | Habitat (in accordance with Resolution No. 4 of the Bern Convention) | | Habitat (in accordance with Annex 1 of the EU Habitats Directive | | Comments |
|---|---|---|---|---|---|---|
| *Code* | *Name* | *Code* | *Name* | *Code* | *Name* | |
| C2.27 | Mesotrophic vegetation of fast - flowing streams | C2.27 | Mesotrophic vegetation of fast-flowing streams | - | - | This habitat category includes the middle reaches of most major rivers, where it remains quite fast, but the concentration of trophic substances in the water increases significantly.<br>Besides this, these habitats include the middle course of small rivers flowing into Lake Sevan, the surrounding mountain ranges (Argichy, Masrik, Dzknaget, Gavaraget, etc.) |
| C3.21 | Common reed beds (Phragmites australis) | C3.2 | Water fringing reedbeds and tall helophytes other than canes | - | - | Habitats sometimes occupy large areas in watercourses or around bodies of water. Usually monodominant simple structured communities. |
| C3.55 | Sparsely vegetated river gravel banks | C3.55 | Sparsely vegetated river gravel banks | - | - | Habitats are typical in the lower reaches of some major rivers in Armenia (Arax, Arpa, Yeghegis, Debed, Agstev), and are also found along the river banks of the highlands. |
| C3.62 | Unvegetated river gravel banks | C3.62 | Unvegetated river gravel banks | - | - | Rocky areas of streams that are permanently or temporarily free of water.<br>They are found in almost all mountain rivers of Armenia when the water level increases in mid-summer |
| E2.162-AM | Forbs meadow - steppes | - | - | - | - | [Habitats are distributed wider than grass meadow–steppes, they are developed on the slopes of different steepness and orientation. Scabiosa bipinnata, Anthriscus nemorosa, Achillea setacea, Artemisia absinthium, Serratula radiata usually are dominants in these communities]. |
| F2.3371-AM | Steppe scrub with Spiraea spp. | - | - | - | - | [Habitats are good presented in Upper Akhuryan, Shirak, Lori, Aparan, Sevan, Areguni floristic regions. Spiraea |

| Habitat according to the classification for Armenia, developed on the basis of the EUNIS classification (Habitats of Armenia, 2016, G.M. Fayvush, A.S. Aleksanyan) | | Habitat (in accordance with Resolution No. 4 of the Bern Convention) | | Habitat (in accordance with Annex 1 of the EU Habitats Directive | | Comments |
|---|---|---|---|---|---|---|
| | | | | | | crenata and/or Spiraea hypericifolia usually are dominants in these communities |
| H3.1B22-AM | Siliceous cliffs of non-forest regions of Armenia | - | - | - | - | [Very common habitats in Armenia. They are represented by solely cliffs as well as big massifs and complexes of cliffs, for example canyons of mountain rivers. Astragalus aureus, Ribes orientalis, Saxifraga rupestris, Festuca valesiaca, Melica transilvanica, Asplenium septentrionale, Parietaria elliptica, Onosma sericeum, Tanacetum parthenifolium are very common in these habitats]. |

### 6.2.4 Specially Protected and Internationally Recognized Areas and Forests

*National sites*

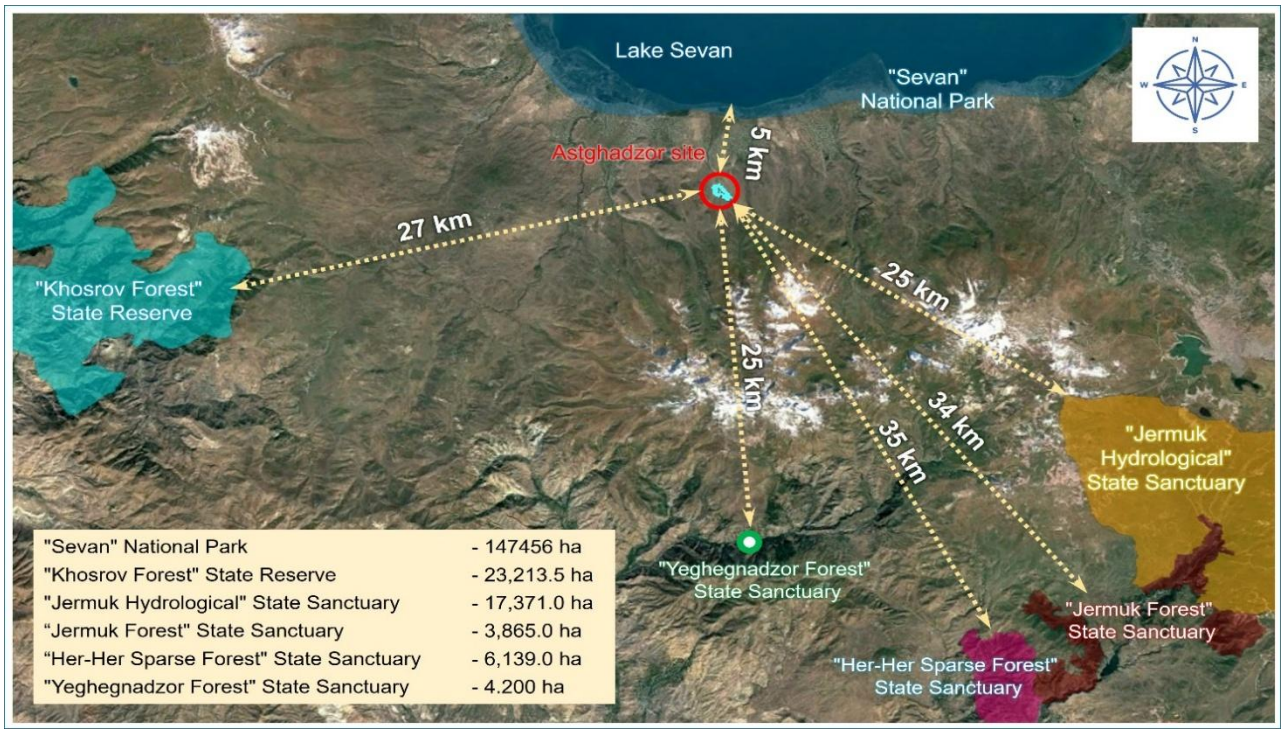
Armenia is rich in Specially Protected Areas of Nature (SPAN). There are 34 officially registered SPANs in Armenia, of which: three state reserves - Khosrov Forest, Shikahogh, and Erebuni, occupying a total area of 35,439.6 ha (1.19% of Armenia's territory); four national parks - Sevan, Dilijan, Lake Arpi, and Arevik, covering 236,802.1 ha (7.96% of the country's area); 27 state sanctuaries, and 232 natural monuments together occupying 114,812.7 ha (3.95% of Armenia's territory).

The planned Astghadzor Reservoir site does not fall within any SPAN. However, the reservoir is planned 5 km to the border of the "Sevan" National Park (**Figure 6-15**).

The "Sevan" National Park was established in 1978 by the Resolution №125, with the purpose of preserving the natural ecosystem of Lake Sevan. The Park, located in Gegharkunik Marz, covers a total of 147,343 ha, which includes the surface area of Lake Sevan as well as 22,585 ha of riparian land[94].

According to the statute of "Sevan" National Park (RA Government Resolution №927-N, dated May 30, 2002), the park's primary objectives include the scientific study of natural heritage; the protection, restoration, reproduction, registration, inventory, monitoring, and documentation of the area's natural ecosystems, landscapes, biodiversity, and natural heritage; as well as the sustainable use of the park's natural resources[95]. By Government Decision №205-N, dated January 18, 2007, the management plan for "Sevan" National Park was approved. However, since the measures outlined in the existing plan have become outdated, a new management plan has been developed under the direction of the Ministry of Environment within the framework of the UNDP “Environmental Protection of Lake Sevan” (EU4Sevan) program. Based on this updated plan, a corresponding government decision for its implementation is currently awaited.

**Figure 6-15. Location of the Project site in relation to the "Sevan" National Park**




[94]Updated ESIA of the Project, 2024
[95]Letter from the Ministry of Environment of the Republic of Armenia, from 24.06.2025, №2/16.2/7145

According to the RA Government Decree №967-N of August 14, 2008 «On Approving the List of Nature Monuments of the Republic of Armenia», there are 15 natural monuments located in Gegharkunik Marz, of which:

- Geological monuments - 7 units,
- Hydrogeological monuments - 6 units,
- Hydrographic monuments - 1 unit,
- Biological monuments - 1 unit.

These monuments are located at a long distance from the reservoir and will not be impacted negatively by its construction and operation.

*Internationally Recognized Areas*

Armenia signed the Bern Convention in 2006 and ratified in 2008. Since then, the country has worked on establishing the Emerald Network and listed more than 110 species requiring protection and habitat conservation, according to the Bern Convention Resolutions No. 4 (1994) and No. 6 (1998).

As of June 2025, Armenia had not officially adopted any Emerald Network sites. However, 23 sites within the territory of the Republic of Armenia had been officially nominated as Candidate Emerald Sites (last confirmation of the candidate sites list was done at the 44th meeting of the Standing Committee of the Convention on the Conservation of European Wildlife and Natural Habitats, December 2024)[96].

At the same time, as a reaction to the immediate challenges identified by the Ministry of Environment (MoE), the Emerald Network database was completely revised and optimized by the World Bank under the European Union for Environment (EU4Environment) Action Program[97]. The proposed set consists of 30 Emerald sites, covering 707,739.22 ha (23.8 percent of the national coverage, almost a third less than previously)[98]. But this revision was not approved yet.

The Astghadzor reservoir area is located inside the Candidate Emerald Site Sevan (AM 0000002) (**Figure 6-16**). The Candidate Emerald Site includes Lake Sevan, the largest freshwater body in Armenia, along with adjacent aquatic and terrestrial ecosystems. The area is characterized by unique hydro-ecological conditions and rich biodiversity, including endemic lake fish species, waterfowl, and a range of habitats such as semi-desert, humid, and swampy environments. The primary objectives are to preserve and restore aquatic and coastal habitats and vegetation zones, prevent ecological degradation of the lake, and ensure favorable conditions for species of international importance[99].

The site covers area of 489,839.8 ha and includes 35 habitats listed in Resolution No. 4 of the Bern Convention. It serves as habitat for 55 species listed in Resolution No. 6 of the Bern Convention , of which 43 are birds, along with 29 other important species. The area is also inhabited by actively migrating mammals such as the Gray Wolf, Brown Bear, Lynx, and Wild Goat (with footrpints of the Gray Wolf observed within and around the Project area).

Two other Candidate Emerald Sites are located at a considerable distance (25-27 km) from the reservoir site (**Figure 6-16**).

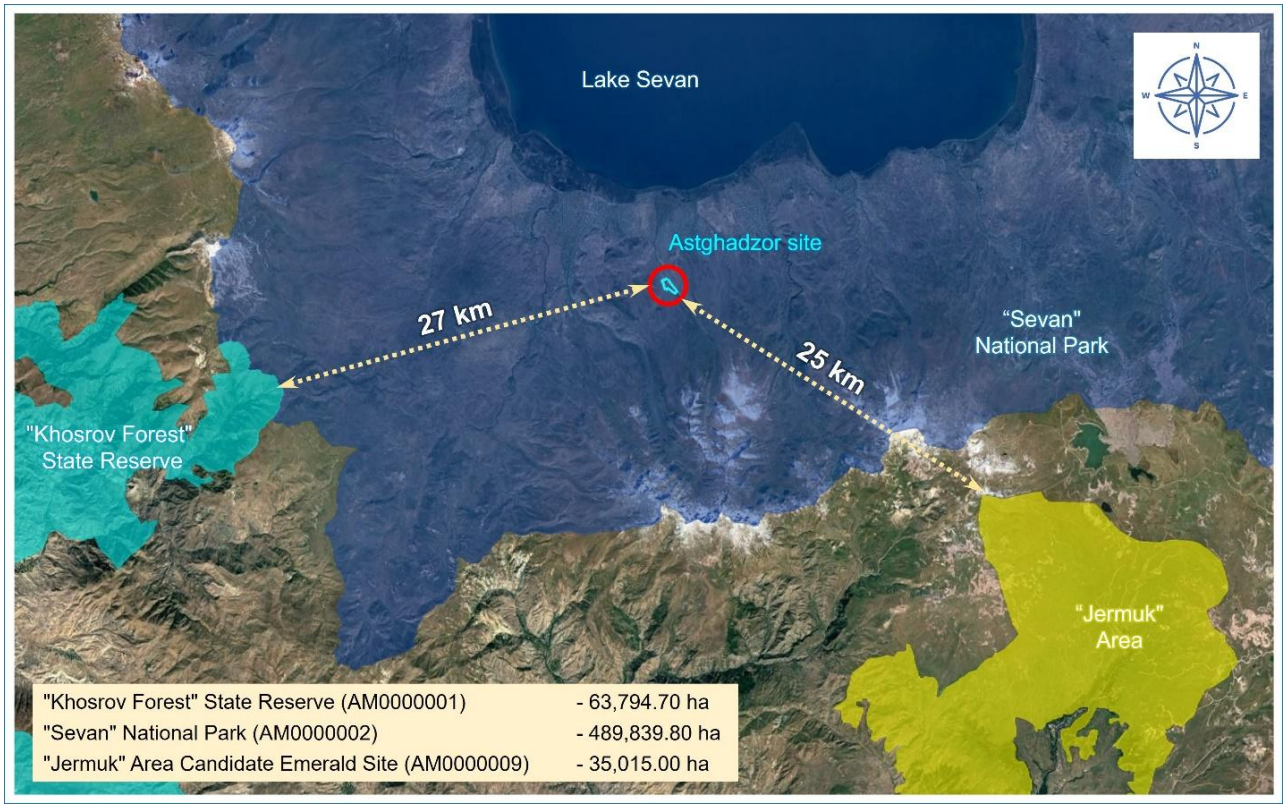
[96] https://rm.coe.int/pa18e-2024-draft-candidate-list-emerald-network-sites-2779-8956-4427-1/1680b27e33

[97] EU4Environment. 2024. Recommendations for Review of the Candidate Emerald Sites in Armenia. Washington DC: World Bank. https://www.eu4environment.org/app/uploads/2024/11/Recommendations-for-Review-of-the-Candidate-Emerald-Sites-in-Armenia.pdf

[98] Ibid

[99] Letter from the Ministry of Environment of the Repiblic of Armenia, from 24.06.2025, №2/16.2/7145

**Figure 6-16. Location of the Astghadzor Reservoir area inside the Candidate Emerald site "Sevan" National park**




The Astghadzor reservoir area is located in the vicinity (1,5 km) to the KBA/IBA - Lake Sevan and Environs (**Figure 6-17**). The IBA covers area of 154,600 ha that includes the whole area of the SPAN “Sevan” National Park and some adjacent terrestrial areas. The borders of another territory, KBA/IBA Khosrov Reserve, are located 28 km from the reservoir area.

Within the IBA Lake Sevan and Environs, three bird species meeting IBA/KBA criteria have been identified: the Armenian Gull, which breeds in the area, the Lesser White-fronted Goose, which winters there, and the Ferruginous Duck, which passes through during migration. Notably, the Armenian Gull migrates through the area of the Project site.

**Figure 6-17. Location of the Astghadzor Reservoir area in relation to the KBA/IBAs Lake Sevan and Environs and Khosrov Reserve**


### 6.2.5 Critical Habitat Assessment Findings

Among the seven habitats, 87 flora species, and 160 fauna species identified during biodiversity surveys, the following features (see **Table 6-20)** have been assessed as triggering Priority Biodiversity Feature (PBF) or Critical Habitat (CH) according to the EBRD PR6.

PBFs include four habitats (according the Bern Convention classification) and 32 species - 30 bird species, one reptile species and one invertebrate species, CHs - three species - one species of mammal, reptile and amphibia.

**Table 6-20. Summary Table of Priority Biodiversity Features and Critical Habitats Identified in the footprint area[100]**

| № | Criterion | Features (Habitats/species) |
|---|---|---|
| **Priority Biodiversity Features as per EBRD PR6 (§12)** | | |
| i | 12.i.a EAAA[101] is habitat type listed in Resolution 4 of the Bern Convention | Habitats (x4 - according the Bern Convention)<br>C2.27 Mesotrophic vegetation of fast- flowing streams (0.31 ha),<br>C3.2 Water fringing reedbeds and tall helophytes other than canes (0.1 ha)<br>C3.55 Sparsely vegetated river gravel banks (1.87 ha),<br>C3.62 Unvegetated river gravel banks (0.25 ha) |

[100]In case a species would trigger several criteria in the PBF and CH, it is listed in this table once as the highest conservation concern, which is CH.
[101]EAAA - ecologically appropriate area of analysis

| № | Criterion | Features (Habitats/species) |
|---|---|---|
| ii | 12.ii.a EAAA for species and their habitats listed in Annex II of the Habitats Directive, Annex I of the Birds Directive, or Resolution 6 of the Bern Convention | Birds (×29)<br>*Egretta garzetta (LC)*<br>*Ciconia nigra (LC)*<br>*Tadorna ferruginea (LC)*<br>*Milvus migrans (LC)*<br>*Circaetus gallicus (LC)*<br>*Circus cyaneus (LC)*<br>*Circus pygargus (LC)*<br>*Circus macrourus (NT)*<br>*Circus aeruginosus (LC)*<br>*Pernis apivorus (LC)*<br>*Gypaetus barbatus (NT)*<br>*Gyps fulvus (LC)*<br>*Neophron percnopterus (EN)*<br>*Aquila chrysaetos (LC)*<br>*Aquila nipalensis (EN)*<br>*Aquila heliacal (VU)*<br>*Clanga pomarina (LC)*<br>*Hieraaetus pennatus (LC)*<br>*Tachyspiza brevipes (LC)*<br>*Buteo rufinus (LC)*<br>*Falco naumanni (LC)*<br>*Falco peregrinus (LC)*<br>*Crex crex (LC)*<br>*Grus grus (LC)*<br>*Anthropoides virgo (LC)*<br>*Coracias garrulus (LC)*<br>*Lanius collurio* (LC)<br>*Lanius minor* (LC)<br>*Emberiza hortulana* (LC) |
| iii | 12.ii.d EAAA for regularly occurring nationally or regionally listed EN or CR species | Birds (×2, already triggering cr.12 ii.a)<br>*Neophron percnopterus (EN)*<br>*Aquila nipalensis (EN)* |
| | 12.ii.e EAAA for regularly occurring range-restricted species | Birds (×1)<br>*Phylloscopus sindianus (LC)*<br>Reptilia (×1)<br>*Vipera (Pelias) eriwanensis*<br>Insects (×1)<br>*Carabus cribratus* |
| | 12.iii Significant biodiversity features identified by a broad set of stakeholders or governments | Birds (×3, listed in the Red Book of RA as Vulnerable)<br>*Larus armenicus*<br>*Motacilla citreola*<br>*Rhodopechys sanguineus* |
| **Critical Habitats as per EBRD PR6 (§14)** | | |
| ii | 14.ii.a EAAA for species and their habitats listed in Annex IV of the Habitats Directive | Mammals (×1)<br>*Canis lupus (LC)*<br>Reptiles (×1)<br>*Natrix tessellata*<br>Amphibians (×1)<br>*Bufo viridis* |

## 6.3 Social and Socio-economic Environment

The Sub-sections below are informed by the review of primary and secondary sources, such as publications and bulletins of Statistical Committee of the RA, Martuni Community Five-Year Development Plan for 2022-2026, focus group discussion held in August 2024, interviews with the Head of Agricultural and Nature Protection Division, Head of Astghadzor village and residents of Astghadzor village held in August 2024 and ESIA Consultant's observations during the site visits.

### 6.3.1 Overview of the Project area

Gegharkunik Marz is situated in the eastern part of Armenia, surrounding Lake Sevan. It borders Lori and Tavush Marzes from the north, the Republic of Azerbaijan from the east, Vayots Dzor Marz from the south, and Kotayk and Ararat Marzes from the south-west.

Gegharkunik Marz is the largest region in the RA by total area. The longest stretch of the Marz is from the north-west to the south-east which comprises 115 km, from the west to the east - 85 km, the deepest landslide is the canyon of the Getik River (1,325 masl), the highest peak - Ajdahak Mount (3,598 masl).

Sevan national park is located within the territory of the Marz (founded in 1978). The surface area comprises 147.3 K ha, including 22.6 K ha of lakeside land territories.

Martuni community encompasses the town of Martuni and 16 surrounding villages. The area is characterized by its proximity to the Geghama and Vardenis mountain ranges.

Astghadzor Reservoir is proposed to be sited on the Astghadzor River to ensure sustainable irrigation for the agricultural lands of Astghadzor, Vaghashen, Martuni, and Zolaqar settlements of Martuni community.

Martuni town is situated on the south-western shore of Lake Sevan, approximately 40 km from the Marz's regional centre Gavar and 130 km from the capital city of Yerevan.

**Figure 6-18. Martuni town central square**

*Source: Martuni municipality official web-site*

Astghadzor village is situated downstream along the Astghadzor River, approximately 50 km (by road) southeast of Gavar town and 10 km of Martuni town. The village lies at an elevation of 2,023 masl, on a low hill about 2 km from Lake Sevan.

**Figure 6-19. View of Astghadzor rural settlement**

*Source: Astghadzor settlement Facebook page*

Zolaqar village is situated downstream along the Zolaqar River, 45 km southeast of Gavar at an elevation of 1,985 masl.

**Figure 6-20. View of Zolaqar rural settlement**

*Source: Zolaqar settlement Facebook page*

Vaghashen village is located east of Martuni town, 2 km south of Lake Sevan, at an elevation of 1,956 masl.

**Figure 6-21. View of Vaghashen rural settlement**

*Source: https://bnapahpanakan.wordpress.com*

### 6.3.2 Demography[102]

As of the beginning of 2024, the population of Gegharkunik Marz was 213,200 people, of whom around 50% were women. Population of Martuni community comprised around 42% of the total Marz's population.

The demographic data of the Project affected community and settlements is summarized in **Table 6-21**.

**Table 6-21. The demographic data of the affected community and settlements**

| Community / Settlement | Population (people) | | Women (people) | Households |
|---|---|---|---|---|
| | Registered | Actual | | |
| *Martuni community* | *89,200* | *89,000* | *44,120* | *26,208* |
| Martuni | 13,700 | 13,250 | 6,350 | 4,153 |
| Zolaqar | 6,617 | 6,585 | 3,190 | 1,758 |
| Astghadzor | 4,386 | 4,335 | 2,036 | 1,352 |
| Vaghashen | 4,052 | 4,000 | 1,925 | 1,218 |

[102]Information for this sub-section was mainly extracted from the website of Armstat's publication RA Gegharkunik Marz in figures, 2024 available at https://armstat.am/file/doc/99553373.pdf and Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

### 6.3.3 Regional and Local Economy

The leading branch of the economy of Gegharkunik Marz is agriculture, particularly cultivation of grain, potatoes, other vegetables, as well as animal husbandry. The marz is the main supplier of fresh fish in the RA. In recent years, fish stocks in Lake Sevan have been increasing, including populations of valuable fish species.

The main industrial activity in Gegharkunik Marz is the mining industry. Manufacturing also plays a significant role, with machinery, building materials, and the food industry representing the largest sectors within manufacturing.

Freight and passenger transportation in the marz is primarily carried out by road transport. Yerevan - Sevan - Dilijan highway of republican importance runs through the territory of the marz. The Vardenyats (Selim) Mountain pass runs through the Martuni community. Transport connection of the community with the capital city of Yerevan and rural communities of Martuni region is provided by minibuses.

Martuni community operates under an approved five-year development plan[103]. The Plan aims to create a comfortable and modern community through initiatives such as asphalting roads, constructing sidewalks, building multifunctional playgrounds for youth recreation, overhauling old drinking and irrigation water systems, constructing new water systems, and expanding gasification. It also emphasizes promoting investment programs across various economic sectors, developing agriculture, supporting small and medium-sized businesses, protecting the environment, increasing green spaces, and planting forests.

One of the major challenges for the community is the lack of sufficient passenger transport to rural settlements. Residents report limited services, while companies cite low demand, especially in winter. The Community Development 5 year Plan[104] proposes replenishing the bus fleet, monitoring vehicle condition and service quality, and improving road infrastructure through asphalting, repairs, and installation of road signs, markings, and traffic lights. Parking shortages in Martuni town are also noted.

The agricultural sector also faces several challenges. One major obstacle is the absence of irrigation networks in rural settlements, or their physical deterioration where they exist. Additionally, villages suffer from a lack of agricultural machinery. Residents are primarily engaged in farming, animal husbandry, and gardening. However, the absence of a central market for agricultural products means that most goods are sold through resellers, consumed internally, or exchanged within the community.

According to an interview with the Head of Astghadzor settlement, villagers are primarily engaged in livestock farming and gardening, while some residents are employed in the administrative centre of the community, the city of Martuni. A resident noted that although the cattle population had increased in previous years, it has decreased this year due to rising forage prices. Villagers cultivate wheat, barley, potatoes, and cabbage, and in recent years have also begun beekeeping. However, increasing fertilizer costs limit crop production, and water shortages continue to affects the types of crops that can be grown.

[103] Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

[104] It is a five-year community development plan that is prepared and approved by the elected community leader for the duration of their five-year term.

### 6.3.4 Poverty and Unemployment, Incomes and Expenditures

The average monthly nominal wage in Gegharkunik Marz reached 138,616 AMD (361 USD), which is lower than the national average 269,994 AMD (701 USD).

The share of poor population in Gegharkunik Marz decreased from 48.1% in 2020 to 35.4% in 2023 but remained considerably higher than the national average (23.7%). Extremely poor population had increased from 1.9% in 2020 to 3.1% in 2023.

Unemployment rate in Gegharkunik Marz reduced from 9.7% in 2020 to 5.5% in 2023 (RA average is 12.4%). Reported urban unemployment rate (10.0%) is significantly higher than rural (3,2%).

The average monthly nominal income in Martuni community is 134,488 AMD (353 USD). Unemployment level in Martuni community is 1.8%.

According to the interview with the Head of Astghadzor settlement, the main sources of household income are agriculture and migrant work. Focus group discussion revealed that agricultural production is primarily for commercial purposes; however, villagers often face challenges in selling their potato crops.

The main categories of household expenditures for residents include food, utility bills, and other goods and services.

### 6.3.5 Ethnic Minorities

Gegharkunik Marz, Martuni community and Project affected settlements are almost entirely populated by ethnic Armenians who belong to the Armenian Apostolic Church.

Gegharkunik hosts small numbers of national minority individuals. These include Yezidis, Russians, Kurds, Ukrainians, Greeks, Assyrians, etc. As of 2022 reports, there were about 495 persons from national minorities across 57 communities in Gegharkunik[105].

### 6.3.6 Social Infrastructure[106]

There are 76 pre-school institutions, 124 secondary schools, 43 libraries, eight sports organizations, two museums, and one professional theatre in Gegharkunik Marz[107].

According to Martuni Community Development Plan[108] preschool educational institutions are not adequately equipped with verbal-informational, technical, and observational teaching resources. Another identified gap in the early childhood education sector is lack of nurseries and kindergartens within the community. Furthermore, many kindergartens, administrative offices, libraries, cultural centres and other facilities require renovation. Conditions of roads, sidewalks, playgrounds, apartment roofs, sewage systems, and water pipelines are deteriorating, while unfinished Soviet-era buildings remain unused.

Residents of Martuni community including affected settlements have access to electricity, gas and water.

[105]Council of Europe. Sixth periodical report: Armenia (2024). Available at: https://rm.coe.int/armeniapr6-en/1680af6e84?utm_source=chatgpt.com.

[106]Information for this sub-section was mainly extracted from the website of Armstat's publication Main statistical indicators of the Gegharkunik Marz, 2019-2023. Available at https://armstat.am/file/Map/Gegharkunik.pdf and Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

[107]Armstat. Main statistical indicators of the Gegharkunik Marz, 2019-2023. Available at https://armstat.am/file/Map/Gegharkunik.pdf

[108] Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

### 6.3.7 Gender Issues

According to the National Statistical Committee, 52% of women in Armenia are not employed and are not seeking employment[109]. A major reason for women's absence from the labour market is their engagement in unpaid household activities. The gender pay gap in Armenia was 39.2% in 2022. The poorest households in the country tend to be women-headed households.

National gender problems such as underrepresentation in labour market and decision-making processes, gender pay gap are relevant in the Project affected villages as well.

In general, women's participation in decision-making at the community level, especially in rural communities, is fairly low. The principal reasons for their limited involvement in community leadership include public opinion, men's lack of acceptance of women's leadership, women's fear of expressing themselves, and a lack of self-confidence among women[110]. Women underrepresentation remains also a problem in Water Users Associations.

Furthermore, the construction of the reservoir may increase the risk of gender-based violence (GBV), including sexual harassment, exploitation, and domestic violence, particularly affecting women and girls in nearby communities. These risks often arise from the influx of non-local male workers, increased income disparities, and temporary worker accommodation sites located near rural settlements.

In the Armenian context, where traditional gender roles remain strong and rural women may have limited access to protection or reporting mechanisms, the presence of a large, predominantly male workforce can heighten vulnerabilities. Women engaged in small businesses, agriculture, or service provision around the construction area may face risks of harassment or coercion.

According to women's focus group discussions, the reservoir is a primary concern, as population growth has increased water demand. They emphasized that agricultural land remains an important source of income, however, water shortages limit the variety of crops that can be cultivated.

### 6.3.8 Socially Less Protected / Vulnerable Population

There are 8 859 families in Gegharkunik Marz receiving social benefits from the state.

The Martuni community administration receives a high number of applications for social assistance and employment support. Unemployment in the community is largely attributed to the limited range of professions available in the local labor market, low wages, and other social factors.

According to the Martuni Community Development Plan[111], the community faces challenges in integrating young people, managing their free time effectively, and identifying and utilizing their potential. Limited opportunities for out-of-school and non-formal education further hinder youth engagement and, consequently, community development.

According to the Head of Astghadzor village, 275 families in the village receive state social benefits.

[109]European Union. 2024. Country Gender Profile Armenia. Eu4genderequality Reform Helpdesk. Available at: https://euneighbourseast.eu/wp-content/uploads/2024/04/eu4genderhelpdesk_armenia_countrygenderprofile_2024-cgp_v3__compressed.pdf

[110]Ibid

[111]Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

### 6.3.9 Public Health and Safety

In Gegharkunik Marz, the number of doctors per 10,000 population has slightly increased from 15.9 in 2020 to 16.7 in 2023, compared to the national average of 46.6. Similarly, the number of paramedical personnel increased from 36.2 in 2020 to 38.0 in 2023 per 10,000 population (53.9 in the RA)[112]. However, the number of hospital beds has slightly decreased, from 35.3 in 2020 to 34.2 in 2023 (41.7 in the RA).

The Marz currently has 39 institutions providing primary healthcare services.

In Martuni community medical services are delivered through existing healthcare facilities, and a new hospital commissioned in November 2023 designed to meet modern healthcare standards with the capacity of 78 inpatient beds.

There is one medical unit operating in each Project affected village, however the facilities are largely outdated, employ only one doctor each.

No confirmed cases of cholera and polio were registered in Armenia in this millennia. At the same time, as of 2024 Armenia is categorized as a country with a high-intermediate prevalence of Hepatitis A. Bacterial dysentery is another public health concern at the national and regional levels.

Main chronic diseases of local population include diabetes, cardiovascular disease, and arthritis.

### 6.3.10 Land Use Issues

Gegharkunik Marz covers an area of 535,100 ha, accounting for 18% of Armenia's territory, making it the largest marz in the country. Agricultural land occupies 345,083.3 ha, of which 81,413.2 ha is arable.

The land resources data of the affected settlements is shown **Table 6-22**.

**Table 6-22. Land resources of the Project affected settlements, ha**

| Types of land | Settlement | | | |
|---|---|---|---|---|
| | Astghadzor | Zolaqar | Vaghashen | Martuni |
| ***Total*** | ***2,946*** | ***6,207*** | ***6,185*** | ***4,514*** |
| Agricultural | 2,402 (81.5%) | 5,380 (86.7%) | 5,561 (89.9%) | 3,426 (75.9%) |
| Residential | 362 (12.3%) | 527 (8.5%) | 288 (4.7%) | 603 (13.4%) |
| Industrial | 21 (0.7%) | 19 (0.3%) | 17 (0.3%) | 85 (1.9%) |
| Energy, transport, communications, utilities | 28 (1%) | 12 (0.2%) | 8 (0.1%) | 20 (0.4%) |
| Cultural heritage | 125 (4.2%) | 245 (3.9%) | 194 (3.1%) | 310 (6.9%) |
| Special purpose | 0 | 0 | 0 | 1 (0.02%) |
| Forest | 0 | 8 (0.1%) | 97 (1.6%) | 44 (1%) |
| Water | 8 (0.3%) | 16 (0.3%) | 20 (0.3%) | 25 (0.6%) |

[112]Armstat. RA Gegharkunik Marz in figures, 2024 available at https://armstat.am/file/doc/99553373.pdf

The reservoir site is planned about 1.3 km south of Astghadzor village (**Figure 6-22**).

**Figure 6-22. Location of planned Astghadzor reservoir relative to the nearest settlements**


*Source: prepared by the Consultant based on the information from the Client*

According to the interview with the Administrative Head of Astghadzor rural settlement, there are approximately 17 ha of communal land used as pasture within the area allocated for the reservoir construction. Additionally, there are about 4 ha of private lands, which are also used as pasture. However, the terrain in this area is not entirely suitable for grazing due to limited vegetation, and the land allocated for crop production remains uncultivated. According to the estimates, up to 15-20 households can use the pasture areas within the around the reservoir site. More detailed information about the land take is provided in the land impact assessment section based on the Resettlement Framework (RF) and preliminary Resettlement Plan (RP).

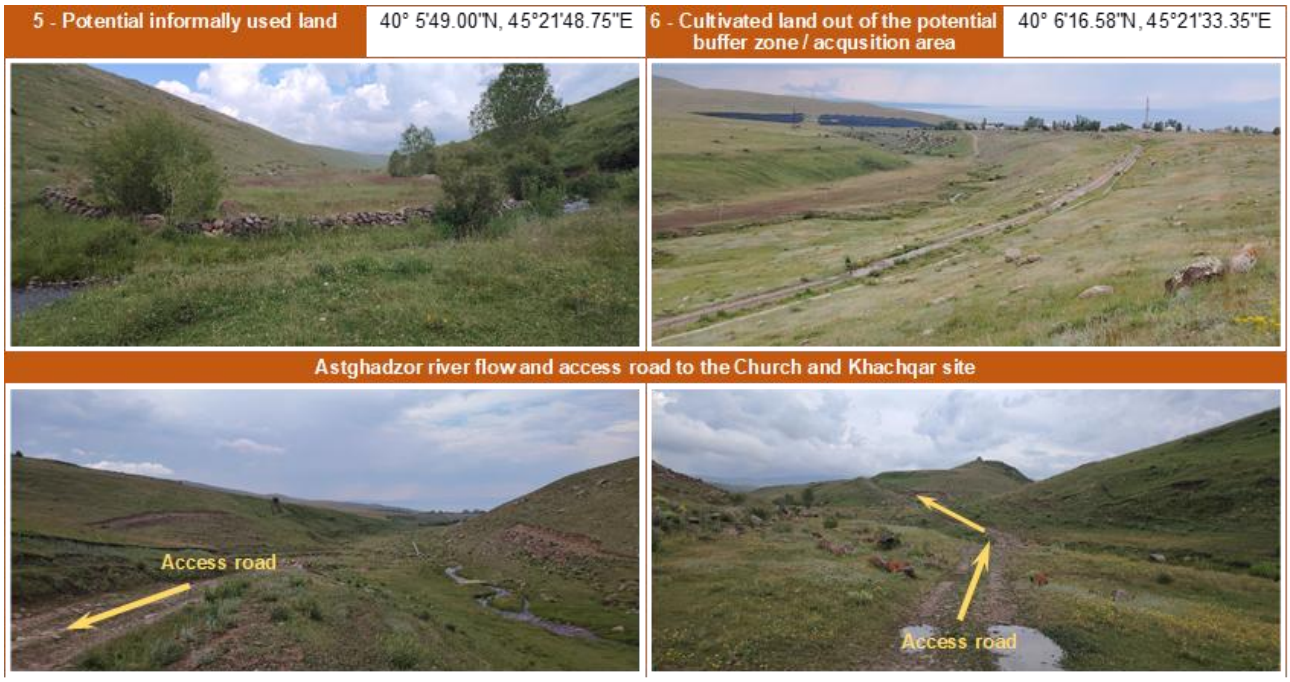
The reservoir area is crossed by cattle routes leading to high mountain pastures; according to the interviews with local residents and Head of Astghadzor rural settlement, alternative routes are available in the vicinities, so no impediments are expected (of course, the locals need to be informed about the planned construction and its dimensions is advance).

The Consultant did not observe any extensive signs of the land being cultivated. There are no orchards on the land to be acquired. Yet, according to the interviews with land users, there are formal and informal users of the land, for instance a consulted resident of Astghadzor mentioned that he cultivates cattle feed crops and raspberry on the community (municipal) land to be acquired; another consulted resident of Astghadzor owns a private land plot and practices ploughing and haymaking. Overall, during the preparation of the detailed RP, specific attention is to be paid to informal land users at this site.

There is a commemorative rest area with a khachkar (cross-stone) and a water intake point with an irrigation channel, located within the planned reservoir area (**Figure 6-23**). The impact related to khachkar, and public / private infrastructure has been considered in the Entitlement Matrix of the RF.

Vanki Berd Church, that is situated on a hill outside the reservoir area (**Figure 6-23**), will remain unaffected; however, the existing earth road leading to the church will be submerged. Thus, an alternative route will be required to be arranged by the Project.

**Figure 6-23. Astghadzor Reservoir: schematic map and photographs illustrating the site and land use**




## 6.4 Cultural Heritage

### 6.4.1 Tangible Cultural Heritage

The historical-cultural and archaeological surveys, consisting of both desktop and field studies, were conducted in 2024 as part of the national EIA study by an expert team from the Institute of Archaeology and Ethnography under the RA National Academy of Sciences.

Desktop studies were performed based on:

1) The RA Government Decree № 80-N dated 09.01.2002 "On approval of the State List of Immovable Historical and Cultural Monuments in the RA Gegharkunik Marz",
2) The RA Government Decree № 385-N dated 15.03.2007 "On Approval of the List of State-owned Immovable Historical and Cultural Monuments that are not subject to Alienation/Acquisition".

As a result of the desktop study, eighteen monuments located in the Astghadzor settlement registered under reference 4.13 in the Annex to Government Decree №80-N dated 09.01.2002 are identified. Of these, only the "Vanqi Berd" archaeological complex (2nd-1st millennium BC, 9th-17th centuries; ref. 4.13.1) falls within the Project implementation area. The remaining monuments are situated at a considerable distance and will not be affected by the Project. The list of monuments in the neighbouring Zolaqar settlement was also reviewed, but no cultural heritage units were found in the study area or its vicinity.

The "Vanqi Berd" archaeological complex comprises the following components:

- A castle dating to the 2nd-1st millennium BC (ref. 4.13.1),
- A grave field from the 2nd-1st millennium BC (ref. 4.13.1.1),
- The Vanqi Berd village from the 9th - 17th centuries (ref. 4.13.1.2), which includes:
  - Church 1, dated to the 9th - 10th centuries (ref. 4.13.1.2.1),
  - Church 2, dated to the 9th - 10th centuries (ref. 4.13.1.2.2),
  - A cemetery from the 9th - 10th centuries (ref. 4.13.1.2.3),
  - A cross-stone (khachkar) from the 9th - 10th centuries (ref. 4.13.1.2.3.1).

In the studied area, various research and excavation works were conducted at different times by expeditions of the Institute of Archaeology and Ethnography of the National Academy of Sciences, as well as by the joint Armenian-Italian expedition in 1994-2001. During these surveys, the plan of the Astghadzor Fortress was studied, its preliminary dating was established, and four Late Bronze-Early Iron Age tombs were excavated in the early 1950s (led by H. Mnatsakanyan). The materials from these excavations have not been published.

During the field archaeological survey, the entire area designated for the construction of the future reservoir and its surroundings was surveyed. As a result, the boundaries of the "Vanqi Berd" archaeological complex were verified, and newly discovered cultural units not included in the existing list of monuments were documented. These units include fully or partially preserved structural remains, intact and looted tombs, remnants of individual walls and structures, medieval and modern cross-stones (khachkars), cut features containing pottery fragments, and surface finds of ceramic material, among others (**Figure 6-25**).

The map of the archaeological and cultural heritage sites identified during the field archaeological survey within the Project area and surrounding protection zone is shown in **Figure 6-24**.

According to the Project design document and taking into account the project's location in relation to the terrain's relief, these units can be categorized into the following groups: monuments extending along the right and left riverbanks, along the sides of river gorges, and within riverbeds.

**Figure 6-24. Cultural heritage sites identified during the archaeological study**

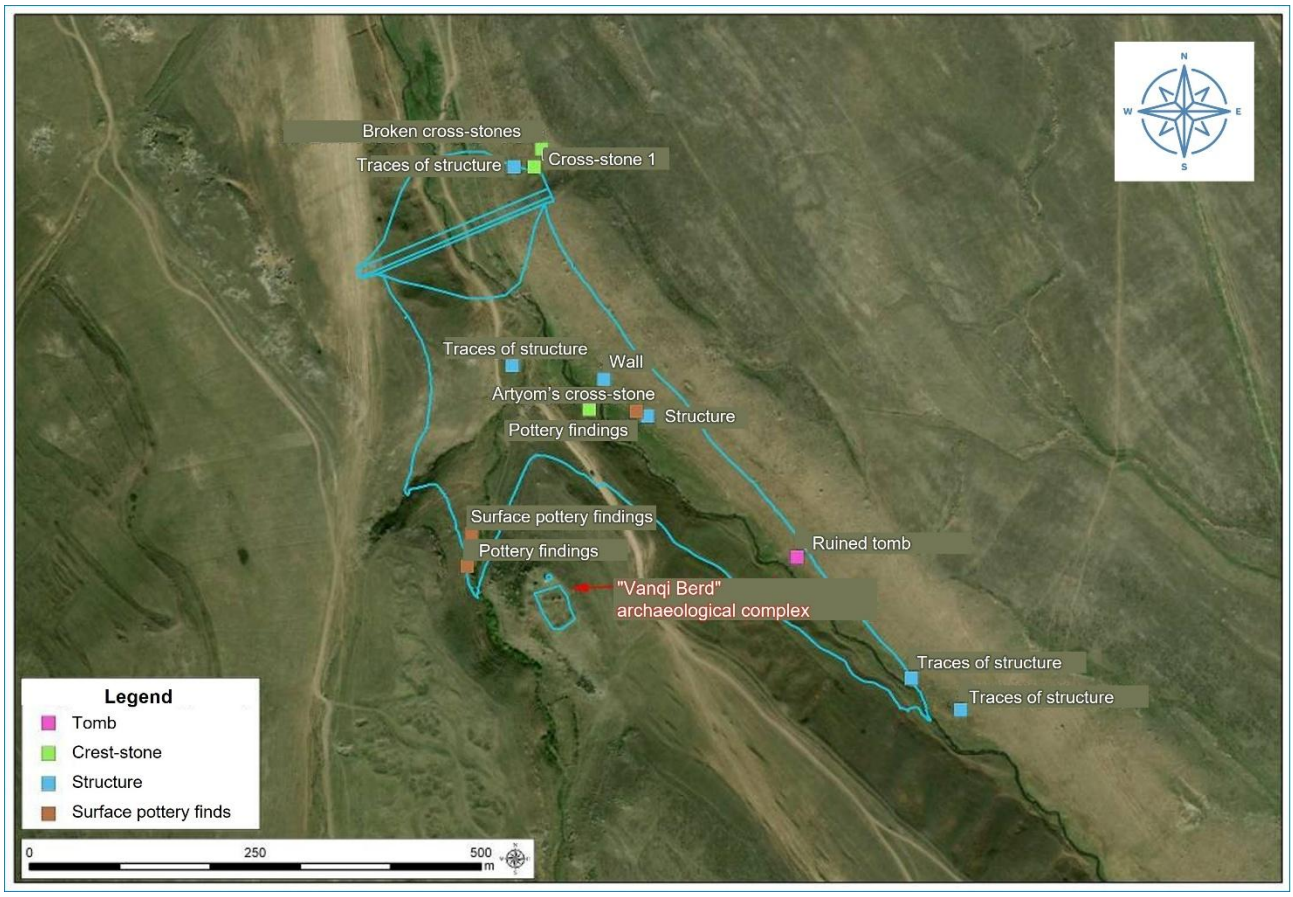
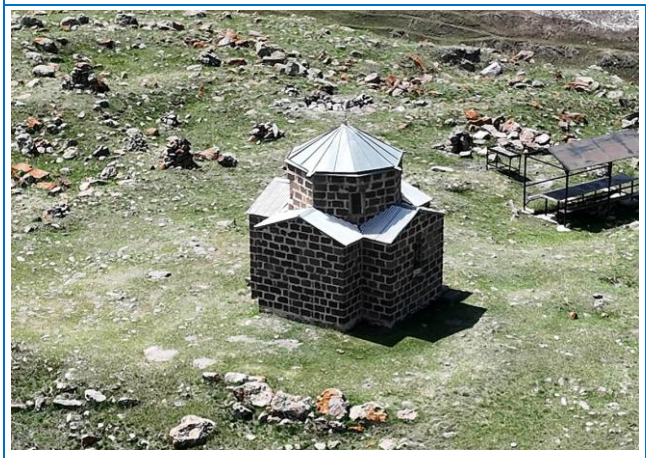


**Figure 6-25. Aerial view of the Astghadzor reservoir site and its surroundings, showing registered and newly discovered cultural heritage sites *(note: not all identified units are shown)***

*a) View of the "Vanqi Berd" archaelogical complex and fence section of Cyclops' castle*



*b) View of the modern St. Grigor church constructed in the northern part of the "Vanqi Berd" complex*

*c) Remnants of the 1st church within the "Vanqi Berd" complex*

*d) Remnants of the churches (9th-10th centuries) within the "Vanqi Berd" complex*

*e) Cross-stone (9th-10th centuries) of the 2nd church within the "Vanqi Berd" complex*

*f) Destroyed cross-stone within the planned reservoir area*

*g) Section of a double-layered wall on the side slope of the Astghadzor River gorge*

*h) Ruins of tomb within the planned reservoir area*

*i) Structures with a livestock-related function*

| | |
|---|---|
|  |  |
| *j) Modern monument of individual spiritual significance dedicated Artyom Mkhoyan* | *k) Surface pottery findings* |

### 6.4.2 Intangible Cultural Heritage

The Intangible Cultural Heritage (ICH) in the context of the Project is considered at both the national (**Sub-section 6.4.2.1**) and community (**Sub-section 6.4.2.2**) levels.

#### *6.4.2.1 National Context*

Armenia is one of the oldest countries in the world, known for its ancient history and unique culture. Scientific research, numerous archaeological discoveries, and ancient manuscripts indicate that the

Armenian Highlands are one of the Cradles of Civilization. References to Armenia and the Armenian people are preserved in Sumerian, Assyrian, Persian, Egyptian, and other ancient texts. Today, the Republic of Armenia is located in the northeastern part of the Armenian Highland and occupies about one-tenth of its historical territory. Armenia's rich archaeological heritage dates back 2 million years and includes remains from the Paleolithic, Neolithic, and Chalcolithic periods, as well as the Bronze and Iron Ages, Hellenistic period, and Middle Ages. The world's oldest leather shoe (5,500 years old), sky observatory (7,500 years old), depictions of agriculture (7,500 years old), and a wine-making facility (6,100 years old) have all been discovered in Armenia.

Armenia is often referred to as the Land of Noah, based on biblical scriptures. According to the Bible, Noah's Ark came to rest on Mount Ararat, which at that time was part of historical Armenia. Some of his sons and grandsons are believed to have settled in the region. It is commonly accepted that Armenians are direct descendants of his son Japheth.

Armenia was the first country in the world to adopt Christianity as a state religion in 301 A.D. Since then, Christianity has played a critical role in shaping the Armenian people. Religion has been an essential part of Armenian identity and has significantly influenced the course of the nation's history.

Armenia has eight elements inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity[113]:

1) **Duduk and its music** (2008): The distinctive Armenian woodwind instrument made of apricot wood, traditionally played in pairs.
2) **Armenian cross-stones art: symbolism and craftsmanship of Khachkars** (2010): carved memorial steles bearing crosses and intricate motifs.

[113] https://ich.unesco.org/en/state/armenia-AM?info=elements-on-the-lists

3) **Performance of the Armenian epic "Daredevils of Sassoun" (David of Sassoun)** (2012): oral storytelling of the national heroic epic.
4) **Lavash: the preparation, meaning and appearance of traditional bread** (2014): the communal baking of flatbread in clay ovens.
5) **Kochari, traditional group dance** (2017): a vigorous circle dance embodying bravery and unity.
6) **Armenian letter art and its cultural expressions** (2019): the decorative art of the Armenian alphabet, created by Mesrop Mashtots.
7) **Pilgrimage to the St. Thaddeus Apostle Monastery** (2020): a joint Armenian-Iranian nomination honoring historic religious pilgrimages.
8) **Tradition of blacksmithing in Gyumri** (2023): the local craft of forging iron objects central to Gyumri's identity.

The photos of the Armenian ICH values registered in the UNESCO Representative List of the Intangible Cultural Heritage of Humanity are presented in **Figure 6-26**.

**Figure 6-26. Photos of Armenia's elements inscribed on the UNESCO Representative List of the Intangible Cultural Heritage of Humanity**

1) 2) 3) 4)

5) 6) 7) 8)

In addition to the eight intangible cultural heritage elements inscribed on UNESCO's Representative List, Armenia also has ICH elements of national significance. According to the latest amendment (dated 31.10.2024) to Annex 2 of RA Government Decision №310-A[114], the national list currently includes 68 ICH elements, including the eight internationally recognized ones. These encompass traditional songs and musical instruments, dances, ethnic cuisine, handicrafts (such as carpet weaving, knitting, embroidery, woodwork, pottery, forging, etc.), winemaking, ceremonies (including weddings, funerals, Christmas, New Year, Easter, baptisms, and more), pilgrimages, regional dialects, and other cultural expressions.

#### *6.4.2.2 Community Context*

According to Annex 2 of RA Government Decision №310-A, around ten of the 68 nationally registered Intangible Cultural Heritage (ICH) elements are practiced across all regions of Armenia. These include: (i) the preparation of lavash, inscribed on both the UNESCO and national ICH lists, which is an integral part of Armenian cuisine; (ii) the tradition of producing tondir (underground clay ovens), used for baking lavash and other traditional dishes, recognized as an ICH element of national

[114] https://www.arlis.am/hy/acts/199058

significance; (iii) the making and playing of the duduk; (iv) the Kochari dance; (v) the celebration of Christmas, New Year, and Easter, among others.

No community specific rituals or celebrations have been identified in the affected villages. Christmas, New Year, and Easter are widely celebrated in the rural settlements of Martuni community typically with family gatherings at home. The "Trndez" ritual is also included in the national list of ICH elements. Rooted in Armenian pagan tradition, Trndez is celebrated annually on February 13. The purifying qualities of fire were central to pre-Christian Armenian beliefs. According to several sources, people believed that the strength of the fire could drive away the winter cold and ensure fertile land and a prosperous harvest. Couples, especially newlyweds, would jump over the Trndez flames for luck, prosperity, and fertility.

Weddings, funerals, and baptisms in Astghadzor and Zolaqar villages are also carried out with respect to the national traditions and customs.

Currently, the project-affected rural settlements, Astghadzor and Zolaqar villages, are primarily engaged in agricultural activities, namely the cultivation of wheat, potatoes, other vegetables, and cattle farming. Due to climate change, the climatic conditions in the region are becoming increasingly favorable for the cultivation of apricots, peaches, pears, nuts, and other fruits. According to the administrative head of Astghadzor village, the availability of irrigation water would support the development of orchards in the command area.

#### *6.4.2.3 Cultural Landscape*[115]

Recognized types of cultural landscapes are:

- **Designed** (planned cultivated lands, gardens, estates),
- **Associative** (spiritually or culturally meaningful landscapes),
- **Evolved** (traditional agricultural areas like vineyards),
- **Vernacular** or **Ethnographic** (day-to-day or group-specific traditional use),
- **Agricultural** or **Working** (subtype often included under evolved or vernacular landscapes).

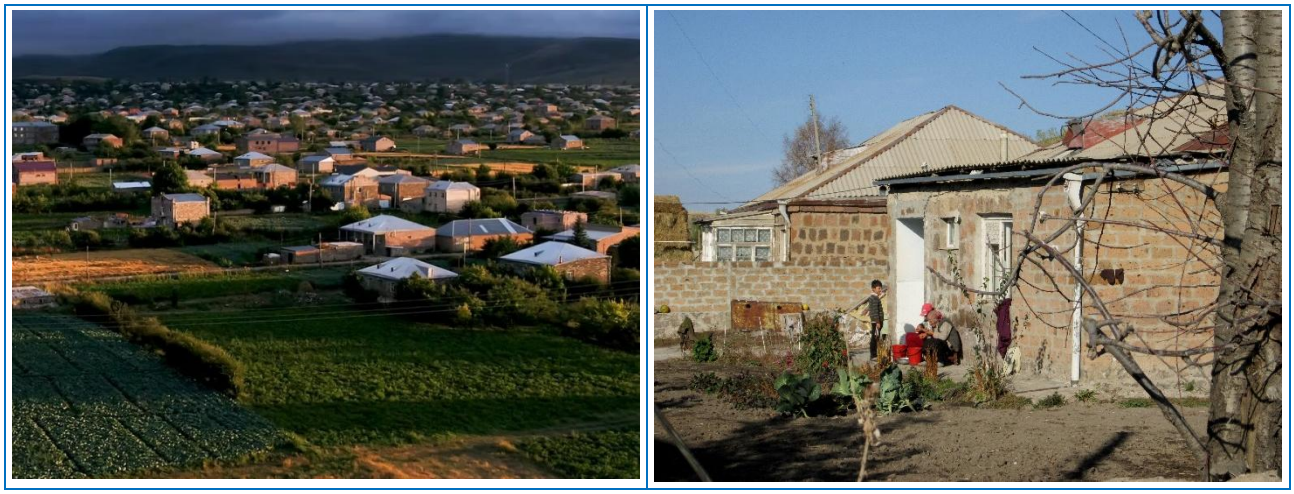
The residential areas within the Astghadzor, Zolaqar and Vaghashen rural settlements are characterized by a vernacular cultural landscape (**Figure 6-27**), while the agricultural lands outside the settlement are represented by a combination of organically evolved and working cultural landscapes. As of now (**Section 2.2**), 320 ha of irrigated agricultural land in the command area is occupied by potato, 290 ha - by wheat and 130 ha - by other vegetables.

Due to climate change, the climatic conditions in the region are becoming increasingly favorable for the cultivation of apricots, peaches, pears, cherries, and other fruits. According to the administrative head of Astghadzor village, the availability of irrigation water would support the development of orchards in the command area. The newly cultivated areas may be characterized by a combination of designed and organically evolved cultural landscapes.

[115]Cultural landscapes include tangible and intangible characteristics, such as natural systems and features, spatial organization and land use. Cultural landscapes are historically significant places that show evidence of human interaction with the physical environment. Their authenticity is measured by historical integrity, or the presence and condition of physical characteristics that remain from the historic period.

**Figure 6-27. Vernacular cultural landscape in Astghadzor, Zolaqar and Vaghashen rural settlements**

*a) Astghadzor village*



*b) Zolaqar village*

*c) Vaghashen village*

**Figure 6-28. Combination of vernacular, organically evolved and working cultural landscape in rural settlements of martuni community**

# 7. Stakeholder Consultation

## 7.1 Introduction

This chapter provides the overview of the Project stakeholder engagement and consultation activities carried out to date as part of both the national EIA and this ESIA study and summarizes their key findings. The stakeholder identification and engagement process for the Project was initiated in accordance with the RA Law on Environmental Impact Assessment and Expert Examination, the Procedure on Public Notification and Discussions approved by RA Government Decree №1325-N[116], as well as the stakeholder identification approach recommended by the EBRD.

## 7.2 Stakeholder Identification

The identification of stakeholders relevant to the Project was conducted according to the following criteria:

- **Impact:** the implementation of the Project may significantly affect a certain social group (stakeholders),
- **Influence:** the social group may have the capacity to significantly influence the process of Project implementation,
- **Partnership:** there are opportunities for building partnerships between the Project proponent and the given social group, and
- **Expressed Interest:** a social group or individuals not necessarily directly affected by the Project may (or may not) show interest in it.

On the other hand, the RA Law on Environmental Impact Assessment and Expert Examination defines **stakeholders** or the **stakeholder society** as individuals or legal entities that are directly or potentially affected by Project implementation or who show interest in decisions related to the Project. The same law also defines **participants of the EIA process** as state and local self-government bodies, individuals, and legal entities, including the affected community, affected settlements, and the interested public who in accordance with the Law participate in the assessment or expert examination process.

Stakeholder engagement requires the identification of stakeholders considering the above noted national and international criteria and the definition of appropriate methods for engagement with them. Different stakeholders have varying interests and influence in any project. Generally, those with low interest and low influence are to be kept informed, while those with high interest and high influence should be collaborated with.

The Project stakeholders can be grouped into two major categories: namely, external stakeholders and internal stakeholders (Water Committee, its staff, consultants and contractors).

For the purposes of effective and tailored engagement, the external stakeholders of the Project have been clustered into the following groups:

- Potentially affected parties,
- Vulnerable groups,
- Governmental authorities,

[116]The procedure for public notification and discussions was amended by the RA Government Decree №1343-N, dated 28.12.2023. However, at the time the first public notification was initiated, the previous version of the public notification and discussions procedure was still in force.

- Local self-governing bodies,
- Private sector and business,
- Other interested parties (civil society organizations, mass media, academia, etc.).

## 7.3 Public Discussions during the National EIA

In accordance with the procedure established by RA Government Decree №1325-N, four public discussions/hearings must be conducted as part of the national EIA and expert examination process in the project-affected community or settlement. The date, location and agenda of each of the four public discussions are outlined below:

**1st public discussions**

Date: 18.12.2023

Location: Astghadzor settlement

Agenda:

- Presentation of the Project objective and main components,
- Environmental and social framework,
- Initial consent of the affected community.

**2nd public discussions**

Date: 08.05.2024

Location: Astghadzor settlement

Agenda:

- Key findings of the preliminary environmental impact assessment,
- Draft Terms of Reference to be issued by the State Authorized Body (ME).

**3rd public discussions**

Date: 27.06.2024

Location: Astghadzor settlement

Agenda:

- Key findings of the EIA studies,
- Recommended mitigation and monitoring measures.

**4th public discussions**

Date: 09.10.2024

Location: Astghadzor settlement

Agenda:

- Main outputs of the EIA report,
- Feedback to the comments raised by the EIA process participants and stakeholders,
- Draft environmental impact expert examination conclusion.

The details and phases, as well as the main concerns and recommendations raised by stakeholders (participants) during the four public discussion events described above, are summarized in **Table 7-1**. These were taken into account by the national EIA developers during both the preliminary and main EIA studies. However, if any concern was not addressed in the national EIA report, it has been reviewed and, if relevant, considered in this ESIA report.

**Table 7-1. Summary of public discussion events conducted as a part of national EIA study**

| Moderation and presentation | Date, time | The place | Number of participants (women) | Participants | Questions and suggestions raised |
|---|---|---|---|---|---|
| **1st public discussions**<br>- Presentation of the Project objective and main components,<br>- Environmental and social framework,<br>- Initial consent of the affected community. | | | | | |
| Discussion moderator: Administrative head of the Astghadzor settlement<br>The project was presented by: representatives of design company and EIA developers ('Modul' LLC and 'Consecoard' LLC) | 18.12.23<br>12:00 | Residence of the administrative head of the Astghadzor settlement, (Martuni community, Gegharkunik Marz) | 30 (4) | Administrative head of Astghadzor settlement, representatives of 'Modul' LLC, 'Consecoard' LLC, affected population | - When is the construction of the reservoir scheduled to begin?<br>- How long will it take to fill the reservoir?<br>- Which settlements are planned to be irrigated by the reservoir?<br>- Is it possible to treat the reservoir water for drinking purposes?<br>***Conclusion:*** *There were no objections from the participants. They welcomed the project initiation and implementation.* |
| **2nd public discussions**<br>- Key findings of the preliminary environmental impact assessment,<br>- Draft Terms of Reference to be issued by the State Authorized Body (ME). | | | | | |
| Discussion moderator: Administrative head of the Astghadzor settlement<br>The project was presented by: representatives of design company and EIA developers ('Modul' LLC and 'Consecoard' LLC) | 08.05.24<br>11:00 | Residence of the administrative head of the Astghadzor settlement, (Martuni community, Gegharkunik Marz) | 36 (6) | Administrative head of Astghadzor settlement, representatives of the "Environmental Impact Expert Examination Center" (EIEEC), Water Committee, Gegharkunik Regional Administration, Martuni community, "Modul" LLC, "Consecoard" LLC and affected population | - What impact will the construction of the reservoir have on the level of Lake Sevan, and will the pumping stations continue to operate?<br>- What threats to biodiversity are expected as a result of the planned activities?<br>- Will the pumping stations be dismantled after the reservoir is constructed?<br>- Will the reservoir area be sufficient to fully irrigate the planned lands?<br>- How were the hydrological calculations conducted? |

| Moderation and presentation | Date, time | The place | Number of participants (women) | Participants | Questions and suggestions raised |
|---|---|---|---|---|---|
| | | | | | - What will be the water losses in the irrigation networks?<br>- What will be the water loss from releases into the Ararat Valley?<br>- Will the reservoir be filled as planned during the spring floods, and how will irrigation of downstream land areas be managed?<br>- Are there reliable baseline data available for the Astghadzor River?<br>- Have studies been conducted on the water pumped through the pumping stations and the water volumes planned for the reservoir?<br>- It was proposed taking into account international experience and successful examples to allow clean, cold-quality water to flow into Lake Sevan, and then pump it out for irrigation purposes (this proposal was met with discontent from residents).<br>- Will the reservoir be filled to its intended volume?<br>- What position did the expert committee take regarding the issues affecting Lake Sevan?<br>***Conclusion:***<br>*All voiced questions and concerns were duly addressed.*<br>*Residents demanded the implementation of the project that the* |

| Moderation and presentation | Date, time | The place | Number of participants (women) | Participants | Questions and suggestions raised |
|---|---|---|---|---|---|
| | | | | | *construction of the reservoir not be hindered.* |
| **3rd public discussions**<br>- Key findings of the EIA studies,<br>- Recommended mitigation and monitoring measures. | | | | | |
| Discussion moderator: Administrative head of the Astghadzor settlement<br>The project was presented by: representatives of design company and EIA developers ('Modul' LLC and 'Consecoard' LLC) | 27.06.24 11:00 | Residence of the administrative head of Astghadzor settlement, Martuni communi ty, Gegharkunik region | 15 (3) | Administrative head of Astghadzor settlement, representatives of the Water Committee, Gegharkunik regional administration, Martuni community, "Modul" LLC, "Consecoard" LLC and affected population | - What measures are being taken to ensure the safety of the reservoir?<br>- How much land will be required for the construction of the reservoir?<br>- How will the reservoir be filled to full capacity during dry or low-rainfall years?<br>***Conclusion:*** *There were no objections from the participants. They welcomed the project, emphasizing the importance of starting the reservoir construction as early as possible.* |
| **4th public discussions**<br>- Main outputs of the EIA report,<br>- Feedback to the comments raised by the EIA process participants and stakeholders,<br>- Draft environmental impact expert examination conclusion | | | | | |
| Discussion moderator: Administrative head of Astghadzor settlement<br>The project was presented by the representatives of EIA developers | 09.10.24 11:00 | Residence of the administrative head of Astghadzor settlement, Martuni communi ty, Gegharkunik region | 12 (1) | Administrative head of Astghadzor settlement, representatives of the EIEEC, Martuni community, "Consecoard" LLC and affected population | - It was proposed that all benefits and harms be adequately assessed, taking into account the importance of constructing the Astghadzor reservoir for the village residents.<br>- Do the identified historical and cultural heritage sites include the area that will become the reservoir's surface?<br>- If the reservoir is not constructed due to the availability of historical and cultural sites, is it possible to develop the village into a tourist |

| Moderation and presentation | Date, time | The place | Number of participants (women) | Participants | Questions and suggestions raised |
|---|---|---|---|---|---|
| | | | | | center that would benefit everyone?<br>***Conclusion:*** *There were no objections from the participants.* |

## 7.4 Consultations with Project Stakeholders during the Socio-Economic Studies

Consultations with the representatives of Martuni community, namely head of community, deputy head, secretary of staff and head of agricultural and nature protection division were held on 07.08.2025. The meetings with the administrative head of Astghadzor rural settlement and his staff have taken place on 07.08.2025 and 26.08.2025. Before the consultation meetings, a letter with a request for socio-economic information was submitted by the Consultant to the head of Martuni community, introducing:

i) the Project and its components,
ii) current status of the Project implementation process,
iii) the scope of the environmental and socio-economic studies,
iv) potential land use limitations, land acquisition and compensation issues,
v) the list of officials and groups of Project Affected Persons (PAPs) to be consulted.

The main topics discussed with the representatives of Martuni community included: the overall socio-economic situation in the community; socio-economic programs to be implemented both in the community as a whole and in the Astghadzor and Zolaqar rural settlements in particular over the coming years; the risks and benefits associated with the Project's implementation at the community level; and the main livelihood and income sources of the Project-Affected Persons (PAPs).

The agenda of the consultations conducted with the administrative head of Astghadzor rural settlement covered issues related to the village's socio-economic and environmental profile, including:

- The total area of the settlement, types of land, and land use,
- Engagement of residents in the EIA consultations and discussions, and concerns related to environmental impacts,
- Population dynamics, migration trends, residents' main occupations, and vulnerable groups,
- People likely to be affected by the Project's implementation and issues of economic displacement,
- Restrictions within the protection zones around the planned reservoir area.

The attitude of the heads of the Martuni community and Astghadzor rural settlement toward the Project's implementation is positive. They believe that the Project will create temporary jobs for local residents during the construction phase and permanent employment opportunities during the reservoir's operational stage. The planned reservoir is expected to provide irrigation water for approximately 740 ha of agricultural land.

## 7.5 Summary of Stakeholders Concerns, Questions and Recommendations

During public discussions and stakeholder consultations, participants raised questions and concerns regarding the required land area for the reservoir and associated infrastructure; the presence of cultural and sacred sites; potential effects on Lake Sevan and local biodiversity; irrigation network water losses; the adequacy of spring floods to fill the reservoir and ensure downstream irrigation; the completeness of hydrological studies of the Astghadzor River; the reservoir's capacity to meet planned irrigation needs; the future of existing pumping stations; and the anticipated timeline for construction. Where relevant, these matters are addressed in the corresponding sections of this ESIA report.

## 7.6 Planned Stakeholder Engagement

The next stakeholder consultation meetings will take place during the 120-day public disclosure period of the ESIA package, which includes the ESIA Report, Non-Technical Summary (NTS), Environmental and Social Management Plan (ESMP), Environmental and Social Action Plan (ESAP), Stakeholder Engagement Plan (SEP), Resettlement Framework (RF), and Biodiversity Action Plan (BAP).

Two public consultation events are planned: one in Astghadzor (or Martuni enlarged municipality, will be discussed later) settlement and another in Yerevan, with the participation of relevant state authorities, NGOs, and other project stakeholders. In both cases, the residents of Zolaqar and Vaghashen rural settlements will be invited. These meetings are tentatively scheduled for the third quarter of 2026. This component will be led by the ESIA Consultant, with support from the Water Committee.

The Stakeholder Engagement Programme has been developed as part of the SEP to ensure effective engagement with all identified stakeholders, foster and maintain respectful relationships between the Water Committee and stakeholders, and help prevent potential conflicts. It covers the Project's design, pre-construction, and construction stages.

The Programme will be reviewed and updated at least once a year after the start of the construction stage and again prior to the commissioning of the Astghadzor reservoir. It provides a detailed action plan outlining responsibilities and a timeframe for the implementation of the proposed activities. Should there be any changes during Project implementation that necessitate modifications to the engagement mechanisms, or if new stakeholders are identified, the Programme will also be updated accordingly.

Stakeholder engagement will continue in parallel with the ESIA information disclosure process and will include several components aimed at facilitating ongoing meaningful consultation and providing timely information on the Project and its E&S implications.

# 8. Environmental and Social Impacts, Benefits and Opportunities, Mitigation Measures

## 8.1 Introduction

This Chapter provides a summary of the environmental and social impacts and benefits identified during the national EIA study, which were further updated through supplementary surveys and analyses conducted by the Consultant. These efforts were undertaken to align this ESIA study report with the requirements of the EBRD ESP and provisions of the applicable GIPs. This process helps ensure that the E&S information used for decision-making presents a comprehensive picture of the potential effects of the proposed Project, including issues of particular concern to affected groups and individuals. The methodology used for the impact assessment and management is described in detail in **Chapter 5** of this ESIA report.

## 8.2 Environmental Impacts and Benefits, Mitigation Measures

### 8.2.1 Transboundary Impact

The construction of the Astghadzor reservoir is not planned on transboundary water resources. Astghadzor is a river located in the Gegharkunik Marz, within the Lake Sevan basin. It originates on the western slopes of Mount Batssar in the Vardenis mountain range, at an altitude of 2,599 masl. The river is 16.7 km long, with a catchment area of 43 $km^2$. The river valley is V-shaped in its upper reaches and becomes trough-shaped downstream. The river has a mixed feeding regime, and its average annual discharge is 43 $m^3/s$. Its water is primarily used for irrigation purposes.

The hydrological impact assessment[117] has been undertaken comparing the average and dry year flows at the boundary with relevant neighbouring countries, with and without the project. The hydrology baseline considered for this assessment was that defined using the SWAT+ model established for the purpose of the present study[118]. The main conclusion is that it is unlikely that the Project generates significant hydrological impacts downstream of the proposed reservoir.

Astghadzor reservoir is not expected to cause significant sediment impacts, as existing dams or lakes located between these reservoirs and the borders already trap sediments. It is very unlikely that the project will have significant sediment load and soil stability impacts.

The Astghadzor reservoir study shows an absence of fish and aquatic habitats in the reservoir impounded rivers. Therefore, it is unlikely that the Project reservoir will result in impacts on fish resources and aquatic habitats.

A conservative evaluation of the planned reservoir' impacts has been made possible through basic hydrological modelling (SWAT+) and expert judgment. The assessment indicates that the Astghadzor reservoir is unlikely to cause significant impacts downstream of the proposed reservoir. This conclusion is primarily based on the upstream positions relative to existing lakes or reservoirs, and the relatively small size of the rivers they impound.

[117]SLR Consulting. Armenia reservoirs Project: Transboundary Impact Assessment Report, Revision A, June 2025.
[118]Ibid

### 8.2.2 GET Assessment[119]

#### *8.2.2.1 Introduction*

The Project is assessed as aligned with the goals of the Paris Agreement[120] based on the directly financed methodology. Specific assessments for climate adaptation and climate mitigation have been undertaken for the Astghadzor reservoir site and outlined below.

#### *8.2.2.2 Paris Alignment Assessment*

Alignment with the mitigation goals of Paris Agreement: general screening

The Project is on the aligned list under the water supply and wastewater category[121]. No Project activities have been identified as on the 'non-aligned list'.

Alignment with the mitigation goals of Paris Agreement: specific assessments

*Review against Nationally Determined Contribution (NDC) and Low Emission Development Strategy*

In the case of Armenia, the NDC outlines an intention to achieve an unconditional Greenhouse Gas (GHG) emissions reductions target of at most 2.07 t CO2eq/capita by 2050. These are reflected in Armenia's Draft Long Term - Low Emission Development Strategy (LT-LEDS). Armenia's LT-LEDS outlines improvements in water supply and irrigation as a priority area to reduce energy consumption, with an estimated total GHG emissions reduction of 8.946 Gg CO2eq until 2050.

As such, the Project does align with some of the targets outlined in Armenia's draft LT-LEDS and, therefore, the country's NDC in that it is designed to improve water supply and efficiency in irrigation. However, it is noted that GHG emission estimates at this stage show net positive carbon emissions for reservoir over 100 years.

*Review against energy policies in Armenia*

In 2022, the International Energy Agency, in partnership with the European Union, produced an in-depth review of the energy policies of Armenia which sets the path for the sector's transition through 2040 including guidance on energy efficiency and security of supply. Water supply, construction and agriculture do not feature explicitly in this review. However, the economic assessment identifies that the Project will result in an annual decrease in energy costs due to decreased pumping costs. Therefore, the Project is concluded to align with Armenia's energy transition policies through to 2040.

*Carbon lock-in test*

Carbon lock-in occurs when technical, economic or institutional factors mean an asset will continue to operate in an emissions-intensive way, even when there are feasible and economically preferable lower carbon options that could replace it. The risk of lock-in is considered low if the project entails investment in assets that will cease to operate in an emissions-intensive way in the near future or the project credibly demonstrates low-carbon readiness.

A review of the Project has not identified (at this stage) the use of any low-carbon alternatives and use of renewable energy sources. However, there are still opportunities to embed low-carbon alternatives into the design of the Project and there are no barriers identified to the use of renewable energy in the operation of the project. Therefore, the risk the Project's overall lock-in risk can be considered low.

[119]This GET Assessment has been prepared based on the Chapter 5 and Section 8.3 of the *Armenia Water Reservoirs - Technical, Economic and Green Due Diligence Gap Analysis, Draft Final Report*, 2023-2024, Ove Arup & Partners

[120]https://unfccc.int/sites/default/files/english_paris_agreement.pdf

[121]Implementing the Green Economy Transition Technical Guide, EBRD, March 2024 and Annexes to Implementing the Green Economy Transition - Technical Guide, EBRD, March 2024

*Economic viability test*

An economic viability test has not been completed as the CO2 emissions assessment has not identified that any of the individual reservoirs exceeds the 'significant' emissions thresholds outlined in the EBRD Methodology to determine the Paris Agreement alignment of EBRD investments.

Conclusion: The Project is assessed as aligned with the mitigation goals of Paris Agreement (BB1 aligned).

Alignment with the adaptation goals of Paris Agreement

Internal screening of the Project has identified increased heat stress, increased water stress and drought / flooding / sea-level rise / mass movement[122] / forest fires / erosion] as potentially material physical climate risk(s) for the Project location.

A climate risk assessment was undertaken as part of the Project's technical due diligence[123] (**Sub-section 8.2.2.3**). As a response, the Project incorporates adaptation responses to ensure assets are resilient to identified material risks:

- Extreme heat (for the reservoir and dam),
- Heavy precipitation and flooding (for the reservoir, dam and spillway).

The Project is unlikely to undermine climate resilience of the system in which it operates. Although it is noted that uncertainties regarding downstream flood impacts mean that, at this stage, the downstream receptors remain potentially at high risk to heavy precipitation and flooding. This also takes into account the fact that the reservoirs are primarily designed to address future water storages and support agriculture.

Potential high risks are also identified for extreme high temperatures and forest fires for ecological receptors downstream. This is a conservative rating applied in the absence of information on the ecological receptors, and also the vegetation clearing and planting approach for the reservoirs.

### *8.2.2.3 Climate Change Adaptation and Mitigation Assessment*

Climate adaptation (Climate change risk assessment)

*Step One: Current and future baseline*

To define the current and future baseline the assessment has utilised historical climate data and climate projections from national, regional and site-specific sources, where available. Regional-level climate projections and site-specific climate data provided by "Modul" design company has been used to look in further detail at the current and future climate conditions for the Astghadzor reservoir. A summary of the key trends is provided in **Table 8-1**.

**Table 8-1. Summary of current and future climate trends for the Astghadzor reservoir**

| Climate hazard | Baseline | Projected change[124] | | |
|---|---|---|---|---|
| | | 2020-2039 | 2040-2059 | 2060-2079 |
| Average temperature | ↑ The annual average surface air temperature for the Gergharkunik region has increased from 6.67°C in 1901 to 7.39°C in 2020.<br>A peak average temperature was hit in 2010, with a | ↑ For both the SSP2-4.5 and SSP5-8.5 scenarios, average temperatures are projected to increase in the Gergharkunik region. | | |

[122]The assessment of mass movement considers it occurring as a result of heavy rainfall/storms, i.e., as a climatic factors. Seismic risk is covered by the technical review

[123]*Armenia Water Reservoirs - Technical, Economic and Green Due Diligence Gap Analysis, Draft Final Report*, 2023-2024, Ove Arup & Partners

[124]Preparation of design and cost estimation documents for construction of Astghadzor reservoir in Gegharkunik Marz of the Republic of Armenia, Explanatory Note, 2024

| Climate hazard | Baseline | Projected change[124] | | |
|---|---|---|---|---|
| | | 2020-2039 | 2040-2059 | 2060-2079 |
| | reading of 8.5°C. | | | |
| Extreme high temperatures | The extreme heat hazard rating for the Martuni municipality is assigned as very low, meaning that there is less than a 5% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. | ↑ For both the SSP2-4.5 and SSP5-8.5 scenarios, average maximum air temperatures are projected to increase in the Gergharkunik region. | | |
| Extreme low temperatures | For the time period of 1990-2014, the observed annual average minimum temperature in the Gergharkunik region was 0.52°C with an average number of 170 frost days and 82 ice days. | ↑ Future projections for both the SSP2-4.5 and SSP5-8.5 scenarios project that minimum air surface temperature will increase.<br>↓ Future projections for both the SSP2-4.5 and SSP5-8.5 scenarios project that the number of frost days and ice days will decrease. | | |
| Wildfire & Forest Fires | The wildfire hazard rating for the Martuni municipality is assigned as high. | ↑ Modelled projections indicate a likely increase in the frequency of fire weather across Armenia. | | |
| Extreme wind | Data available on wind is limited. Data from The Global Wind Atlas indicates an average wind speed of 5.37m/s for the top 10% windiest areas in the location of the Astghadzor reservoir. | Changes in wind speed as a result of climate change are difficult to predict and are affected by high levels of uncertainty. | | |
| Average precipitation | ↓ Average annual precipitation in the Gergharkunik region has decreased from 634.9mm in 1901 to 584.16mm in 2020.<br>Annual precipitation levels range between 361.57 and 854.12mm in this time period. | ↑ Projected average annual precipitation for the SSP2-4.5 and SSP5-8.5 scenarios is projected to increase. | | |
| Heavy precipitation and flooding | The river flood and urban flood hazard ratings for the Martouni municipality are assigned as low, this means that there is a chance of more than 1% that potentially damaging and life-threatening river floods occur in the coming 10 years. | ↑ For the SSP2-4.5 scenario the projected average largest 5-day cumulative precipitation is projected to increase.<br>↓ For the SSP5-8.5 scenario the projected average largest 5-day cumulative precipitation is expected to decrease. | ↓ For both the SSP2-4.5 and SSP5-8.5 scenarios the projected average largest 5-day cumulative precipitation is projected to decrease. | |
| Drought | The water scarcity hazard rating for the Martuni municipality is assigned as low, meaning there is up to 1% chance droughts will occur in the coming ten years. | ↑ The current low hazard rating for the Martuni municipality may increase in the future due to climate change. | | |
| Erosion | Localised data on current and future erosion patterns has not been identified. | | | |
| Mass movement | The landslide hazard rating for the Martuni municipality is medium, meaning that there are conditions that contribute to making localised landslides an infrequent | Climate change is likely to alter slope and bedrock stability through changes in precipitation and/or temperature. However, | | |

| Climate hazard | Baseline | Projected change[124] | | |
|---|---|---|---|---|
| | | 2020-2039 | 2040-2059 | 2060-2079 |
| | hazard phenomenon. | it is difficult to determine future locations and timing of large rock avalanches, as these depend on local geological conditions and other non-climatic factors. | | |

*Step Two: Definitions of exposure of impacts to climate change*

**Table 8-2** outlines the definitions used to rate the exposure of the Astghadzor reservoir to relevant climate hazards. The rating considers current and future climate conditions that may occur across the Project lifecycle. On the basis of the exposure ratings, the mass movement hazard is not considered further.

**Table 8-2. Exposure ratings for the Astghadzor reservoir**

| Climate hazard | Exposure rating |
|---|---|
| Extreme high temperatures | Probable |
| Extreme low temperatures | Probable |
| Forest fires | Plausible |
| Extreme wind | Plausible |
| Heavy precipitation and flooding | Probable |
| Drought and increased water stress | Plausible |
| Erosion | Plausible |
| Mass movement | Not likely |

*Step Three: Definition of sensitivity impacts to climate change*

**Table 8-3** outlines the definitions used to rate the sensitivity of the Astghadzor reservoir to relevant climate hazards. The rating considers current and future climate conditions that may occur across the Project lifecycle.

**Table 8-3. Sensitivity ratings for the Astghadzor reservoir**

| Climate hazard | Sensitivity rating | | |
|---|---|---|---|
| | Reservoir and Dam | Spillway | Guard house and instrumentation |
| Extreme high temperatures | Medium | Low | Low |
| Extreme low temperatures | Low | Low | Low |
| Forest fires | Low | Low | Medium |
| Extreme wind | Medium | Medium | Low |
| Heavy precipitation and flooding | High | High | Medium |
| Drought and increased water stress | Low | Low | Low |
| Erosion | Medium | Medium | Low |

**Table 8-4** outlines the definitions used to rate the sensitivity of receptors located downstream of the Astghadzor reservoir to relevant climate hazards. The rating considers current and future climate conditions that may occur across the project lifecycle.

**Table 8-4. Sensitivity ratings for receptors located downstream of the Astghadzor reservoir**

| Climate hazard | Sensitivity rating | | |
|---|---|---|---|
| | Agricultural land | Water users (including farmers) | Ecological receptors |
| Extreme high temperatures | Low | Low | Medium |
| Extreme low temperatures | N/A - The Project is not anticipated to impact on the sensitivity of the | | |

| Climate hazard | Sensitivity rating | | |
|---|---|---|---|
| | Agricultural land | Water users (including farmers) | Ecological receptors |
| | receptors to extreme low temperatures. | | |
| Forest fires | Low | Low | Low |
| Extreme wind | N/A - The Project is not anticipated to impact on the sensitivity of the receptors to extreme winds. | | |
| Heavy precipitation and flooding | High | High | High |
| Drought and increased water stress | Low | Low | Medium |
| Erosion | Low | Low | Medium |

*Heavy precipitation and flooding hazard*

The design company has applied the Armenian dam hazard classification system to select the Safety Check flood as a 1 in 1000-year return period. The safety check should be selected based on the downstream hazard posed by an uncontrolled release of water from the dam. However, at this stage no consequence assessment has been undertaken. Probable Maximum Flood analysis has also not been completed.

The choice of Armenian dam category appears reasonable based on the descriptions in the standard, but is lower than typically expected for the likely consequences when compared with other international dam safety flood standards. An allowance has not been made for climate change in the selection of the Safety Check Flood. This is not unusual for extreme flood events of 1 in 1000 years and above and there is little to no firm guidance on how this should be implemented although it is considered to be good practice.

The design document for the Astghadzor reservoir notes that future climate change projections anticipate a decrease in river flows by the year 2100 under multiple climate change scenarios. However, the projections quoted are provided at a national level and in the event that river flows show an overall decreasing trend, climate change may still increase the frequency and magnitude of flood events that do occur. Therefore, the Astghadzor reservoir, dam and spillway and downstream receptors are identified as having a 'High' sensitivity to heavy precipitation and flooding.

### *Step Four: Definition of a risk assessment level*

**Table 8-5** outlines the risk ratings for the Astghadzor reservoir for relevant climate hazards. The rating considers current and future climate conditions that may occur across the Project lifecycle.

**Table 8-5. Risk ratings for the Astghadzor reservoir**

| Climate hazard | Risk rating (Exposure × Sensitivity) | | |
|---|---|---|---|
| | Reservoir and Dam | Spillway | Guard house and instrumentation |
| **Extreme high temperatures** | High | Medium | Medium |
| **Extreme low temperatures** | Medium | Medium | Medium |
| **Forest fires** | Low | Low | Medium |
| **Extreme wind** | Medium | Medium | Medium |
| **Heavy precipitation and flooding** | High | High | Medium |
| **Drought and increased water stress** | Low | Low | Low |
| **Erosion** | Medium | Medium | Low |

**Table 8-6** outlines the risk ratings for receptors located downstream of the Astghadzor reservoir for relevant climate hazards. The rating considers current and future climate conditions that may occur across the Project lifecycle.

**Table 8-6. Risk ratings for receptors located downstream of the Astghadzor reservoir**

| Climate hazard | Risk rating (Exposure x Sensitivity) | | |
|---|---|---|---|
| | Agricultural land | Water users (including farmers) | Ecological receptors |
| Extreme high temperatures | Medium | Medium | High |
| Forest fires | Medium | Medium | Medium |
| Heavy precipitation and flooding | High | High | High |
| Drought and increased water stress | Low | Low | Medium |
| Erosion | Low | Low | Medium |

*Step Five: Identification of recommended climate resilience measures*

For the purpose of this assessment, risks identified as "High" are considered material and accordingly resilience measures are identified to reduce the materiality of these risks.

Reservoir, dam and spillway

To mitigate the potential impacts of heat on reservoir and dam structures, construction materials should be selected based on a proven track record of performance under high-temperature conditions. During operation, inspections should be carried out more frequently during and immediately after heatwave events to identify and address any issues associated with heat-induced expansion and other related effects.

As part of a risk-based approach, a Probable Maximum Flood (PMF) analysis and sensitivity testing should be undertaken to assess how downstream consequences may be affected by higher-magnitude flood events resulting from climate change. Expert judgment should then be applied to determine whether an allowance for climate change is required when defining the Safety Check Flood.

Downstream receptors

In relation to extreme high temperatures and ecological receptors, this reflects a conservative approach undertaken in the absence of knowledge of the ecological species located in proximity to the reservoir. This risk should therefore be re-evaluated following ecological surveys and assessment to determine whether it remains material and if so, what resilience measures should be implemented.

The measures outlined above would address the risks posed to downstream receptors by heavy precipitation and flooding.

Climate change mitigation: CO2e impact analysis

The data inputs to the G-res tool relied on the design document for the reservoir, from which the key information is summarised in **Table 8-7**. The reservoir site and catchment area were delineated in Google Earth Engine for the assessment of upstream catchment and reservoir datasets.

**Table 8-7. G-res data inputs for the Astghadzor reservoir**

| Upstream catchment | | |
|---|---|---|
| **Catchment area** | 24.7 | km2 |

| | | | | | |
|---|---|---|---|---|---|
| **Population in catchment** | | 1,602 | | persons | |
| **Catchment annual runoff** | | 55 | | mm. yr | |
| **Landcover and mineral soils** | | | | | |
| **Bare areas** | 0% | **Croplands** | 28.57% | **Forest** | 2.17% |
| **Grassland/ shrubland** | 69.26% | **Settlements** | 0% | **Waterbodies** | 0% |
| **River area before impoundment** | 13.764 | km | | | |
| **Area to be inundated by reservoir** | | | | | |
| **Climate zone** | | Temperate | | | |
| **Reservoir area** | | 100 | | ha | |
| **Reservoir volume** | | 1.7 | | MCM | |
| **Water level** | | 2,156 | | masl | |
| **Maximum depth** | | 38 | | m | |
| **Annual wind speed** | | 5.37 | | m/s | |
| **Mean air temperature** | | 4.6 | | °C | |
| **Reservoir** | | | | | |
| **Primary service** | | Irrigation | | | |
| **Secondary service** | | Flood control | | Environmental flow | |
| **Earth removed** | | (none included)[125] | | $m^3$ | |

The outputs indicate the post-impoundment emissions rate of CH4 as 81 tCO2e/yr and pre-impoundment emissions rate of CO2 as 7 tCO2e/yr. The reservoir emission over 50 years is 65 tCO2e/yr (**Table 8-8**).

**Table 8-8. G-res outputs for the Astghadzor reservoir**

| | | |
|---|---|---|
| **Total net GHG footprint** | | |
| **Total reservoir emissions per year** | 7 | tCO2e/yr |
| **Total reservoir emissions at year 1** | 293 | tCO2e/yr |
| **Total reservoir emissions at year 50** | 65 | tCO2e/yr |
| **Reservoir net GHG footprint by pathway** | | |
| **Emission rate of which $CO_2$** | 7 | tCO2e/yr |
| **Emission rate of which $CH_4$** | 81 | tCO2e/yr |

GET assessment

**Table 8-9** outlines the GET outcomes anticipated for the Astghadzor reservoir.

**Table 8-9. GET CROs for the Astghadzor reservoir**

| GET Outcome | Valorisation of GET CRO[126] | CRO ratio (CRO/Capex) |
|---|---|---|
| **Increased agricultural potential (€/year)** | €6,248,332[127] Excluding consideration of Capex | 29.5% |
| **Increased water availability (€/year)** | €4,405,074 | 20.8% |

It is considered that there is double counting between the increased agricultural potential and the increased water availability outcomes. Therefore, it is proposed that only the highest of these two figures is reported, i.e. 29.5% for the Astghadzor reservoir.

[125]No information available on amount of earth removed
[126]Cumulative Results Overview
[127]Please note this figure accounts for the fact that in the absence of the project there would be an 11% reduction in agricultural potential by 2030 compared to baseline

At an earlier stage of the Project, potential was identified for the Project to reduce damage from flooding as a result of improving control of floodwaters. Through further review, it has been identified that whilst the Astghadzor reservoir will be designed to attenuate flows to an extent it is not anticipated that this will have any measurable impact on flood risk receptors downstream.

No GET outcomes were identified under the "Other environmental benefits" category at this stage.

### 8.2.3 GHG Emissions

The CO2e impact analysis relied on the use of the GHG Reservoir Tool (G-res Tool) which is based on the principles agreed on by IPCC[128] for net reservoir emissions. When assessing the CO2e for a reservoir a whole catchment approach was followed to account for the terrestrial areas which act as net carbon sinks. Net GHG emissions caused by a reservoir are the difference between total fluxes of CO2e emissions for the river basin before and after the creation of a reservoir. The G-res tool builds on this principle of calculating the net anthropogenic GHG emissions, that is, what the atmosphere will see when a new, man-made reservoir is introduced into the landscape.

This assessment calculates the net GHG footprint using the following formula:

$$\textit{Net GHG Footprint} = \frac{\textit{Post-impoundment GHG balance from catchment after introduction of reservoir}}{\textit{Pre-impoundment GHG balance of catchment before introduction of reservoir}}$$

The pre-impoundment GHG balance relied on an assessment of the landscape. The G-res tool assesses the overall pre-impoundment GHG balance by multiplying the surface area of each land cover sub-unit with a specific emission factor appropriate for both CO2 and CH4. These are then summed over a 100-year assessment period and averaged to obtain a mean rate over the entire surface area to be occupied by the reservoir.

The post-impoundment GHG balance relies on an analysis of semi-empirical models based on existing datasets. These relate to annual CH4 diffusive emission, predicted gross annual emission and estimating the CO2 emissions rightfully attributed to the reservoir. The post-impoundment emissions are expressed in the G-res as areal emissions (gCO2e/m2/yr) and as reservoir wide emissions (tCO2e/yr) merged as GHG emissions, but also separately as CO2 and CH4. A global warming potential for 100 years was used to obtain CH4 emissions as CO2e.

The outputs of the G-res calculations indicate the post-impoundment emissions rates of CH4 and CO2 as 81 tCO2e/yr and 7 tCO2e/yr respectively. Pre-impoundment emissions are low because the project land is mainly covered by grassland and croplands. The total GHG emissions from the planned reservoir at year 1 are estimated 293 tCO2e/yr, while at year 50 - 65 tCO2e/yr (**Table 8-8**).

### 8.2.4 Impact on Air Quality

*Construction phase*

During the construction stage the following activities / operations are considered as potential sources (stationary and mobile) of air emissions:

- Site clearance,
- Access road construction and temporary facilities setup,
- Excavation of reservoir basin and spillways, irrigation outlets (around 5 km in length),
- Dam construction (backfill and concrete works),

[128]Intergovernmental Panel on Climate Change

- Grading and compaction of soil,
- Operation of stone, gravel-pebble and sandy borrow pits,
- Loading, transportation and unloading of friable materials,
- Drilling works (for the installation of OTL pillars),
- Operation of construction equipment and machinery.

Air emissions expected during the Project's construction phase from both stationary and mobile sources, along with their estimated volumes, were calculated and presented in the national EIA report. The calculations were based on the CORINAIR methodology[129] for vehicles and construction machinery, and the guide for calculating unorganized air emissions from the construction industry for dust emissions. The calculated air emissions (in g/sec and ton/construction phase) from the reservoir construction activities are provided in **Table 8-10**.

**Table 8-10. Calculated volumes of air emissions**

| № | Air pollutants | Emissions, g/sec | Emissions, ton/construction phase |
|---|---|---|---|
| 1 | Dust | 2.55 | 35.2 |
| 2 | Nitrogen dioxide | 0.58 | 8.04 |
| 3 | Carbon oxide | 0.5 | 6.9 |
| 4 | Hydrocarbons | 0.116 | 1.6 |
| 5 | Solid particles | 0.06 | 0.82 |
| 6 | Sulphur anhydride | 0.055 | 0.76 |
| **Total** | | **3.861 (Max)** | **53.32** |

Approximately 65% of the total air emissions from construction activities consist of dust (PM2.5 and PM10). Based on instrumental measurements conducted within the Project site (**Table 6-11** and **Table 6-12**) during the baseline data collection study, the concentrations of PM2.5 and PM10 were approximately 4 to 7 times below the maximum permissible concentrations (MPCs) set by both national environmental standards and IFC/WHO guidelines.

Therefore, the maximum dust emission rate of 2.55 g/sec expected during the construction phase is unlikely to significantly impact ground-level dust concentrations in nearby residential areas, considering that the direct distances between the construction site and the project-affected rural settlements of Astghadzor and Zolaqar are 1,300 m and 2,200 m respectively.

A similar conclusion applies to gaseous emissions, which are also expected to remain below acceptable limits and pose minimal risk to ambient air quality. Furthermore, calculated air emission levels can be further reduced through the implementation of appropriate mitigation measures (see **Table 8-12**).

There could be some beekeeper HHs in the wider area, scattered in the villages. The nearest settlements, Astghadzor, Zolaqar, and Vaghashen, are located ca. 1,300 m, 2,200 m and 3,800 m away from the construction site. So, there is no impact from the construction site on villagers' bee-keeping. However, there could be some disturbance / dust from the traffic.

*Operation phase*

[129]The methodology is based on the classification of vehicles in accordance with the "Core Inventory of Emissions in Europe" (hereinafter referred to as CORINAIR), which is part of the "Base Inventory of Atmospheric Emissions in Europe" methodology

The potential sources, causes and environmental impacts from the operated reservoir are outlined in Table 8-11.

**Table 8-11. Sources, causes and impacts from the reservoirs**

| Source | Cause | Impact |
|---|---|---|
| **AIR POLLUTANTS** | | |
| **Volatile Organic Compounds (VOCs)** | | |
| Volatile organic compounds are emitted in small amounts from reservoirs, particularly if the water is affected by pollutants or chemicals in the surrounding environment. | VOCs can be released from aquatic plants, algae, or even from chemicals used in water treatment, runoff, or industrial activities near the reservoir. | VOCs can contribute to local air pollution, causing smog formation and having potential health impacts. They also contribute to the formation of ground-level ozone and other secondary pollutants. |
| **Ammonia ($NH_3$)** | | |
| Ammonia can be emitted from water reservoirs, especially if the water quality is influenced by agricultural runoff or other sources of nitrogenous compounds. | Ammonia is often released as a result of the breakdown of organic nitrogen in the water. It can also evaporate from surface waters where nitrogen-rich fertilizers or waste runoff have been deposited. | Ammonia can be toxic to aquatic life at high concentrations and, when released into the atmosphere, can contribute to the formation of fine particulate matter. |
| **Dust and Particulate Matter** | | |
| Dust and particulate matter can be emitted from areas surrounding the reservoir, especially in arid or semi-arid regions. | Even wind erosion can cause particulate matter to be emitted from the reservoir's surrounding landscape. | Dust can affect local air quality, contribute to respiratory problems in humans, and have ecological impacts. |
| **Sulphur Compounds (e.g., $H_2S$)** | | |
| In reservoirs with high organic material and low oxygen (anaerobic conditions), sulphur compounds like hydrogen sulphide ($H_2S$) can form. | Sulphate-reducing bacteria in the water may produce hydrogen sulphide when they break down organic matter in low-oxygen conditions. It may also occur in sediments at the bottom of the reservoir. | Hydrogen sulphide has a foul odor and can be toxic at high concentrations. It may also contribute to the formation of other sulphur-related compounds that can impact air and water quality. |
| **Phosphorus Compounds** | | |
| Although phosphorus is typically considered a water pollutant, in some cases, phosphorus compounds can be emitted to the air, particularly in the form of aerosols or particulates. | Phosphorus compounds may volatilize or become airborne when sediment is disturbed or if water quality management practices like aeration are implemented. | Phosphorus itself isn't a greenhouse gas, but it can contribute to nutrient pollution, leading to eutrophication, algal blooms, and subsequent methane emissions. |
| **GHG EMISSIONS** (discussed in Section 8.2.3) | | |
| **Methane ($CH_4$)** | | |
| Methane is one of the most significant greenhouse gases emitted from water reservoirs. It is produced through the | Organic matter like plants, algae, and other organic material decomposes in the absence of oxygen, producing | Methane is a potent greenhouse gas, with a global warming potential many times higher than carbon dioxide |

| Source | Cause | Impact |
|---|---|---|
| **AIR POLLUTANTS** | | |
| anaerobic (oxygen-free) decomposition of organic matter at the bottom of the reservoir, where conditions are conducive to methane production. | methane as a byproduct. This is most common in deeper, more eutrophic (nutrient-rich) reservoirs. | ($CO_2$). Its release into the atmosphere contributes significantly to climate change. |
| **Nitrous Oxide ($N_2O$)** | | |
| Nitrous oxide is a trace greenhouse gas that can be emitted from reservoirs, typically in areas where nitrogen compounds are present. | $N_2O$ emissions can result from the nitrification and denitrification processes, where nitrogen from agricultural runoff or wastewater undergoes biological transformations. This process often occurs under anaerobic conditions in sediment or water, producing $N_2O$ as a byproduct. | Nitrous oxide is a potent greenhouse gas, with a global warming potential over 250 times that of $CO_2$. Although it is typically released in smaller amounts than methane, it still plays a role in climate change. |
| **Carbon Dioxide ($CO_2$)** | | |
| Carbon dioxide is another common emission from reservoirs, resulting from aerobic (oxygen-present) decomposition of organic material in the water. It can also be released through respiration by aquatic organisms. | When organic material in the water decomposes in the presence of oxygen, it breaks down into carbon dioxide. Additionally, photosynthesis by aquatic plants and algae can lead to $CO_2$ release. | While $CO_2$ is a less potent greenhouse gas than methane, it still contributes to the greenhouse effect and global warming. |

The volume of air emissions from the reservoir during the operational phase will be minimal and will primarily depend on the climatic conditions in the Project region. Theoretically, these emissions can be controlled solely through the implementation of a defined operational regime and the application of technical measures; however, given the small quantities of air emissions, such measures are often considered unfeasible. Nevertheless, a set of technical measures that could potentially be considered in the Project design documentation is outlined in **Table 8-12**.

Some minor air emissions may occur during the maintenance activities of the operated reservoir. The types of emissions will be similar to those generated during the construction phase; however, their quantities will be significantly lower and can be considered negligible.

*Impact assessment and mitigation measures*

Assessment and mitigation of impacts on air quality during the reservoir construction and operation phases are summarised in **Table 8-12**.

**Table 8-12. Summary of air emissions impact and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Workers, nearby population, soil | Moderate | 1) Use modern construction machinery equipped with engines compliant with at least Euro IV standards, | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| and water resources, flora and fauna, and beekeeping | (minor for beekeeping) | with emission control and minimal noise characteristics,<br>2) Perform regular technical maintenance of used construction machinery and heavy vehicles,<br>3) Cover friable materials with tarpaulin during the transportation ,<br>4) Minimise dust from open area sources, including storage piles and top-soil storage areas, by using control measures such as installing enclosures and covers, and increasing the moisture content,<br>5) Restrict excavation and earthworks during the periods of strong winds,<br>6) Select the sites for construction facilities and construction machinery with due regard to the prevailing wind directions,<br>7) Apply regular watering to on-site and off-site dirt roads, especially during the excavation and other earthworks,<br>8) Minimize the period between excavation and backfilling works,<br>9) Prohibit construction materials and waste burning,<br>10) Engage with the beekeepers and map the locations of the bee-hives. In case they are located closer than 100m from the village road used by Project transport, assist the bee-keepers in the relocation of the bee-hives farther from the sources of disturbance (roads). | (negligible for beekeeping) |
| *Monitoring:* According to the Air, water and soil quality monitoring plan | | | |
| OPERATION PHASE | | | |
| Nearby population, soil and water resources, flora and fauna | Low | ***Maintenance works***<br>1) Use modern construction machinery equipped with engines that comply with at least Euro IV standards, featuring emission control systems and low-noise characteristics,<br>2) Perform regular technical maintenance of all construction machinery,<br>3) Ensure that maintenance contractors use modern, well-maintained equipment that complies with all applicable technical requirements.<br>***Technical measures that could potentially be included in the Project design documentation***<br>1) Consider aeration systems to oxygenate water and suppress anaerobic methane production,<br>2) Install surface aerators or diffused air systems to increase dissolved oxygen,<br>3) Remove decaying vegetation, crop residues, or debris from the reservoir and inflows, | Negligible |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 4) Keep banks and inflow channels clear to reduce organic loading,<br>5) Establish buffer zones with vegetation to absorb nutrients before they reach the reservoir. | |

### 8.2.5 Impacts on Landscape and Visual Amenity

*Construction phase*

The hilly terrain of the project region effectively conceals the reservoir area from sensitive receptors, including the populations of the adjacent rural settlements, travelers along the M11 road, and visitors to Lake Sevan. A hill, whose right slope forms the riverbed of the Astghadzor River, obstructs the view of the reservoir for residents of Zolaqar and most parts of the Astghadzor rural settlement (**Figure 8-1**). The dam of the reservoir may be visible only from a few residential houses located in the southern part of Astghadzor village (**Figure 8-2**).

As outlined in **Section 2.6** of this ESIA report, the borrow pits and topsoil storage areas will be located within the Project's construction site, therefore is unlikely to disturb the visual amenity of the population of Astghadzor and Zolaqar villages.

Only local villagers who cultivate agricultural land around the reservoir area or use these plots for cattle grazing, as well as occasional visitors, such as custodians of the "Vanqi Berd" archaeological complex, may experience visible changes to the landscape during the construction phase of the Project. The main sources of visual disturbance include construction machinery, heavy vehicles, borrow pits, and storage areas for construction materials and soil/topsoil. While this impact is unavoidable, it is short-term, limited to the construction period, and will affect only a small number of people.

**Table 8-1. Overview of the landscape in the area designated for reservoir construction**



**Table 8-2. View to the Astghadzor village from the reservoir dam area**


Prior to the start of construction, the planned reservoir area shall be cleared from all vegetation, including bushes and approximately 38 trees. According to calculations conducted in the frames of the national EIA study, around 190 trees shall be planted as a compensatory measure. This shall be carried out in accordance with the Tree Management Plan, which will be prepared by the construction contractor and implemented during the construction phase.

*Operation phase*

During the operation phase the landscape of the Project area will experience a permanent transformation due to the formation of the reservoir and the presence of supportive infrastructure. Main impacts include:

**1) Permanent change in land cover**

The original hilly terrain, river flow and vegetation will be replaced by a standing water body, altering the natural character and visual identity of the area.

**2) New visual elements**

The reservoir, dam structure, and supportive facilities will become dominant and permanent features in the landscape.

**3) Potential aesthetic value**

The reservoir will enhance the visual appeal of the area, depending on how well it integrates with the surrounding environment.

**4) Landscape alteration**

Natural regeneration and vegetation growth around the reservoir perimeter may gradually soften visual contrasts and help the area blend with the surrounding environment.

In addition to natural landscaping, the following man-made interventions may contribute to a positive visual perception and enhanced visual amenity for sensitive receptors:

1. **Orchard Development**: Due to climate change phenomena, conditions in the project region have become favorable for the cultivation of apricots, peaches, pears, and nuts. As a result, the development of new orchards is anticipated following the implementation of the project.
2. **Tree Planting Compensation**: According to the national EIA study, 38 trees within the reservoir and dam area will be removed. As a compensatory measure, 190 trees will be

planted, primarily around the reservoir site and/or downstream of the dam. Over time, these trees are expected to screen the reservoir dam from view. This activity will be implemented through the Tree Management Plan (TMP), prepared by the construction contractor and approved by the client and the EBRD.

3. **Irrigation-Driven Landscape Enhancement**: Irrigation of currently uncultivated land plots using reservoir water will support the development of a rural vernacular and organically evolved landscape.

Overall, the visual impact during the operation phase is long-term and permanent but is generally more stable and potentially less intrusive than during the construction phase. Effective landscaping and environmental integration measures can help mitigate negative visual effects and may even result in a net positive visual outcome, particularly in terms of the cultural landscape.

*Impact assessment and mitigation measures*

Assessment and mitigation of visual impacts during the reservoir construction and operation phases are summarised in **Table 8-13**.

**Table 8-13. Summary of visual impact and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Local villagers, shepherds, and travelers/ visitors | Moderate | ***Pre-construction phase***<br>1) Develop Tree Management (TrMP) and obtain approval from the Supervising engineer and agreement from the affected community.<br>***Construction phase***<br>2) Plant 190 trees in locations agreed upon with the head of Martuni community, preferably downstream of the reservoir, to gradually screen the dam from view over time. Ensure a two-year aftercare period, which may be carried out during the reservoir's operation phase.<br>3) The proposed types of trees to be planted are:<br>• Salix purpurea L.,<br>• Populus nigra L. | Low |
| OPERATION PHASE | | | |
| Population, visitors | Significant | Ensure maintenance and aftercare of the planted trees envisioned by the TrMP for two years.<br>*Over time, natural regeneration and vegetation growth may reduce visual contrasts and facilitate the integration of the area into the surrounding landscape.*<br>*If well integrated with the natural landscape, the reservoir may contribute positively to the area's overall visual character.* | Low<br><br>Can be positive (after 3-5 years) |
| Population, landowners, visitors, tourists | Neutral | ***Cultural Landscape***<br>Consult the heads of affected settlements and landowners who will gain access to irrigation water as a result of the project implementation, regarding the | Positive |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | design solutions for establishing orchards and cultivating wheat and vegetables based on modern cultivation and irrigation technologies.<br>*This may transform the organically evolved cultural landscape, characterized by traditional crop fields and orchards, into a designed cultural landscape.* | |

### 8.2.6 Impact on Geology

*Construction phase*

The main impacts on the geological structure within the Project area are associated with the following construction activities:

1) Vegetation clearance and removal of topsoil,
2) Excavation and earthworks,
3) Soil erossion in the construction site, topsoil and spoil temporary disposal areas.

The impact of vegetation clearance and topsoil removal is minor and is unlikely to generate significant erosion processes as these works deal with the ground surface layer (up to 0.2 m) only.

Excavation and earthworks will involve the movement of a certain amount of soil (including topsoil and excavated subsoil), which may potentially trigger landslides, mass movements, and other erosion processes. Improper practices in the storage of topsoil and spoil, particularly: (i) excessive height of stockpiles and steep slope gradients, (ii) location of storage sites near watercourses and roads, and (iii) open storage without vegetation cover or protective sheeting, can negatively affect the geology of the Project site and surrounding areas. These aspects and the relevant mitigation measures are discussed in detail in **Section 8.2.8**.

Another potential impact of the Project on geological erosion is the temporary destabilization of disturbed soils due to precipitation and surface runoff. These effects on the soil, along with resulting changes in topography, may create conditions that lead to temporary but harmful erosion and sedimentation. The proposed mitigation measures are presented in **Table 8-14**.

*Operation phase*

During the operation phase, impacts on the geological conditions of the Project area may result from:

1) Water infiltration from the reservoir body and the dam base, potentially affecting groundwater,
2) Coastal erosion around the entire perimeter of the reservoir due to water encroachment during the initial years of operation.

Water infiltration aspects were addressed as part of the Project's engineering-geological study (**Section 2.5**). This study included an analysis of the infiltration properties of the upper soil layer within the planned reservoir area. The estimated annual water infiltration from the reservoir body is approximately 1.8 mln. $m^3$, highlighting the need for anti-infiltration measures. However, these measures are not described in detail in the current Project design documentation. Therefore, the development of anti-infiltration standard measures shall be discussed with the Client and EBRD and included in the Project's Environmental and Social Action Plan (ESAP).

The management and mitigation of the second impact also require technical and technological solutions. Some of these are likely addressed in the Project design documentation; however, additional mitigation measures may be recommended by the Consultant to minimize coastal erosion during the early years of reservoir operation. These measures (**Table 8-14**) can be discussed with the Client and the EBRD and incorporated into the Project design documentation, if deemed relevant:

1. **Bioengineering / Vegetative Measures**
   - **Revegetation of shorelines:** Planting native grasses, shrubs, and trees to stabilize soil through root systems and reduce erosion,
   - **Use of geotextiles:** Biodegradable or synthetic mats that support vegetation growth while preventing initial soil loss.
2. **Shoreline Stabilization Measures**
   - **Riprap (rock armoring):** Placing layers of large, durable stones along vulnerable shorelines to dissipate wave energy and prevent erosion,
   - **Revetments:** Sloped structures placed on banks to absorb and deflect the energy of incoming water.
3. **Reservoir Operation Management**
   - **Controlled filling rates:** Gradually filling the reservoir to allow shoreline soils to stabilize and minimize sudden saturation that can lead to collapse,
   - **Water level fluctuation control:** Avoiding large, rapid fluctuations in water level during early years to reduce destabilization of new shorelines.
4. **Erosion Monitoring and Adaptive Management**
   - **Regular monitoring:** Using drones, surveys, or satellite imagery to detect early signs of erosion and assess the effectiveness of mitigation measures,
   - **Adaptive management plans:** Revising and enhancing shoreline protection measures based on ongoing monitoring results,
   - **Erosion-sensitive zoning:** Identifying high-risk areas and applying stricter protection or engineering controls there.

*Impact assessment and mitigation measures*

Assessment and mitigation of impacts on geological conditions during the reservoir construction and operation phases are summarised in **Table 8-14**.

**Table 8-14. Summary of geological impacts and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Soil resources | Moderate | 1) Diversion ditches or berms: Redirect surface runoff away from disturbed areas,<br>2) Proper grading: Ensures slope stability and directs water flow along controlled paths, including through designated construction outlets,<br>3) Slope breakers: Break long slopes into smaller segments to reduce erosion potential,<br>4) Phased construction: Limits the area of exposed soil at any given time, | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 5) Avoiding earthworks during the rainy season: Where feasible, schedule earthworks outside of the rainy season to reduce erosion risk. | |
| *Monitoring:*<br>- Regular site inspections: Especially after rainfall, to check for erosion signs and repair damaged controls,<br>- Maintenance of sediment control measures: Ensure ditches, berms and drains are functioning properly. | | | |
| OPERATION PHASE | | | |
| Soil resources | Moderate | 1) Bioengineering / Vegetative Measures<br>- Planting native grasses, shrubs, and trees to stabilize soil through root systems and reduce erosion,<br>- Biodegradable or synthetic mats that support vegetation growth while preventing initial soil loss.<br>2) Shoreline Stabilization Measures<br>- Placing layers of large, durable stones along vulnerable shorelines to dissipate wave energy and prevent erosion,<br>- Sloped structures placed on banks to absorb and deflect the energy of incoming water.<br>3) Reservoir Operation Management<br>- Gradually filling the reservoir to allow shoreline soils to stabilize and minimize sudden saturation that can lead to collapse,<br>- Avoiding large, rapid fluctuations in water level during early years to reduce destabilization of new shorelines.<br>4) Erosion Monitoring and Adaptive Management<br>- Regular monitoring: Using drones, surveys, or satellite imagery to detect early signs of erosion and assess the effectiveness of mitigation measures,<br>- Adaptive management plans: Revising and enhancing shoreline protection measures based on ongoing monitoring results,<br>- Erosion-sensitive zoning: Identifying high-risk areas and applying stricter protection or engineering controls there. | Low Negligible (after 3-5 years of operation) |
| *Monitoring:*<br>- Using drones, surveys, or satellite imagery to detect early signs of erosion and assess the effectiveness of mitigation measures,<br>- Revising and enhancing shoreline protection measures based on ongoing monitoring results,<br>- Identifying high-risk areas and applying stricter protection or engineering controls there. | | | |

### 8.2.7 Impact on Water Resources

The potential impacts of the Project on surface water resources during the construction and operation phases are described in **Subsections 8.2.7.1-8.2.7.3**.

#### *8.2.7.1 Water Quality / Water Contamination*

*Construction phase*

The results of water quality analysis of the Astghadzor River, compared with the environmental norms set by RA Government Decree №75-N, are presented in **Section 6.1.5** of this ESIA report. The analysis shows that, except for the concentrations of suspended solids, sulfates and color indicator, the water quality may be categorised as 'excellent' or 'good'. In terms of suspended solids and sulfate ions content, however, the water quality is classified as 'fair' and 'poor' accordingly. The water samples were taken in April, when snowmelt, mixed with soil particles, was feeding the Astghadzor River. This phenomenon may explain the relatively high content of suspended solids in the samples.

During the construction phase, contamination of the Astghadzor River may occur due to the deposition of dust and exhaust gas emissions (from construction machinery and heavy trucks), spills of hazardous materials, and improper management of storage areas. Surface water quality may also deteriorate as a result of soil erosion and runoff caused by rainfall or snowmelt.

Earthworks, blasting, and improper transportation or storage of topsoil, spoil, friable construction materials, and oil products, as well as loading/unloading operations, can lead to pollutants partially settling into nearby surface watercourses and/or potentially infiltrating into groundwater, thereby degrading overall water quality. Additionally, potential spills or leakages of oil and lubricants from construction machinery may be carried by runoff and discharged into downstream surface waters.

The removal of topsoil, excavation, and other earthworks will disturb the soil and vegetation cover within the Project area, potentially triggering or intensifying soil erosion. This erosion may cause soil to migrate into waterways via surface runoff, increasing turbidity and silting of water bodies, ultimately leading to further deterioration in surface water quality.

In can be concluded that the implementation of mitigation measures presented in **Sections 8.2.4**, **8.2.6** and **8.2.8**, supplemented by the measures proposed in **Table 8-15** will significantly minimise the impact of the construction works on water quality.

*Operation phase*

During the operation phase, the water quality of the Astghadzor River upstream of the reservoir is not expected to change, as the reservoir operation will not cause contamination of upstream watercourses.

Within the reservoir, several natural processes contribute to the self-purification of water. These include sedimentation of suspended solids, adsorption and precipitation of nutrients and metals, microbial degradation of organic matter, and nutrient uptake by aquatic vegetation. Together, these ongoing processes help to maintain and improve water quality, supporting the long-term sustainability of irrigation activities. As a result, the quality of water downstream of the reservoir, including both environmental flow and irrigation water, is expected to improve due to the implementation of the Project.

However, one important precondition must be taken into account: soil erosion along the perimeter (shoreline) of the reservoir, particularly during the early years of operation, as well as stormwater and agricultural runoff into the Astghadzor River and reservoir must be minimized (see **Section 8.2.6**). In addition, any manmade inflows from domestic or industrial activities into the reservoir must be eliminated.

#### *8.2.7.2 Changes to Hydrological Regime*

The following parameters are characterizing the hydrological regime of the reservoir:

**1) Flow Regulation**

The pre-construction river flow is natural with seasonal variations, with high flows during snowmelt or rainy seasons, and low flows during dry periods. After the construction the reservoir operation will regulate the flow, reducing peak discharges during floods and augmenting flow during dry periods. Therefore, the regulation of the water flow may benefit irrigation, but affect the natural water flow seasonal fluctuations downstream.

**2) Alteration of Flow Timing**

Reservoir operation often changes the timing of downstream flows, releasing water based on demand rather than natural cycles. This can shift peak flows from spring (due to snowmelt) to summer or autumn (due to irrigation needs), disrupting ecological processes.

**3) Reduction in Peak Flows and Flood Frequency**

Controlled releases from the reservoir reduce peak flood events downstream. This can lower the risk of flood damage but also impact floodplain ecosystems that depend on periodic flooding for nutrient cycling and habitat renewal.

**4) Evaporation Losses**

Large surface areas of reservoirs increase evaporation, especially in arid or semi-arid climates. This can lead to reduced downstream water availability compared to pre-reservoir conditions.

**5) Environmental Flow Modification**

Without proper planning, minimum environmental flows downstream may not be maintained. Therefore, environmental flow requirements must be included in the reservoir operation plan to support aquatic ecosystems and community needs.

In can be concluded that particularly the operation phase of the Project will significantly alter the hydrological regime of the Astghadzor River. These changes include the regulation of natural flow variability, reduction of peak discharges, changes in flow timing, and sediment retention. While these changes support improved water availability for irrigation, they may also impact downstream ecosystems and groundwater dynamics. To mitigate adverse effects, the implementation of irrigation water and environmental flow releases management plan is recommended.

#### *8.2.7.3 Water losses*

*Construction phase*

No changes in water losses compared to the baseline situation are expected during the construction phase.

*Operation phase*

Water losses can occur from the reservoir body, the dam, the irrigation main outlet OJ 1 and irrigation pipelines OJ 1-1 and OJ 1-2. Calculations of water infiltration from the reservoir body and the dam, along with required anti-infiltration, are presented in the Project design document and summarised in **Section 2.5** and **Section 8.2.6** of this ESIA report.

The irrigation network comprises a 1,433 m long stainless-steel main irrigation outlet OJ 1 (Ø630×10 mm), a 342 m long stainless-steel pipeline OJ 1-1 (Ø426×6 mm) to the Astghadzor settlement, and a 3,254 m long stainless-steel pipeline OJ 1-2 (Ø426×6 mm) to Vaghashen, all of which will be installed during the Project's construction phase. As a result, water losses from the

main outlet and pipelines are unlikely, except in the event of incidents or technological breakdowns. To address such cases, regular technical maintenance of the reservoir's supporting infrastructure will be required in accordance with the Reservoir Operation and Maintenance Plan (see also **Section 8.4**).

*Impact assessment and mitigation measures*

Assessment and mitigation of impacts on water resources during the reservoir construction and operation phases are summarised in **Table 8-15**.

**Table 8-15. Summary of impacts on water resources and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Water resources | Moderate | ***Construction phase - Water Contamination***<br>1) Construct intermediate collection pools between runoff-generating surfaces and downstream watercourses to regulate flow to water bodies. These pools will allow soil particles to settle at the bottom, thereby reducing the turbidity of the runoff,<br>2) Limit excavation and other earthworks near the Astghadzor River during the rainy season,<br>3) Prohibit the discharge of any untreated wastewater effluent into surface water bodies,<br>4) Where practical, construct local perimeter drains around working areas (e.g., storage and parking areas) to collect suspended runoff and prevent its discharge into surface water resources. | Low |
| *Monitoring:* According to the Air, water and soil quality monitoring plan | | | |
| OPERATION PHASE | | | |
| Water resources | Low | ***Operation phase - Water Contamination***<br>1) Minimize potential stormwater and agricultural runoff release to the Astghadzor River, if any,<br>2) Eliminate manmade inflows from domestic or industrial activities into the reservoir. | Positive |
| Water resources, irrigation water users, ecosystems downstream the reservoir | Significant | ***Pre-operation phase - Hydrological Regime***<br>Develop irrigation water and environmental flow releases management plan to:<br>- Ensure reliable and efficient delivery of irrigation water to agricultural areas,<br>- Maintain minimum environmental flows to support the health of downstream aquatic and riparian ecosystems,<br>- Prevent over-extraction and degradation of water resources,<br>- Comply with national water use regulations and environmental protection standards.<br>***Operation phase - Hydrological Regime*** | From moderate to low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 1) Review the irrigation water and environmental flow releases management plan annually, or after major hydrological events, to incorporate new data, regulatory changes, and operational experience,<br>2) In the event of low reservoir levels or critical drought conditions, implement a prioritization protocol that protects environmental flows up to a predefined minimum threshold before allocating water for irrigation. | |
| *Monitoring:*<br>- Real-time monitoring to adjust schedules based on demand and supply conditions,<br>- Monthly reports on water releases for irrigation and environmental purposes must be submitted to the Water Committee,<br>- Regular ecological monitoring downstream to evaluate the adequacy of flow for habitat maintenance. | | | |
| Water resources, irrigation water users, | Low | ***Pre-operation phase - Water losses***<br>Develop Reservoir Operation and Maintenance Plan,<br>***Operation phase - Water losses***<br>Carry out technical maintenance of the reservoir's supporting infrastructure to eliminate incidents and breakdown in accordance with the Reservoir Maintenance Plan. | Negligible |

### 8.2.8 Impact on Soil

#### *8.2.8.1 Topsoil Management*

*Construction phase*

Construction works will begin with vegetation clearance and topsoil removal. According to the Project design study, 48,640 $m^3$ of topsoil will be stripped and stored in temporary topsoil storage areas located outside the reservoir area but within the construction site (**Figure 2-6**). The topsoil will later be used for landscaping activities.

If not properly managed, the removed topsoil can be damaged through mixing with subsoil (spoil) and/or other materials. Additionally, the topsoil may lose its physical and biological properties due to compaction by heavy machinery within the construction site. Losses may also occur during transportation to the topsoil temporary storage areas, as well as through wind and water erosion while in storage. Furthermore, the quality of the topsoil may deteriorate if the stockpiles are not properly maintained during the storage period.

According to the national legislation, topsoil management shall be regulated by the *Procedure for Topsoil Use*, approved by the RA Government Decree №1396-N, and the *Requirements for Determining Topsoil Stripping Norms and for the Preservation and Use of Stripped Topsoil*, approved by the RA Government Decree №1404-N. These documents define:

- Organizational aspects, including the procedure for permit issuance for soil removal, transportation and storage,
- Technical aspects, such as the prescribed norms (thickness) of topsoil to be stripped and removed,

- Technological and environmental aspects, including conditions and specifications for topsoil storage, preservation and use.

Topsoil removal, transportation, storage, and reuse operations should be carried out by the construction contractor in accordance with the requirements of the above-mentioned documents and the supplementary mitigation measures proposed in **Table 8-17**. The topsoil will be stored outside the construction site but within the designated protection zones, and will later be used for landscaping purposes (see **Section 8.2.5**). The construction contractor shall also develop and implement a Topsoil Management Plan (TsMP).

*Operation phase*

No impacts on topsoil are expected during the Project operation phase.

#### *8.2.8.2 Soil Excavation and Disposal*

*Construction phase*

According to the RA Law on Waste, and in particular the *List of Wastes Generated in the Republic of Armenia*, approved by Order №342-N of the RA Minister of Environment, excavated material (subsoil or spoil, waste code: 31401101 01 00 5) is classified as non-hazardous waste. Since the excavated spoil materials will be used as backfill, the permanent disposal of this material is not addressed in this section (see also **Section 8.2.9**).

*Operation phase*

No impacts associated with soil excavation and disposal are anticipated during the reservoir operation phase.

#### *8.2.8.3 Management of Hazardous Materials*

*Construction phase*

The list of hazardous materials that may potentially be used during the construction of the reservoir and its infrastructure, along with their associated hazards, is presented in **Table 8-16**.

**Table 8-16. Hazardous materials to be used during the reservoir construction, their uses and associated hazards**

| № | Materials | Use | Hazards |
|---|---|---|---|
| 1 | Fuels (diesel, petrol) | Powering construction machinery, generators, and heavy trucks. | Flammable, risk of spills leading to soil and water contamination. |
| 2 | Lubricants and oils | Machinery operation and maintenance (e.g., excavators, loaders, vehicles). | Toxic to aquatic life, potential for soil contamination. |
| 3 | Concrete and additives | Enhancing performance of concrete (e.g., accelerators, retarders). | May contain hazardous chemicals (e.g., formates, chlorides), skin and eye irritants. |
| 4 | Paints and coatings | Corrosion protection of metal structures, tanks, and pipelines. | May contain solvents and heavy metals; volatile organic compounds (VOCs). |

| № | Materials | Use | Hazards |
|---|---|---|---|
| 5 | Explosives | Blasting during reservoir construction. | High risk if not properly managed, requires strict storage and usage protocols. |

Leakages and accidental spills of hazardous materials, along with their management measures, are discussed in **Sub-section 8.2.8.4**. The impacts of hazardous materials on health and safety, as well as fire risks, are outlined in **Section 8.3.6**. Before the commencement of construction works, the construction contractor shall develop a Hazardous Materials Management Plan (HMMP) and Blasting Safety Management Plan (BSMP). Additional mitigation measures are presented in **Table 8-17**.

*Operation phase*

Only a few types of hazardous materials, and in small quantities, will be used during the maintenance of the reservoir and its infrastructure. Their potential impacts are negligible; therefore, they do not require mitigation measures.

### *8.2.8.4 Soil Contamination*

*Construction phase*

Accidental spills of friable materials, leakages of oil, fuel, and other liquid chemicals during the field works within the construction site as well as their transportation, storage, and use, may inevitably occur and lead to soil contamination. Improper waste management can also result in littering and further soil pollution (see **Section 8.2.9**). Therefore, the handling of hazardous materials, including their transportation, storage, and use, must be carefully managed.

The use of old or technically outdated construction machinery and heavy trucks for the Project shall be strictly prohibited. Friable materials shall be transported using trucks fitted with waterproof canvas covers. Oil products and chemicals must be stored separately in clearly marked drums or tanks, placed on secondary containment systems or spill trays. The refuelling or the transfer of oil, fuel, or other chemicals should take place in dedicated areas with impervious surface equipped with protective berms (**Figure 8-2**). Excavated spoil and topsoil shall be stored and managed in accordance with the procedures outlined in **Subsection 8.2.8.1**.

Facilities designated for the storage of oil and chemicals, as well as heavy trucks used to transport such materials, shall be equipped with appropriate spill kits (**Figure 8-2**). Construction and other friable materials shall be stored in separately allocated, fenced areas covered with waterproof sheeting. In addition, it is recommended to regularly monitor soil quality near potentially contaminated areas, in accordance with the Air, Water, and Soil Quality Monitoring Plan. All of the specified measures, along with others, shall be consolidated into the Spill Prevention and Management Plan (SPMP).

**Figure 8-2. Recommended tools and kits for prevention or mitigation of spillages and leakages**

*a) Secondary containments or trays for storage and refilling of oil products and chemicals*


*b) Spill kits for oil products and chemicals*

Provided that the measures recommended in **Table 8-17** are implemented, the Project's impact on soil contamination during the construction phase can be assessed as low.

*Operation phase*

Some small-scale accidental spills of oil products and friable materials can be expected during routine maintenance of the reservoir body, dam, and supporting infrastructure, as well as during regular cleaning of the irrigation channel. These leaks (spills) can be prevented or minimised through the implementation of some administrative and organizational measures, such as outsourcing of the maintenance works to the contractors equipped with modern and technically serviced equipment.

*Impact assessment and mitigation measures*

Assessment and mitigation of impacts on soil during the reservoir construction and operation phases are summarised in **Table 8-17**.

**Table 8-17. Summary of soil impacts and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Soil and water resources, flora and fauna | Moderate | ***Pre-construction phase***<br>1) Develop a Topsoil Management Plan (TsMP) and obtain approval from the Supervising Engineer,<br>2) Obtain the required permits for topsoil transportation and storage operations from the affected municipality,<br>3) Develop a Hazardous Materials Management Plan (HMMP) and obtain approval from the Supervising Engineer,<br>4) Develop a Spill Prevention and Management Plan (SPMP) and obtain approval from the Supervising Engineer.<br>***Construction phase - Topsoil management***<br>1) Carry out the removal, transportation, storage, and use of topsoil in accordance with RA Government Decrees №1396-N and №1404-N,<br>2) Store topsoil separately to prevent mixing with subsoil, maintaining it in a condition that preserves the natural seed bank, until construction works are completed, | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 3) Locate topsoil stockpiles at least 50 m away from watercourses to prevent water siltation,<br>4) Avoid placing topsoil stockpiles near planned excavation areas,<br>5) Limit the height of stockpiles to a maximum of 3 m, and ensure the slope gradient does not exceed 25º,<br>6) Clearly label all topsoil stockpiles to ensure easy identification,<br>7) Cover topsoil stockpiles to prevent soil erosion, where natural revegetation has not occurred,<br>8) Fence off topsoil stockpiles to prevent unauthorized access and compaction by Project vehicles,<br>9) Reuse the stored topsoil for landscaping the disturbed areas and/or tree planting within the Project area after the completion of reservoir and dam construction.<br>***Construction phase - Hazardous materials***<br>1) Store all hazardous materials in clearly labeled, secure, and ventilated areas,<br>2) Hazardous materials containers to be clearly labelled according to contents and hazards,<br>3) Equip sites with spill response kits and train workers on emergency response,<br>4) Maintain Material Safety Data Sheets (MSDS) for all hazardous materials on-site,<br>5) Incompatible hazardous materials must not be stored together,<br>6) Hazardous materials storage areas will be equipped with eye wash kits and fire extinguishers,<br>7) Use appropriate PPE.<br>***Construction phase - Soil contamination***<br>1) A total volume of 608,089 $m^3$ of spoil material, generated during excavation and earthworks, will be re-used as backfill material for the reservoir and dam body (**Section 2.6.7**, **Table 2-11**). Therefore, designated Spoil Disposal Areas will not be required for the Project<br>2) Store construction and other friable materials in separately designated areas that are fenced and covered with waterproof tents,<br>3) Store oil products and chemicals separately, in special drums or tanks placed on secondary containment systems or trays (110% of the volume of the container),<br>4) Carry out refueling of oil, fuel, and other chemicals only in dedicated area with impervious surface eqipped with protective berms, | |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 5) Equip storage facilities for oil and chemicals, as well as heavy trucks transporting these materials, with appropriate spill kits,<br>6) Immediately stop work in the event of uncontrolled spillage of fuel, engine oil, or chemicals. Contain the spill and remediate contaminated soil by removing the affected layer (to be treated as hazardous waste) and replacing it with clean soil,<br>7) Train all staff on the safe execution of construction works and on response procedures for environmental incidents such as spills and leaks,<br>8) Ensure spoil piles do not exceed 3 m in height, and maintain slope gradients not exceeding 25º. Manage spoil piles to prevent erosion and runoff. | |
| *Monitoring:* According to the Air, water and soil quality monitoring plan | | | |
| OPERATION PHASE | | | |
| Soil and water resources, flora and fauna | Low | Outsource the maintenance of the operated reservoirs to the contractors equipped with modern and technically serviced equipment. | Negligible |

### 8.2.9 Waste Generation and Management

*Construction phase*

Typically, the construction of the reservoir, dam, and associated components is accompanied by the generation of industrial and household wastes, including:

- Excavated material (spoil) from excavation and other earthworks,
- Construction waste (residues of concrete, sand, gravel, used wood materials, etc.),
- Used oil and lubricants,
- Oily rags and soil contaminated with oil products,
- Used tires,
- Used lead-acid batteries,
- Ferrous and non-ferrous metal scraps, welding electrode slag,
- Empty containers of fuel, oil products and chemicals,
- Used packaging materials (cardboard and paper),
- Household waste.

Roughly 600,000 $m^3$ of ground material, mostly in a form of sandy loam, will be generated during excavation and earthworks. These materials will be temporarily stored in the construction site and will totally be used as backfill material for the reservoir and dam body (**Section 2.6.7**, **Table 2-6**). Therefore, designated Spoil Disposal Areas will not be required for the Project.

There is no information relating to the volumes of household waste to be generated during the construction provided in the design document.

According to the World Bank Project - *Armenia SWM Sector Assessment and Reform Plan, Sector Assessment Report* (2024), the current household waste generation rate is 219 kg/capita/year (or 18.25 kg/capita/month) for Armenian settlements with populations under 40,000 residents. Taking

into account that 99 workers (see **Section 2.6.7**) will be engaged in construction activities, it can be assumed that the monthly amount of household waste will be 18.25 × 99 = 1,807 kg (or approximately 1.81 tonnes). Over the entire reservoir construction period (36 months × 1.81 tonnes), 65.16 tonnes of household waste will be generated. The volumes of other types of waste remain unknown.

The types, hazard classes and codes of industrial and household waste to be generated during the construction phase as well as recommended waste management actions as per waste hierarchy, are presented in **Table 8-18**.

**Table 8-18. Types, hazard classes and codes of wastes generated during the construction works**

| № | Types of waste | Hazard Class | Hazard Code[130] | Recommended management actions |
|---|---|---|---|---|
| 1 | Excavated material (spoil) | V (non-hazardous) | 31401101 01 00 5 | Use as a backfill material |
| 2 | Construction waste | IV | 91200601 01 00 4 | Use as a backfill material, if possible. The residual part will be disposed of in the landfill |
| 3 | Used oil and lubricants:<br>- Industrial oil<br>- Engine oil<br>- Hydraulic oil<br>- Diesel oil | III | 54100205 02 03 3<br>54100201 02 03 3<br>54100213 02 03 3<br>54100203 02 03 3 | Store under special conditions and transfer to the licensed companies specialised in oil refining |
| 4 | Oily rags | III | 58200600 01 01 4 | Store under special conditions and transfer to the licensed companies for the treatment |
| 5 | Soil contaminated with oil products | III | 31402303 01 03 4 | |
| 6 | Used tires | IV | 57500200 13 00 4 | Periodically transfer to the licensed companies for the recycling |
| 7 | Used lead-acid batteries | II | 92110100 13 01 2 | Store under special conditions and transfer to licensed companies for the recycling |
| 8 | Ferrous metal scrap, empty metallic containers of fuel, oil products and chemicals | IV | 35131100 01 00 4 | Can be periodically transferred to specialised companies for the recycling |
| 9 | Welding electrode slag | IV | 31404800 01 99 4 | |
| 10 | Non-ferrous metal scrap:<br>- Copper scrap<br>- Aluminium scrap | III<br>V (non-hazardous) | 35310301 01 01 3<br>35310105 01 99 5 | Can be transferred to specialised companies for the recycling |
| 11 | Used packaging materials:<br>- Cardboard<br>- Paper | V (non-hazardous) | 18710202 01 00 5<br>18710300 01 00 5 | Can be transferred to specialised companies for the recycling |
| 12 | Household waste | IV | 91200400 01 00 4 | Shall be disposed of in the landfill |

[130]According to the list of waste generated in the Republic of Armenia (https://www.arlis.am/hy/acts/100155)

Proper management of the waste streams to be generated during the construction phase will be ensured through a detailed Waste Management Plan (WMP), to be prepared by the appointed construction contractor prior to the start of construction works. The WMP as a minimum shall include:

- Waste storage locations, containers and conditions,
- Environmental, fire, health and safety of the waste storage facilities,
- Actions to be implemented to ensure the provisions of waste management hierarchy (prevention, minimization, reuse, recycling, energy recovery and disposal, see also Table **8-18**),
- Safe transportation of waste,
- Response to the accidents (leakages of liquid waste, spills of friable materials, etc.) (see also **Section 8.2.8**),
- Requirements and responsibility of the engaged personnel,
- Waste inventory and records, etc.

All required permits and documents regulating waste management in Armenia shall be obtained by the construction contractor prior to the commencement of construction. These documents shall include, at a minimum:

(i) Hazardous waste passports;
(ii) Approved waste generation norms and disposal limits;
(iii) Waste generation register;
(iv) Waste primary registration logbooks;
(v) Contracts with licensed waste handling companies;
(vi) Other relevant documentation, as applicable.

*Operation phase*

During the Astghadzor reservoir operation phase, the main types of waste generated will be associated with the maintenance of the reservoir, dam, and supporting infrastructure (e.g., irrigation channels, spillways, etc.), including:

- Debris and general litter,
- Metal scraps from repair works,
- Used oil and lubricants,
- Sludge (sediment) resulting from dredging operations (if required),
- Household waste (including small quantities of oily rags, which can be collected together with household waste due to their minimal volume).

Currently, it is unclear whether the volume of sediment accumulated in the reservoir will periodically require removal from the reservoir bottom through dredging operations. However, if required, disposal at a landfill or the use of dredged sediment as fertilizer shall be considered.

Although only small volumes of waste are expected to be generated from maintenance operations, they should be properly managed by the operator of the Astghadzor reservoir, most likely "Jrar" CJSC under the MTAI. Taking into account that "Jrar" CJSC also manages other first and second category reservoirs[131] in Armenia, the company should have a corporate Waste Management Plan (WMP) in place for the maintenance of all reservoirs under its control.

[131] *Armenia Water Reservoirs - Technical, Economic and Green Due Diligence Gap Analysis, Draft Final Report*, 2023-2024, Ove Arup & Partners

All waste-related permits required for the construction phase are also applicable to the operation phase and must, therefore, be obtained by "Jrar" CJSC. These provisions will also be included in the Project's Environmental and Social Action Plan (ESAP).

*Impact assessment and mitigation measures*

Assessment and mitigation of the reservoir construction and operation related waste impacts are summarised in **Table 8-19**.

**Table 8-19. Summary of waste-related impact assessment and mitigation measures for the construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Workers, nearby population, soil and water resources, flora and fauna | Moderate | ***Pre-construction phase - Waste management***<br>1) Obtain all required permits and mandatory documents regulating waste management in Armenia, as a minimum including:<br>- hazardous waste passports,<br>- waste generation norms, and their disposal limits,<br>- waste generation register, etc.,<br>- waste primary registration log-books,<br>- contracts with licensed waste handling companies.<br>2) Prepare and put into effect the Waste Management Plan (WMP) for the Project.<br>***Construction phase - General***<br>1) Train the workers engaged in waste management on provisions of the WMP,<br>2) Apply waste hierarchy approach (prevention, minimization, reuse, recycling, energy recovery, disposal) while implementing the construction activities,<br>3) Elaborate and implement waste handling procedures for the construction operations,<br>4) Equip the construction site and construction camps with the waste separate collection / storage containers and locations,<br>5) Furnish the waste storage / collection facilities with fences, fire extinguishers, secondary containment trays, oil and chemicals spill clean-up kits, etc.,<br>6) Store liquid waste leak-proof, sealed containers.<br>7) Sign contracts with the licensed waste handling (recycling, treatment, disposal) companies to hand them over the generated wastes.<br>***Construction phase - Waste transportation***<br>1) Transport all types of wastes using adequate, sealed and covered trucks to avoid the leakage or dispersal of the waste on roads and surroundings,<br>2) Ban fly tipping waste on the route and/or their disposal in unauthorized locations, | Low |

| | | | |
|---|---|---|---|
| | | 3) Select less risky transportation route from the waste generation and temporaray storage area to its transfer and recycling / disposal area,<br>4) Train the waste truck drivers on waste transportation safety rules.<br>***Construction phase - Household waste management***<br>1) Equip the construction site with clearly labelled household collection containers / bins,<br>2) Sign a contract with the communal company for the regular removal of household waste from the construction site and construction camps. | |
| Workers of the construction contractor | Moderate | In addition to the measures listed above: enforce the use of PPE and in particular, the protective clothes, shoes, gloves, respirator / masks for the workers dealing with the waste. | Low |
| *Monitoring:* According to the Waste Management Plan | | | |
| OPERATION PHASE | | | |
| Workers of the reservoir operator | Low | 1) Obtain all required permits and mandatory documents relevant to the operation of reservoirs in Armenia, as required by local waste-related legislation (can be done at the corporate level),<br>2) Develop and implement WMP for the operation and maintenance of the reservoir (can be done at the corporate level),<br>3) Apply waste hierarchy approach (prevention, minimization, reuse, recycling, energy recovery, disposal) for the generated waste,<br>4) Equip the site with clearly labelled waste collection and storage containers and areas,<br>5) Sign contracts with the licensed waste handling (recycling, treatment, disposal) companies to hand them over the generated wastes,<br>6) Sign a contract with the communal company for the regular removal of household waste from the reservoir site. | Negligible |
| *Monitoring:* According to the operation phase Waste Management Plan | | | |

### 8.2.10 Noise and Vibration Impact

*Construction phase*

The main sources of noise and vibration during the construction stage are:

1) Operation of construction machinery within the construction site,
2) Movement of heavy trucks along community and regional roads, as well as within the construction site,
3) Operation of the construction camps and borrow pits,
4) Noise-generating activities such as the loading and unloading of topsoil and spoil, construction materials, and combustibles.

The dominant source of noise from most construction equipment is the engine, which typically runs on diesel and may lack adequate muffling. However, in some cases, noise generated by construction processes may exceed that produced by the equipment itself. Noise levels during construction will vary depending on the specific activities, schedule, and combination of equipment in use.

There are no residential areas in the immediate vicinity of the Project site. The nearest settlements, Astghadzor, Zolaqar, and Vaghashen, are located approximately 1,300 m, 2,200 m and 3,800 m away from the construction site, respectively. Therefore, construction-related noise and vibrations are not expected to significantly impact the local population. However, minor noise disturbances may affect residents of Astghadzor and Zolaqar during the transportation of construction materials and personnel via community roads. Construction workers may also be exposed to noise and vibration during on-site activities. Additionally, construction noise could disturb local wildlife and livestock grazing in the areas surrounding the Project site.

It is evident that typical noise levels generated by construction equipment exceed the national hygienic standard of 80 dBA. Therefore, several mitigation measures, such as the provision of personal protective equipment (PPE) for workers, should be implemented (**Table 8-20**). These measures, along with other mitigation efforts, will help reduce noise exposure for construction workers, local farmers cultivating nearby agricultural land, shepherds guiding livestock to grazing areas near the construction site, and occasional visitors to the Project area.

The analysis of similar projects and the Consultant's experience indicate that construction-related vibration impacts are localized and typically limited to within 40 m of the source. Considering that the nearest residential houses and commercial facilities are located at a considerable distance from the Project site, it can be concluded that there will be no vibration impacts on sensitive receptors. Furthermore, construction vibrations will not affect the seismic stability of existing buildings and structures except for structures within "Vanqi Berd" archaeological complex (see **Section 8.5**). Only operators of construction equipment and machinery may be exposed to vibration. Therefore, appropriate PPE should be provided to the relevant workers.

The analysis of similar projects, along with the Consultant's experience, indicates that construction-related vibration impacts are typically localized and confined to within 40 m of the source. Given that the nearest residential houses and commercial facilities are located at a considerable distance from the Project site, it can be concluded that sensitive receptors will not be affected by vibration. Furthermore, construction vibrations are not expected to impact the seismic stability of existing buildings and structures, with the exception of those within the "Vanqi Berd" archaeological complex (see **Section 8.5**). Within the Project site, only operators of construction equipment and machinery may be exposed to vibration; therefore, appropriate personal protective equipment (PPE) should be provided to relevant workers.

*Operation phase*

No significant noise or vibration exposure is expected from the operation of the reservoir. Only periodic maintenance activities may generate noise, which is anticipated to be negligible.

*Impact assessment and mitigation measures*

The assessment and mitigation of noise and vibration impacts during the construction and operation phases of the reservoir are summarised in **Table 8-20**.

**Table 8-20. Summary of noise and vibration impacts and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Workers of construction contractor, villagers, shepherds | Moderate *(in case of heavy trucks movement)*<br>Low *(in case of operation of construction machinery)* | 1) Keep all diesel-powered vehicles and equipment (such as generators and air compressors) at a high level of maintenance. This will particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers,<br>2) Machinery/vehicles that are used intermittently will be shut down or throttled back during periods when not in use,<br>3) Whenever possible: enclose noisy equipment, restrict non-stop operation of noisy equipment, avoid simultaneous operation of noise generating equipment,<br>4) Avoid unnecessary idling times,<br>5) Minimise the need for equipment to reverse. This will reduce the frequency at which disturbing but necessary reverse warnings will occur,<br>6) Avoid unnecessary horn hooting from the used construction machinery,<br>7) Limit truck speeds - not to exceed 40 km/h, when driving through local community roads,<br>8) Inform population of Astghadzor and Zolaqar settlements of the schedule and duration of construction activities, particularly where these are likely to generate high noise levels and before the blasting works,<br>9) Ban the movement of heavy trucks along the communal roads between 10 PM and 6 AM near residential areas. | Low |
| Workers of construction company | Moderate | In addition to the measures listed above:<br>1) Enforce the use of PPE and in particular, the protective devices capable to reduce the sound level at the ear to acceptable levels,<br>2) Ensure that all workers exposed to local vibration are provided with and use appropriate PPE,<br>3) Provide employees engaged in 'noisy' operations with additional 15 minutes break per 2 hours. | Low |
| *Monitoring:* According to the Noise, Vibration and Blasting Monitoring Plan. | | | |

### 8.2.11 Traffic Impacts

*Construction phase*

Access to the planned reservoir area passes through the communal roads of Astghadzor and Zolaqar villages. The roads within these settlements are asphalt-paved; however, as the route

approaches the Project site, it transitions into an earthen road. Construction activities will significantly increase the movement of heavy trucks due to the transportation of:

- Approximately 9,500 m³ of reinforced concrete to the construction site,
- Towers for the overhead transmission lines, along with other electrical equipment and materials,
- Construction materials, oil products, and chemicals to the construction site,
- Industrial and household waste (65.16 tons) to landfills or specialized disposal companies, etc.

The communal roads of Astghadzor and Zolaqar villages will also be used to transport workers between their accomodation facilities to the construction site and back. These roads will also be used to deliver construction machinery to the site.

The implementation of the Project will have a moderate impact on the traffic intensity within the rural settlements of Astghadzor and Zolaqar. The increase in traffic intensity is also connected with higher noise levels; therefore, the mitigation measures proposed in **Section 8.2.10** are partially applicable to traffic-related impacts.

Moreover, the construction contractor shall develop a Traffic Management Plan (TMP), that will be approved by the Supervision engineer and agreed with the client and EBRD as well as relevant regional authorities and road police. The TMP will also address the provisions and measures outlined in **Sections 8.2.11**, **8.3.2**, **8.3.5** and **8.5.2**.

*Operation phase*

No significant traffic impacts are expected during the reservoir operation phase.

*Impact assessment and mitigation measures*

The assessment and mitigation of traffic impacts during the construction and operation phases of the reservoir are summarised in **Table 8-21**.

**Table 8-21. Summary of traffic impacts and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Population of Astghadzor and Zolaqar rural settlements | Significant | ***Pre-construction phase***<br>1) Develop a Traffic Management Plan, that will be approved by the Supervision engineer and agreed with the Client and EBRD as well as relevant regional authorities and road police.<br>2) Prior to the commencement of construction works, the condition of community roads to be used for project purposes shall be inspected and documented by construction contractors and representatives from the affected settlements. In the event that significant damage is caused by the Project, the Construction Contractor shall restore the roads to at least their pre-construction condition.<br>*The TMP shall also cover measures outlined in Sections 8.3.2, 8.3.5 and 8.5.2.* | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | ***Construction phase***<br>1) Construct the access roads as envisioned in the Project design document,<br>2) Implement the Traffic Management Plan,<br>3) Train drivers of heavy vehicles on the key requirements of the Traffic Management Plan,<br>4) Inform local residents of anticipated construction-related traffic impacts at least two weeks prior to the start of construction, and periodically consult with the community regarding any changes in road traffic,<br>5) Equip roads used by Project vehicles with appropriate road safety signs and posters,<br>6) Provide additional crossings for cattle where necessary. | |

### 8.2.12 Impact on Biodiversity

This sub-section presents an assessment of the potential impacts on biodiversity resulting from the Project-related construction and operations activities.

Impacts of the Project will occur within the footprint areas (dam, reservoir), temporary roads and sites (construction roads, camp, areas for storage of the excavated topsoil and soil), and within a potential zone of influence of 500 m around the footprint areas.

The baseline biodiversity studies focused primarily on the footprint areas of the proposed dam and reservoir. For the purposes of this assessment, the scope has been expanded to include biodiversity within these areas and a 500-meter buffer zone surrounding them.

The impacts are considered and assessed taking into account EBRD's PR 6 (2019), and Guidance Notes to the EBRD PR 6 (2023), as well as applicable national legislation of the RA.

#### *8.2.12.1 Impacts of the Project*

As presented in the Baseline section, the Project will be implemented in an area of high biodiversity where valued (priority) habitats and species were identified.

The impacts of the Project on biodiversity will occur during both construction and operation phases. The construction phase includes construction of the dam and reservoir filling. The methodology of impact assessment, including identification of impact characteristics and matrix significance are detailed in **Section 5** "ESIA Methodology and Approach". Due to the species' varying responses to different impacts, the sensitivity of each species (receptors) was taken into account during the assessment.

Potential impacts on biodiversity (including priority biodiversity features and critical habitats) derive from activities during:

1. Construction phase, and include:
    - Destruction (loss) of habitats (vegetation clearance, excavation, top-soil removal and transportation, reservoir filling),
    - Flora species loss (vegetation clearance, including trees cutting, excavation, top-soil removal and its transportation, reservoir filling),

- Disturbance of fauna species by noise, vibration and light pollution (construction machinery, traffic, lighting of the building area),
- Destruction of sedentary animals' habitats and a risk of their death (excavation, top-soil removal and its transportation, reservoir filling),
- Loss of foraging habitats for medium and large mammals (excavation, top-soil removal and its transportation, reservoir filling),
- Loss of breeding and foraging habitats for birds (excavation, top-soil removal and its transportation, reservoir filling),
- Loss of habitats of invertebrates and a risk of partial death of their populations (vegetation clearance, excavation, removal of topsoil and its transportation, reservoir filling),
- Impact on protected areas and internationally designated areas.

2. Operational phase, and include:
   - Emergence of new habitats (water, riparian areas),
   - Increased access to the area.

The negative impacts occur mainly during the construction phase; they are caused by the dam construction and flooding of the reservoir footprint area.

Some positive impacts on biodiversity will occur during the operational phase, associated with the emergence of the new habitats - such as large water surface and coastal vegetation - which will attract various animal species.

The assessment was conducted for each predicted impact during the construction and operation phases and for each group of biodiversity receptors, which were grouped based on their ecological characteristics. Where possible, impacts on individual species were also assessed.

#### *8.2.12.2 Construction phase*

*Destruction (loss) of habitats*

Currently, some of the habitats are in pristine conditions and other are partly disturbed. Some grassland areas are impacted by grazing. Riparian habitats are partly damaged due to the construction of a stone ridge approximately one meter high along one side of the riverbank, apparently built by local population (see **Figure 6-11**). Land clearance, excavation, and topsoil/soil removal will trigger the loss of the habitats within the dam and reservoir footprint (with a total area of 14,98 ha). Initially, habitats will be impacted during clearance of the dam footprint area, followed by topsoil/soil removal, and dam construction. Subsequently, habitats located in the flooded part of the river valley will be lost during the reservoir filling.

Priority habitats of this area are the following habitats[132]:

- C2.27 Mesotrophic vegetation of fast- flowing streams (0.31 ha),
- C3.2 Water fringing reedbeds and tall helophytes other than canes (0.1 ha),
- C3.55 Sparsely vegetated river gravel banks (1.87 ha),
- C3.62 Unvegetated river gravel banks (0.25 ha).

The total lost area of the habitats is 2.53 ha.

[132]Names of habitats in accordance with Resolution 4 of the Bern Convention

The habitats will be finally destructed by the reservoir filling; only C.3.2 habitat may restore along the reservoir shore.

*Flora species loss*

Land clearance, excavation, topsoil/soil removal will result in vegetation clearance in the same areas where habitats will be destructed (see above). According to the national EIA report, 38 trees of the two species (*Salix purpurea L.* and *Populus nigra L.*) will need to be cut during the construction of the reservoir.

There are no protected plant species (nationally or internationally) registered in the Project area.

*Disturbance of fauna species*

Terrestrial animals can be divided in two groups in relation to their reaction to disturbance - those that run away, and those that hide where they live. Below, the identified mammals, birds, reptiles, and amphibians are analysed in terms of their reaction to disturbance.

According to the baseline study, the identified terrestrial mammals were classified into two groups based on size and lifestyle. The first group includes permanent residents of the area, such as small- and medium-sized species, mainly rodents, insectivores, and small predators. The second group includes temporary visitors that transit through the area, such as predators, mainly canids.

Small permanent residents (rodents, insectivores) usually hide (in burrows, for example) in response to disturbances, they do not run away from their homes. This behaviour in the context of the Project is dangerous because it results in death of the animals due to the destruction of their homes; potential impacts on this group of animals are considered in the sub-section below.

The second group of temporary visitors usually move away or avoid disturbance areas.

Identified birds are classified in three groups - i) breeding in the Project area, ii) breeding in proximity to the site and using the area as part of their foraging range, and iii) passing the area during the seasonal migration. They all will also move away or avoid disturbance zones.

Identified reptiles and amphibians are permanent residents; they would choose the same hiding strategy as the small sedentary mammals (see above), so they will be in danger of dying. Potential impacts on this group of animals are considered below.

Noise and soil vibration caused by trees clearance, as well as the start of construction works, will be the initial impacts in the Project area. Impact distance (for noise) can vary from about 100 m to 500 m and more, depending on species sensitivity[133, 134]. As a result, the dam footprint area and parts of the reservoir footprint area, as well as adjoined territories (about 500 m around) will be abandoned by most animals.

The next phase of the construction process will be the dam filling, during which impact factors such as vibration, noise, dust, and lighting will occur. These factors will scare away the animals who are still present around the dam area.

*Loss of sedentary animals' habitats and associated risk of mortality*

[133]Senzaki, M., Yamaura, Y., Francis, C. et al. Traffic noise reduces foraging efficiency in wild owls. Sci Rep 6, 30602 (2016). https://doi.org/10.1038/srep30602

[134]Shilling, F.; Collins, A.; Louderback-Valenzuela, A.; Farman, P.; Guarnieri, M.; Longcore, T., et al. (2018). Wildlife-Crossing Mitigation Effectiveness with Traffic Noise and Light. UC Davis: National Center for Sustainable Transportation. Retrieved from https://escholarship.org/uc/item/8893d8zw

There are two groups of permanent residents which were identified - small mammals (rodents, insectivores), and reptiles and amphibians. Both groups of animals use certain type of shelters (e.g., holes, rocks, hollows, etc.) and hide there in case of danger or disturbance. Such impact as noise will make them hide. Intensive vibration can drive animals out of their shelters, but they will not run far away trying to find temporary shelter and come back when the impact disappears.

Thus, these two groups are mostly likely to be affected during the construction works at the dam footprint area.

A similar negative impact may occur during the filling of the reservoir, as shelters could be flooded, resulting in death of most animals.

The following three biodiversity values were identified among sedentary species:

**Reptilia**

- Dice Snake *Natrix tessellata*, CH (the flooded area will increase the periphery of the shoreline and thus, will increase the habitat of the species),
- Armenian steppe viper *Vipera (Pelias) eriwanensis*, PBF, RDB of RA, range-restricted species

**Amphibia**

- Variable toad/ green toad *Bufo viridis*, CH (the flooded area will increase the periphery of the shoreline and thus, will increase the species habitat).

The Project reservoir probably will not affect the Armenian Steppe Viper's habitats, as the majority of the species' range are located outside the project area. At the same time, to confirm absence of the species shelters in the area, the pre-construction survey is suggested at the beginning (March-April) or end (September) of the species' activities season.

The project is beneficial for other priority species, namely the Dice Snake and Green Toad, as it increases the water surface and shoreline, thereby enhancing habitats and food supply. Therefore, none of the mitigation measures are required.

Permanent residents of the first group of mammals, such as the Badger and Least weasel, use burrows; however, they can leave them when disturbed and relocate to other habitats. To prevent harm to these animals, it is necessary to survey their burrows before the construction works begin and monitor if the animals vacate them; if they do not, special measures to safely drive them away should be implemented.

*Loss of foraging habitats for medium and large mammals*

Animals of the second mammal group (namely, temporary visitors) will move away or avoid disturbance once the site clearance and construction work start. The main deterrent impact is noise.

The Gray wolf *Canis lupus,* was identified as the priority (CH) species. The species individuals may pass through the area, and occasionally hunt there. There are no significant impacts predicted for the species, and, therefore, no mitigation measures are required. Nevertheless, to be sure no den of the species is located in the area, the pre-construction survey is recommended.

*Loss of breeding and foraging habitats for birds*

From 95 identified species, 33 species are assessed as the Priority Biodiversity Features (PBF) according to the EBRD PR6 criterion 12: namely, 29 species as they are listed in the Resolution No. 6 of Bern Convention and Annex I of the EU Birds Directive, three species as they are "significant biodiversity features identified by a broad set of stakeholders or governments" (listed in the RA Red

Book, category Vulnerable), and one species, *Phylloscopus sindianus*, as regularly occurring range-restricted species.

Due to the anticipated flooding of the territory, the loss of breeding habitats[135] is expected for the following numbers of the species (breeding pairs), protected under the Bern Convention (marked as Res 6) and the RA Red Book (marked as RDB AM):

1. Corn crake *Crex crex* 1-2 pairs (RDB AM, Res6),
2. Red-backed Shrike *Lanius collurio* 2-3 pairs (Res 6),
3. Ortolan Bunting *Emberiza hortulana* 2-3 pairs (Res 6).

The flooding will restrict the individual foraging territories for the following numbers of the species, protected under Bern Convention (marked as Res 6):

1. Long-legged Buzzard *Buteo rufinus* 1-2 breeding pairs (Res 6).

The area of the proposed reservoir contains none of the restricted-range species that breed in the territory.

The flooding will not affect majority of the large-ranged species, which use the area only as a part of their foraging range, protected under the Bern Convention and RA Red Book:

1. Bearded Vulture Gypaetus barbatus,
2. Griffon Vulture Gyps fulvus,
3. Long-legged Buzzard Buteo rufinus,
4. Golden Eagle Aquila chrysaetos.

Also, the flooding will not affect the migratory and wintering species, protected under the Bern Convention and the RA Red Book, including those which make relatively high congregations during the migration:

1. Little Egret *Egretta garzetta,*
2. Black Stork *Ciconia nigra,*
3. Ruddy Shelduck *Tadorna ferruginea,*
4. European Honey-buzzard *Pernis apivorus,*
5. Black Kite *Milvus migrans,*
6. Short-toed Snake-eagle *Circaetus gallicus,*
7. Hen Harrier *Circus cyaneus,*
8. Montagu's Harrier *Circus pygargus,*
9. Pallid Harrier *Circus macrourus,*
10. Marsh Harrier *Circus aeruginosus,*
11. Egyptian Vulture *Neophron percnopterus,*
12. Steppe Eagle *Aquila nipalensis,*
13. Imperial Eagle *Aquila heliacal,*
14. Lesser Spotted Eagle *Clanga pomarine,*
15. Booted Eagle *Hieraaetus pennatus,*
16. Levant Sparrowhawk *Tachyspiza brevipes,*
17. Eurasian Buzzard *Buteo buteo,*
18. Lesser Kestrel *Falco naumanni,*

[135]Any activity of the Project has to be implemented before the breeding season or after, and thus we do not assume that any birds will die.

19. Peregrine Falcon *Falco peregrinus,*
20. Common Crane *Grus grus,*
21. Demoiselle Crane *Anthropoides virgo,*
22. Armenian Gull *Larus armenicus,*
23. European Roller *Coracias garrulus,*
24. Citrine Wagtail *Motacilla citreola,*
25. Lesser Grey Shrike *Lanius minor,*
26. Crimson-winged Finch *Rhodopechys sanguineus.*

The absence of impact can be explained by the fact that the majority of raptors and cranes do not stop in the area and pass it. The ducks, gulls, and wagtails will benefit from the creation of the reservoir. The Crimson-winged Finch makes vertical movement from the higher elevation and moves around with the small groups, and the flooded area doesn't play any critical role for it.

The following mitigation measures are suggested for the Priority Species:

1. Implement conservation/restoration measures for grassland habitats located upstream of the reservoir to support the breeding habitat of the Corn Crake.
2. Consider introduction of sustainable grazing practices in Astghadzor community, which can improve the quality of grassland habitat, increase the number and diversity of the herbaceous vegetation and invertebrates, and support the necessary food supply for the Red-backed Shrike and Ortolan Bunting, thus increasing their populations density.

The size of the territory for the Corn Crake is linked to the male's calling site, often defined as a 200- to 250-meter radius, which includes the nest and brood-rearing areas. Therefore, for two pairs[136] of a Corn Crake it is recommended to consider conservation or restoration of 39.25 ha of grasslands that maintain continuous vegetation cover with a minimum height of 20 cm.

The individual breeding territories of the Red-backed Shrike range from 0.64 and 1.33 ha per pair. Considering the degraded conditions of the existing grassland habitats, it is reasonable to apply the upper value of 1.33 ha per pair. Therefore, restoration of approximately 2.66 ha of suitable habitat is recommended the support two breeding pairs of the species.

The spatial distribution of breeding populations of Ortolan Bunting is more complex, which is why the individual breeding territories of the Ortolan Bunting are not fixed and depend on the local habitat structure.

The key characteristic for the Ortolan Bunting is the need for separate foraging and nesting sites, with males often leaving the nest territory for up to 27% of the day to forage at distances as far as 2.7 km away. Territories can vary depending on the local habitat, but they require a mosaic of bare ground, short vegetation, and areas with taller plants for song posts.

Considering that the breeding and foraging ranges of both species usually overlap, it would be reasonable to restore 4 ha of the grassland habitat to support population of both the Red-backed Shrike and the Ortolan Bunting.

Accordingly, a total of 39.25 ha of grasslands habitats should be restored or conserved upstream of the reservoir to support the three target species, taking into account the overlap between the Corn Crake's breeding area and the habitat requirements of the Red-backed Shrike and the Ortolan Bunting.

[136]Two pairs of Corn Crake are taken for calculation basing on the conservative approach

*Loss of habitats of invertebrates and a risk of partial death of their populations*

The planned reservoir will affect the population of the restricted range species *Carabus cribratus*.

To compensate loss of the species population it is recommended to develop specific habitat features for this species in the surrounding grasslands. Specifically, it is recommended to increase the number of large stones, which serve as diurnal shelters for this species. The recommended sizes of the rocks and their spatial distribution are a subject of additional field study.

*Impact on protected areas and internationally designated areas*

The reservoir site is located 5 km from the border of Sevan National Park (see Figure 6-17). No significant impacts of the reservoir on the National Park are expected; however, a potential impact may arise from a reduction in water discharge, as the Lake Sevan ecosystem is particularly sensitive to water shortages. To prevent a reduction in water discharge, an appropriate environmental flow should be maintained from the reservoir. The required flow rate has been calculated and recommended by the national EIA[137]. Accordingly, no additional mitigation measures are proposed.

The reservoir site is located inside the Candidate Emerald site "Sevan" National Park. About 15 ha of native and partially disturbed habitats will be lost due to the reservoir footprint. This area includes a total of 2.53 ha of four priority habitats, three of which are listed among the habitats of the Candidate Emerald Site in Resolution No. 4 of the Bern Convention[138].

The Candidate Emerald site "Sevan" National Park already encompasses a significant portion of disturbed areas around Lake Sevan, including settlements, agricultural lands and other modified habitats. The reservoir will create an additional plot of the artificially altered land, contributing to the fragmentation of the Candidate Emerald Site. From a quantitative point of view, this contribution is insignificant (0,0003% of the Candidate Emerald Site).

The reservoir construction works will destroy animals' habitats and may be the cause of death of the sedentary species of mammals and reptiles. The lost habitats also serve as foraging areas for certain bird and mammal species; as a result, these species will avoid or leave the area during construction. The affected species and potential impacts are described in the relevant sub-chapters above.

The reservoir area is located 1.5 km from the border of the IBA Lake Sevan and environs. The potential impact on this area is limited to the loss of foraging habitats for some far-ranging bird species, particularly birds of prey. However, the Project area does not appear to play a critical role in their foraging, as existing observations indicate that these species use it opportunistically rather than intensively (see above sub-chapter 'Loss of breeding and foraging habitats for birds'). Therefore, this impact is considered minor or negligible.

#### *8.2.12.3 Operation phase*

*Emergence of new habitats (water, riparian)*

The flooding will create additional water and riparian habitats, which can be colonized by some water birds, as well as water invertebrates. Therefore, it can be expected that the bird fauna may be enriched with such species as Green Sandpiper *(Tringa ochropus),* and possibly some species of ducks, herons, egrets, and other shorebirds.

It will create additional habitats for some of the existing priority species, such as:

1. Ruddy Shelduck *Tadorna ferruginea,*

[137]Updated ESIA of the Project, 2024

[138]https://natura2000.eea.europa.eu/Emerald/SDF.aspx?site=AM0000002

2. Common Sandpiper *Actitis hypoleucos.*

Also, it might create better stopover conditions for the following migrating species:

1. Little Egret *Egretta garzetta,*
2. Black Stork *Ciconia nigra,*
3. Demoiselle Crane *Anthropoides virgo*,
4. Peregrine Falcon *Falco peregrinus,*
5. Citrine Wagtail *Motacilla citreola.*

Certain birds of prey from the IBA Lake Sevan and environs will migrate to the new foraging habitats.

*Increased access to the area*

Increase in waterbird diversity and numbers can attract hunters; this is more likely because the Astghadzor and Zolaqar settlements are located in close vicinity to the Project site. Therefore, the biodiversity management plan should consider possible increase of illegal hunting in the area, which can affect not only game birds, but also priority bird and mammal species.

*Impact assessment and mitigation measures*

Assessment and mitigation of impacts on biodiversity during the construction and operation phases are summarized in **Table 8-22**. According to the mitigation hierarchy[139] four types of measures are applied - avoidance, minimization, restoration and offset. Excluding avoidance (as construction of the dam and reservoir at the footprint areas is already approved by the government), the measures are presented in the **Table 8-22**.

**Table 8-22. Summary of impacts on biodiversity and mitigation measures for the Project construction and operation phases**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| **Overarching action:**<br>**Develop a Biodiversity Action Plan (BAP)[140]** during the pre-construction phase to cover mitigation activities of the pre-construction, construction, and operation phases. The BAP will outline and provide guidance for components such as the Biodiversity Management Plan (including monitoring) and the Riverine Habitat Construction Plan, Offset project. The mitigation and/or management measures listed below shall be incorporated into the BAP. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |
| 1. Habitats | Significant | ***Pre-construction phase***<br>1) Study the priority habitats (PBFs) in the Project area, their plant composition and ecological structure, and determine their precise extent,<br>2) Develop detailed habitat maps,<br>3) Develop a Riverine Habitat Construction Plan to guide the development, construction and maintenance of the priority habitat (PBF) along the reservoir banks:<br>C3.2 Water fringing reedbeds and tall helophytes other than canes, | Moderate (after offset - no net loss / a net gain) |

[139]Guidance Notes to the EBRD PR 6 (March, 2023)
[140]Biodiversity Action Plan is developed and approved prior the tendering process for the Construction contractor. Other Biodiversity plans developed by the Construction contractor prior to construction. Some specified mitigation measures are implemented at the pre-construction phase and some - throughout construction.

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 4) Study areas along the river in the reservoir protection/buffer zone, as wells as upstream and downstream to define existing habitats similar to the following:<br>C2.27 Mesotrophic vegetation of fast- flowing streams,<br>C3.55 Sparsely vegetated river gravel banks,<br>C3.62 Unvegetated river gravel banks,<br>5) Develop a habitat offset project aimed at conserving/restoring habitats in areas most suitable for conservation.<br><u>*Preliminary quantitative assessment*</u><br>*The total lost area of the riverine habitat C3.22 is 0.1 ha. The reservoir perimeter potentially suitable for riverine habitat creation is estimated at approximately 1.5 km. Taking these figures into account, if take the width of the shoreline strip 5 m, that's reasonable for the habitat, a "net gain" will be achieved with multiplier 7.5 (1500 m × 5 m = 7500 $m^2$/1000 m = 7.5).*<br>*Total lost area of the habitats C2.27, C3.55, C3.62 is 2.43 ha (these habitats are riverbed habitats of the fast-flowing streams). At the same time, area of the reservoir protection/buffer zone that can be used for conservation of these three habitats is about 0.3 ha. Accordingly, there is not enough area in the protection/buffer zone to apply even «no net loss» approach for conservation of these habitats. Additional areas should be found and conserved upstream and downstream.*<br>*Proposals for the construction and conservation of the habitats, including multiplier, should be finally developed in the BAP.* | |
| OPERATIONAL PHASE | | | |
| Habitats | No new impact, but the mitigation continues: | 1) Implement the Riverine Habitats Construction Plan: construct and maintain the following habitat (PBF) along the reservoir's banks:<br>C3.2 Water fringing reedbeds and tall helophytes other than canes,<br>2) Implement the offset project to conserve the following three priority habitats:<br>C2.27 Mesotrophic vegetation of fast- flowing streams,<br>C3.55 Sparsely vegetated river gravel banks,<br>C3.62 Unvegetated river gravel banks. | - |
| ***Monitoring:*** according to the Riverine Habitats Construction Plan and the monitoring chapter of the offset project | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |
| 2. Flora | Significant | ***Pre-construction phase*** | Moderate |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 1) Study plant composition and structure of the priority riverine habitat,<br>2) Develop a Riverine Habitat Construction Plan using indigenous plant species as the basis for habitat creation,<br>3) Develop a Tree Management Plan (TMP).<br>***Construction phase***<br>4) Plant 190[141] trees and ensure their aftercare for a period of two years (aftercare may be carried out during the reservoir operation phase).<br>The proposed[142] species of trees to be planted include:<br>*Salix purpurea L.*<br>*Populus nigra L.* | (after offset - no net loss / a net gain) |
| OPERATION PHASE | | | |
| Flora | No new impact, but the mitigation continues | Construct and maintain the riverine habitat along the reservoir's banks based on indigenous plant species. | Low |
| ***Monitoring:*** according to Riverine Habitat Construction Plan and TMP. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |
| 3. Fauna (other than those listed below) | Significant | ***Pre-construction phase***<br>1) Develop the Worker Code of Conduct for employees of the Construction contractor to prevent poaching.<br>***Construction phase***<br>1) Plan and commence construction works (including tree cutting) starting from one edge of the dam area progressing along the valley; this approach will allow animals to leave the area,<br>2) Begin the construction works before or after the breeding season - prior to April or after August; this will protect lives of animals, including offspring,<br>3) Monitor compliance with the Worker Code of Conduct by the construction company workers to prevent poaching,<br>4) Develop the Worker Code of Conduct for the operator of the reservoir to prevent poaching. | Low |
| OPERATION PHASE | | | |
| Fauna | Moderate | Monitor compliance of the reservoir's operator with the Worker Code of Conduct to prevent poaching during operations. | Negligible |
| ***Monitoring:*** according to the Biodiversity Management Plan. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |

[141] According to calculations conducted in the frames of the national EIA study, these trees shall be planted as a compensatory measure; there were used 1:5 ratio. Number of trees to be planted are 38 × 5 = 190.

[142] Proposed in the national EIA study

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| 4. Sedentary animals | Significant | ***Pre-construction phase***<br>1) Survey the footprint area to map local habitats and estimate the number of individuals of lizards and snakes, especially Armenian steppe viper,<br>2) Identify existing rocky habitats which are suitable for relocation of snakes and lizards in the vicinities of the flooded area (first of all, in the reservoir buffer/protection zone),<br>3) Create additional rocky outcrops in the vicinity of the flooded area to increase the number of native bush species to enhance habitats for snakes and lizards,<br>4) Survey the area to map inhabited burrows of badger and other burrowing animals.<br>***Construction phase***<br>1) Before the reservoir construction starts, survey the construction area and capture found lizards and snakes (if found before, Armenian steppe viper), and relocate them to safe habitats identified during the pre-construction phase,<br>2) Before filling the reservoir, survey the site and capture as many individuals as possible, including snakes and lizards, and relocate them to the safe habitats identified and/or arranged during the pre-construction phase,<br>3) Before filling the reservoir, inspect the mapped residential burrows of badger and other animals; if any individuals remain, capture them and relocate to the safe habitats. | Low |
| OPERATION PHASE | | | |
| Sedentary animals | No new impact, but the mitigation continues | 1) Introduce or support sustainable grazing practices in the areas that surround the planned reservoir, as improved quality of the habitats can provide a more diverse food supply for reptilians, thus supporting an increase in the population density of the snake and lizard species,<br>2) Maintain rocky habitats which are habitats for relocation snakes and lizards in the vicinities of the flooded area.<br>*Preliminary quantitative assessment*<br>*Area suitable for the construction and conservation of rocky habitats is about 4 ha in the reservoir buffer/protection zone.*<br>*Proposals for the construction and conservation of the habitats, including multipliers, should be developed in the BAP.* | Low |
| ***Monitoring:*** according to the Biodiversity Management Plan. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| 5. Medium and large mammals | Moderate | ***Pre-construction phase***<br>1) Survey the footprint area to confirm/rule out presence of the den of Gray Wolf; if den is found, take measures to scare away animals from the reservoir area,<br>The survey should be conducted before or after the breeding season. | Negligible |
| ***Monitoring:*** according to the Biodiversity Management Plan. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASE | | | |
| 6. Birds | Moderate | ***Pre-construction phase***<br>Provide conservation/restoration of grasslands upstream (around) of the reservoir, to support the breeding habitat of the Corn Crake.<br>*Preliminary quantitative assessment*<br>*Potential area of the protection/buffer zone, suitable for the grasslands restoration and conservation is approximately 20 ha.*<br>*The minimum area (multiplier = 1) for compensation of the lost habitats of the priority bird species, based on a "no net loss" approach is 39.25 ha (see sub-section Loss of breeding and foraging habitats for birds - above). Accordingly, the buffer area is not sufficient to achieve "no net loss" outcome. To achieve "no net loss" outcome, and, moreover, "net gain", additional areas of grasslands should be defined upstream of the reservoir site.*<br>*If sustainable grazing practices are applied in the grasslands surrounding the buffer area, they will help to maintain the necessary food supply for the two priority species (see Operation phase). In this case, these areas may be taken into account in the compensation.*<br>*Proposals for the use of restored and conserved habitats within the protection/buffer zone, as well as for the additional habitats, including multipliers and related calculation, should be developed as part of the BAP.*<br>***Construction phase***<br>Maintain the restored parts of grasslands. | Low |
| OPERATION PHASE | | | |
| Birds | No new negative impact, but the mitigation continues<br><br>Positive impact could manifest | 1) Introduce/support sustainable grazing practices in the Astghadzor community to improve the quality of grassland habitat, increase the number and diversity of invertebrates, and support the necessary food supply for the Red-backed Shrike and Ortolan Bunting, thereby contributing to a potential increase in their population density,<br>2) Maintain the restored parts of grasslands. | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| ***Monitoring:*** according to the Biodiversity Management Plan. | | | |
| PRE-CONSTRUCTION AND CONSTRUCTION PHASES | | | |
| 7.Invertebrates | Significant | ***Pre-construction phase***<br>Study and quantify the lost habitats of the *Carabus cribratus,* establish habitat features for this species in the surrounding grasslands (namely, increase the number of large stones, which serve as diurnal shelters for this species).<br>*These habitats may be included in the restored grassland habitats (see above) in the buffer/protection zone and/or in areas surrounding the reservoir site.*<br>***Construction phase***<br>Maintain developed habitats. | Low |
| OPERATION PHASE | | | |
| Invertebrates | Moderate | 1) Introduce/support sustainable grazing practices in the Astghadzor community around the reservoir site, that can improve quality of grassland habitat,<br>2) Maintain developed habitats. | Low |
| ***Monitoring:*** according to the Biodiversity Management Plan. | | | |

## 8.3 Social Impacts and Benefits, Mitigation Measures

### 8.3.1 Impacts on the Local/Regional Economic Growth, Employment and Business / Investment Opportunities

*Construction phase*

The nearest settlement to the planned construction site is Astghadzor village, located approximately 1.3 km away, followed by Zoloqar village at 2.2 km, Vaghashen village at 3.8 km and Martuni town at 5.5 km away. The nearby residents might be positively impacted by the new employment opportunities during the Project's construction phase, potentially leading to increased household incomes.

Local and regional businesses may benefit through participation in the Project's supply chain, including sectors such as transportation and provision of goods and services. For this, a supplier mapping and capacity assessment is recommended to identify existing local companies in transportation, catering, construction materials, accommodation, equipment rental, and other service sectors. The Project should furthermore establish transparent procurement procedures, and provide clear information about upcoming contracting opportunities, and advertise tenders locally in accessible languages.

*Operation phase*

The Martuni Community Five-Year Development Plan emphasizes modernization, repair, and construction of irrigation systems as key priorities for agricultural development[143]. Thus, the construction of the reservoir will have a positive impact on agricultural productivity in the region.

[143]Martuni Community Five-Year Development Plan for 2022-2026 available at https://martuni.am/Pages/DocFlow/Def.aspx?a=v&g=bc526424-c9d5-4b91-97e0-906a961b7fda

According to economic and financial analysis[144], the Project will generate a positive Net Present Value (NPV) over both 20- and 50- year horizon, even under the most conservative assumptions regarding costs and benefits. The analysis also demonstrates significant potential upside should project costs be reduced or benefits exceed projections. Finally, even with a 20% cost increase or substantially lower benefits, the Project remains economically and financially viable.

Residents expressed strong support regarding the reservoir construction project, noting that its completion will bring long-awaited access to reliable water resources. Many emphasized that the sooner the reservoir is built, the better, as it has been a community aspiration for many years. However, participants also raised concerns about the high interest rates on agricultural loans and the limited market opportunities for selling agricultural products.

According to interviews with the residents, there is here a strong appreciation for the planned reservoir construction, which is expected to expand the area of cultivated land and enable the cultivation of higher-value crops such as green beans, cucumbers, cauliflower, broccoli. Residents also noted the potential to grow high-quality apricots and cherries. The reservoir is anticipated to increase the number of farmers, create additional employment opportunities, boost agricultural income, and reduce work migration from the settlements.

### 8.3.2 Impacts on Public Facilities and Infrastructure

*Construction phase*

An additional pressure on local infrastructural facilities including power lines, roads, and healthcare facilities might occur due to the Project construction activities. A Traffic Management Plan (TMP) should be developed and transportation routes should be disclosed to the public.

Regarding the healthcare facilities, the medical centers in the villages have limited capacities, both in terms of the personnel and equipment, to serve the Project workforce. Therefore, Martuni Medical Center, located in Martuni town, approximately 10 km from the planned reservoir, should be considered for emergency situations.

*Operation phase*

The reservoir's operation is likely to produce both positive and negative effects on public infrastructure. Positively, it will strengthen water security and upgrade irrigation systems. On the other hand, it could place additional demands on local roads, electricity networks, and waste management services.

The assessment and mitigation of impact on public facilities and infrastructure traffic impacts during the construction and operation phases of the reservoir are summarized in **Table 8-23**.

**Table 8-23. Summary of impact assessment on and mitigation measures for public facilities and infrastructure**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Local and regional public facilities and infrastructure | Moderate | 1) Develop a Traffic Management Plan aiming to minimise pressure on the reginal and local road infrastructure and avoiding as much as possible sensitive receptors, | Low |

[144]Armenia Water Reservoirs - Technical, Economic and Green Due Diligence Gap Analysis, Draft Final Report, 2023-2024, Ove Arup & Partners.

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | *The TMP shall also cover measures outlined in Sections 8.2.11, 8.3.5 and 8.5.2.*<br>2) Oblige the construction contractor to set up a medical post at least at one of the labour accommodation camps,<br>3) Consider the need to have an ambulance poted at the construction site or sign an agreement with the Martuni Medical Centre to ensure emergency response when medical services are required for the contractor's workers. This should take into account the 12-15 minutes ambulance response time. | |
| OPERATION PHASE | | | |
| Local and regional public facilities and infrastructure | Positive Low to Moderate | 1) Maximize water use efficiency by introducing modern irrigation technologies (e.g., drip systems) promoted under the RoA Government Decree № 1695-L dated 14.10.2021[145] and commuciate with farmers about the benefits of drip irrigation benefits, including the government's financial compensation for water use payments when drip irrigation is adopted (to be organised by the WCRA and supported by the communities and regional authorities),<br>2) Encourage community participation in water user associations to improve governance, maintenance, and fair access to irrigation services. | Moderate |
| | Negative Low to Moderate | 1) Conduct regular inspections and maintenance of access roads, power lines, and waste systems to anticipate and address infrastructure strain,<br>2) Maintain embankments, spillways, and outlet structures to ensure controlled water releases and avoid downstream flooding that could damage public infrastructure. | Low |

### 8.3.3 Land Tenure Impacts

The Astghadzor Reservoir is expected to affect 54 land plots with the area of 420,111.30 m$^2$ in Astghadzor and Zolaqar settlements (within Martuni Community). Of these, 19 are community-owned[146] and 35 are privately owned. The 19 community-owned plots are agricultural arable lands, totaling 353,510.10 m$^2$, however as noted in the baseline, the terrain and limited irrigation capacity do not create favorable conditions for municipality to cultivate this area. The 35 private plots cover 66,601.20 m$^2$, of these 27 plots (52,875.10 m$^2$) are classified as agricultural arable lands and 8 ones (13,726.10 m$^2$) as agricultural grasslands. The pasture lands within the reservoir area constitute approximately 1.5% of the total pastureland in the village's administrative territory, and similar pasture areas (located 1-2 km away from the settlements) are available. Due compensation and livelihood restoration activities have been outlined in the RF (to be further detailed in the RP).

As per the Preliminary RP, no impact is expected on residential buildings / structures and trees.

[145] https://www.arlis.am/hy/acts/168164

[146] Community-owned land means the land belonging to the municipality, as a word 'community" is a direct translation of an administrative unit from Armenia, which is equivalent to municipality.

As explained in the baseline, within the reservoir site, there is the commemorative rest area with a khachkar, the water intake point with an irrigation canal, and the earth road leading to Vanki Berd Church. These facilities will be affected and the due measures have been proposed in the RF, including compensation and the arrangement of an alternative route to the church (the latter is also included in the ESMP so that the Construction contractor could budget this measure).

In addition, some storage areas and a sandy loam borrow pit will require temporary land acquisition (as per the RF, such are regulated via voluntary agreements between the construction Contractor and the municipality (community) or private persons). These areas will be remediated after completion of the construction and returned to the owners for agricultural or other use (per the legal designation).

*Impact assessment and mitigation measures*

The assessment and mitigation of land tenure impact during the construction and operation phases of the reservoir are summarized in **Table 8-24**.

**Table 8-24. Summary of land tenure impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| PRE-CONSTRUCTION | | | |
| Residents of Astghadzor village | Moderate | 1) Ensure that all users (if any) of the pasture land to be withdrawn for the Project needs are provided with alternative land of equal or better quality for cattle grazing as per approved RAP. | Low to Negligible |
| Private land-owners / users (formal and informal) | Moderate to high | 2) Based on the Resettlement Framework, develop and implement the Resettlement Plan to ensure that the compensation for private and community land is fully provided prior to any construction works on site. | Low to Negligible |
| Community land (owned by Martuni Community) | Low | | Negligible |
| Visitors to Vanki Berd Church | Low to moderate | 3) Construction Contractor to arrange an alternative access to Vanki Berd Church prior to the start of construction activities. | Negligible |

### 8.3.4 Impact on Vulnerable Groups

The construction of the reservoir will have positive effect on the families' standards of living, including socially vulnerable households. The Project implementation will support food security in the households engaged in the subsistence agriculture and might enable accumulation of a larger surplus for sale. At the same time, the price of the irrigation services should account for the affordability to the low-income households.

Furthermore, stable availability of water will benefit women who play an essential role in the provision, use and management of water in the households. However, women can face barriers in the access to the irrigation infrastructure due to their limited involvement in the decision-making processes. Therefore, it is important to regulate and ensure equal access to the Project benefits for women. Equal employment opportunities for men and women should also be ensured during the Project construction stage

The improvement of the irrigation system in the community, the construction of the reservoir will contribute to the increase of cultivated lands and the increase of the income from agriculture, to some extent it will also contribute to the reduction of poverty.

However, vulnerable groups may face social, economic, or physical barriers that limit their ability to access project information or voice concerns. The Project's grievance mechanism and the resettlement framework will be designed to account for these, by providing multiple entry points and assistance to those needing help to file grievances.

According to the women's focus group discussions construction of the reservoir will contribute to the expansion of household agricultural production. Access to irrigation water would enable more residents to fully cultivate their land, thereby increasing household income and improving living conditions.

*Impact assessment and mitigation measures*

The assessment and mitigation of impact on vulnerable groups during construction and operation of the reservoir are summarised in **Table 8-25**.

**Table 8-25. Summary of impact assessment on vulnerable groups and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Vulnerable households of the affected villages | Moderate | 1) Implement the SEP to ensure that information about the Project and its opportunities is widely available and communicated to vulnerable households, including the female-headed and elderly households engaged in agricultural activities, households below the poverty line,<br>2) Account for the special needs of the vulnerable groups when developing RAP/RF and the Project's grievance mechanism. | Low |
| Women | Low | 3) Equal employment opportunities and payment for men and women should also be ensured during the Project construction stage. | Low |
| OPERATION PHASE | | | |
| Vulnerable households of the affected villages | Moderate | 1) Implement subsidies or reduced fees for low-income households to access irrigation water or reservoir-related services, as well as to the water saving technologies under the RoA Government Decree № 1695-L dated 14.10.2021 (see **Table 8-23**, **measure 1**),<br>2) Ensure transparent and equitable allocation of water to all farmers, prioritizing disadvantaged users,<br>3) Ensure emergency response plans explicitly consider vulnerable groups, including designated evacuation routes and assistance during floods or dam releases,<br>4) Prioritize participation of vulnerable groups in water user associations or community decision-making on irrigation schedules and reservoir management. | Low |

### 8.3.5 Impact on Community Health and Safety

*Construction phase*

While the construction of the reservoir is expected to bring economic and social benefits to local communities, it may also increase their exposure to a range of safety and social risks. Elevated traffic volumes may raise the likelihood of vehicle-related accidents involving both workers and community members. These risks can be mitigated through traffic management plans, signage, controlled vehicle routes, and community awareness campaigns. Road reinstatement and improvements should be implemented post-construction. Security provisions and restricted access zones may create tensions with residents and limit their normal access to public areas.

Sensitive receptors in the Project context may include children, the elderly, pregnant women, people with chronic illnesses, low-income households, schools, and healthcare facilities. To protect sensitive receptors, physical safety measures such as fencing, warning signs, lighting, restricted access will be established, as well as dust and noise control measures.

Construction zones themselves pose direct physical hazards, including the risk of falls, injuries, or drowning, particularly for children. Unauthorized entry to the construction area significantly increases the likelihood of accidents or injuries. Other potential risks include emergency situations such as flooding, landslides, or equipment failure, which could impact nearby communities if adequate safety and response measures are not in place. These risks can be effectively mitigated through strict access controls, fencing and signage, community awareness campaigns, traffic management measures, emergency preparedness planning, and ongoing engagement with local residents to ensure they understand the hazards and the required protective measures associated with the construction activities.

An influx of construction workers can increase the risk of Sexually Transmitted Diseases (STDs). The spread of STDs is primarily associated with lack of preventive education, and inadequate medical screening and services. Young people and economically disadvantaged residents are most vulnerable, particularly in rural communities with limited health infrastructure.

*Operation phase*

Potential impacts on community health and safety during the Project operation can occur during the maintenance works and emergency situations that exceed the limits of the Project site and impact the downstream communities. These impacts could include flooding, contamination, or other hazards that pose risks to life and property. To address these risks, a comprehensive Emergency Preparedness and Response Plan (EPRP) should be developed and implemented, outlining clear procedures for incident detection, notification, and mitigation. In addition, downstream communities should be proactively informed about potential hazards and provided with training and awareness programs to ensure they can respond effectively in case of an emergency.

Furthermore, the operation of a water reservoir can increase the risk of vector-borne diseases for nearby communities by creating large areas of stagnant or slow-moving water that serve as breeding sites for mosquitoes and other vectors, while changes in local ecology, vegetation, and humidity can further support their survival.

*Impact assessment and mitigation measures*

The assessment and mitigation of impacts on community health and safety during the construction and operation phases of the reservoir is summarised in **Table 8-26**.

**Table 8-26. Summary of community health and safety impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Residents of the villages | Moderate | ***Pre-construction phase***<br>1) Develop and implement the Traffic Management Plan (TMP) that will contain at least:<br>- Avoiding community access roads if possible and documenting quality of roads prior to their use,<br>- Optimised routes and times of the day for transporting materials to site, especially bulky equipment parts (e.g., pipes) agreed with the traffic police and local administrations,<br>- Identification of the sensitive receptors (schools, hospitals, residential areas, other social infrastructure) along the transportation routes and development of the mitigation measures where necessary,<br>*The TMP shall also cover measures outlined in Sections 8.2.11, 8.3.2 and 8.5.2.*<br>2) Implement appropriate dust and noise control measures,<br>3) Install physical barriers, ensure restricted access to the construction site,<br>4) Screen worker influx for communicable disease and provide treatment, as appropriate, to reduce exposure to local population.<br>5) Conduct information campaigns on STDs among the workers and local community,<br>6) Develop and implement Emergency preparedness and response plan for the whole project lifecycle (see **Chapter 8.4**). | Low |
| OPERATION PHASE | | | |
| Residents of the villages | Moderate | 1) Monitor the technical conditions of the reservoir, provide timely maintenance,<br>2) Implement vector-disease control measures, including targeted mosquito larviciding in high-risk areas and clearing of excess vegetation,<br>3) In case if heavy machinery or large number of vehicles is needed for the performance of the maintenance works, a Traffic Management Plan should be developed, accounting for the recommendation outlined above,<br>4) Update and implement the Emergency Preparedness and Response Plan for the Project operation stage (see **Chapter 8.4**). | Low |

### 8.3.6 Health and Safety Impact

*Construction phase*

The primary Occupational Health and Safety (OHS) risks during the Project construction phase are associated with large-scale earthworks, excavation, operation of heavy machinery, and the transport and delivery of construction materials. Key hazards include dust generation, exposure to fuels, oils, and other hazardous substances, as well as risks of electrocution from temporary electrical installations and power tools. Additional risks stem from manual handling of heavy materials, excessive noise and vibration from equipment, and exposure to extreme weather conditions.

To prevent accidents at the construction site, an OHS Management Plan (OHSMP) should be developed by the construction contractor and shouldat least cover the following:

- Allocation of OHS roles and responsibilities,
- Identification of OHS risks relevant to the Project,
- Development of OHS procedures for different types of work / professions,
- Workers' regular OHS briefing / training,
- Performance of the high-hazard activities, inter alia: earthworks, works at height, with high voltage etc.,
- Provision of workers (including sub-contractors) with Personal Protective Equipment (PPE),
- Initial and periodic medical examination of workers, including the staff of sub-contractors,
- Recording and investigation of safety accidents.

Additionally, the contractor must define proper management procedures for the following activities:

- Storage and handling of materials and chemicals, including hazardous,
- Fire prevention and the maintenance of the firefighting equipment,
- Provision of the first aid,
- Heat stress management,
- Prohibition of drugs use and alcohol consumption,
- Site safety signs, posters and registers,
- Monitoring of construction noise, vibration and air emissions.

Regular monitoring of the safety performance of the construction workers should be conducted. It should cover both monitoring of work practises, and the working environment.

*Operation Phase*

During the operation of the reservoir, workers face occupational health and safety risks from exposure to waterborne pathogens while maintaining the reservoir and irrigation channels. Confined spaces, such as valves, culverts, or inspection tunnels, pose hazards including oxygen deficiency or toxic gas exposure. Maintenance activities may involve chemicals, mechanical equipment, and electrical systems, which carry risks of burns, injuries, or electrocution. There is also a risk of drowning or falls near the water or steep banks. With proper training, protective equipment, and safety procedures, these risks can be effectively managed.

*Impact assessment and mitigation measures*

The assessment and mitigation of the OHS impacts during the construction and operation phases of the reservoir are summarised in **Table 8-27**.

**Table 8-27. Summary of occupational health and safety impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Project workforce | Moderate | ***Pre-construction phase***<br>1) Develop an Occupational Health and Safety Management Plan (OHSMP), covering the key elements of the OHS performance management during the construction stage, including:<br>- Allocation of OHS roles and responsibilities<br>- Identification of OHS risks and hazards,<br>- Briefing, training and knowledge check,<br>- OHS procedures and regulations,<br>- Medical examination,<br>- Emergency response,<br>- Management of hazardous materials, explosive materials (if used), chemicals and oil / fuel,<br>- Fire safety and emergency response,<br>- Performance of high hazard tasks<br>- Use of PPE,<br>- Supervision of sub-contractors,<br>- Investigation of safety accidents,<br>- Responsibilities for non-compliance, etc.<br>***Construction phase***<br>2) Implement the provisions of the Occupational Health and Safety Management Plan,<br>3) Conduct regular audits of the construction site to monitor the OHS performance of the contractors. | Low |
| Monitoring: *OHS daily, weekly and monthly inspections and monitoring as per the OHSMP (to be performed by the Construction contractor, the Supervision engineer, the Client and invited external consultants[147])* | | | |
| OPERATION PHASE | | | |
| Workers performing technical maintenance | Moderate | 1) Develop an OHS procedure/instruction for the maintenance and repair works,<br>2) Comply with the requirements of the relevant national OHS legislation. | Low |

### 8.3.7 Workers' Rights and Working Conditions Related Impacts

*Construction phase*

Contractors should be required, through contractual clauses, to comply with national labour regulations, EBRD PR2 and EBRD/IFC joint guideline of worker accommodation[148].

[147]at least two independent public health and safety (H&S) and OHS audits are recommended during the construction phase (before the start of construction and during the peak of the construction) to verify that the Project complies with the EBRD's OHS requirements. These measure is included in the Project's ESAP.

[148]Workers' accommodation: processes and standards - a guidance note by IFC and the EBRD (2009). Available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/604561468170043490/workers-accommodation-processes-and-standards-a-guidance-note-by-ifc-and-the-ebrd.

Some of the risks include delayed or non-payment of wages, informal hiring, extended hours and pressure to work overtime without adequate compensation or rest, lacking or insufficient grievance and remedy mechanisms.

Therefore, worker practices on site should be monitored, including work schedules, shift durations, rest days, paid sick leave, and wages above the legal minimum. Conditions in labour accommodation camps should also be checked, covering freedom of movement, sanitation facilities, private space, and dining arrangements. Contractors must maintain a grievance mechanism for workers, including the option for anonymous complaints. Where necessary, the Project Implementation Unit (PIU) should extend its grievance mechanism to contractor workers, while responsibility for responding remains with the direct employer.

*Operation phase*

During the operation phase, workers' rights may be at risk due to informal employment, unfair wages, and long or irregular working hours. Workers may also face barriers to grievance reporting, union participation, career advancement, or equitable employment due to gender or disability bias. Implementing formal employment contracts, regulated working hours, grievance mechanisms, equal opportunity policies, and training programs can help protect workers' rights.

*Impact assessment and mitigation measures*

The assessment and mitigation of the impacts on workers' rights and working conditions during the construction and operation of the reservoir are summarised in **Table 8-28**.

**Table 8-28. Summary of occupational health and safety impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Project workforce | Moderate | ***Pre-construction phase***<br>1) Include requirements related to the compliance with the national labour regulations and EBRD PR2 in the contractual clauses with the Construction contractor,<br>2) Develop a Labour and Working Conditions Management Plan (at least a month before the construction) and implement it,<br>3) Develop and implement a Construction Camp Management Plan, including sub-plans for Camp Code of Conduct and Camp Management, with requirements for worker accommodation in compliance with the Armenian labour, sanitary and health standards, EBRD PR 2 requirements, EBRD/IFC guidance on worker accommodation (2009), ILO Workers' Housing Recommendation 1961 (No. 115), and gender-specific provisions.<br>***Construction phase***<br>Set up and maintain grievance mechanisms available to all project workforce, including the opportunity for anonymous complaints. | Low |
| *Monitoring: Daily, weekly and monthly inspections and monitoring of the human resource practises, as well as working and living conditions at the construction site and construction camp (to be performed by the Construction contractor, the Client and invited consultants). Points to be monitored should include, among others: work schedule and shift duration, full rest days and shift breaks, provision of payments above the* | | | |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| *minimum required level, availability and conditions of sanitary facilities, as well as living conditions in the labour accommodation camp (freedom of movement, sufficient private space, dining facilities etc.).* | | | |
| OPERATION PHASE | | | |
| Operation phase staff | Moderate | 1) If a large-scale maintenance is planned, oblige the Maintenance Contractor to develop a Labour and Working Conditions Management Plan and Worker Code of Conduct (if needed) in line with Armenian labour laws and EBRD PR2 at least a month before any maintenance works, and implement it,<br>2) Ensure formal contracts for all workers specifying wages, roles, and duration of employment,<br>3) Implement regulated working hours with adequate breaks and rest periods,<br>4) Establish transparent grievance and complaint mechanisms for all staff,<br>5) Promote gender equality and inclusivity of persons with disabilities in recruitment, training, and promotion,<br>6) Provide regular training on operational procedures, safety, and skills development. | Low |

### 8.3.8 Gender-Based Violence and Harassment

*Construction phase*

The influx of non-local male workers may increase the risk of Gender-Based Violence and Harassment (GBVH). Women engaged in small businesses, agriculture, or service provision around the construction area, as well as those among the Project workforce, may face risks of harassment or coercion.

A Worker Code of Conduct and GBVH Policy should be developed and conveyed to all construction workers and contractors. A grievance mechanism with a specific mandate on GBVH should be developed and disclosed, a dedicated person to manage / oversee it should be appointed.

*Operation phase*

As discussed in **Chapter 8.3.4**, women (especially single women headed households) can face obstacles in the access to the irrigation infrastructure due to their limited involvement in the decision-making processes. Related GBVH cases might occur, and therefore the Project's implementing agency and the local governing authorities should employ appropriate measures to monitor and prevent such cases.

*Impact assessment and mitigation measures*

The assessment and mitigation of the GBVH impact during the construction and operation phases of the reservoir are summarized in **Table 8-28**.

**Table 8-28. Summary of GBVH impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Female residents of Astghadzor village | Moderate | ***Pre-construction phase***<br>Develop GBVH Policy and assign focal points responsible for handling GBVH incidents within the workforce and beyond.<br>***Construction phase***<br>1) Conduct mandatory and regular training for workers on required lawful conduct in local community, the Code of Conduct and GBVH Policy and consequences for failure to comply with the above,<br>2) Maintain a grievance mechanism, which includes a specific mandate on GBVH,<br>3) Organize information and awareness raising campaigns for community members, specifically women and girls,<br>4) Provide information to communities on how to use the grievance mechanism to report GBVH issues. | Low |
| OPERATION PHASE | | | |
| Female residents of Astghadzor village | Moderate | 1) Monitor access to the irrigation infrastructure following the Project completion.<br>2) Maintain the grievance mechanism during the Project operation, including the GBVH cases. | Low |

## 8.4 Emergency Situations and Response

*Construction stage*

During reservoir construction, emergencies can result from natural hazards, hazardous material use, or other man-made accidents. According to the World Bank's Good Practice Note on Dam Safety (2020)[149], such emergencies include uncontrolled water releases that threaten downstream life, property, or economic activities, as well as intentional or accidental water release and potential dam failure. Astghadzor reservoir dam is classified as High Dams, therefore an Emergency Preparedness Plan (EPP) and Emergency Response Plan (ERP) is required. The EPP should be prepared at least one year before reservoir filling and provide clear guidance on early emergency detection, classification, and response actions. It must also be coordinated with national and regional emergency management agencies and downstream communities to ensure effective preparedness and response.

For this Project, it is proposed to develop a comprehensive Emergency Preparedness and Response Plan (EPRP) that integrates the key provisions of both the EPP and ERP.

[149]Good Practice Note on Dam Safety and Technical Notes (WB 2020). Available at: https://www.worldbank.org/en/topic/watersupply/publication/good-practice-note-on-dam-safety-new-guidance-on-managing-risks-associated-with-dams

*Operation stage*

In addition, the World Bank's Good Practice Note requires an Operation and Maintenance (O&M) Plan for the reservoir. This plan should outline operational procedures, ensure structural dam safety through periodic inspections and dam safety reviews, and establish procedures for downstream notification and early warning.

*Impact assessment and mitigation measures*

The assessment and mitigation of the emergency situations during the construction and operation phases of the reservoir are summarised in **Table 8-29**.

**Table 8-29. Summary of emergency situations impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Construction workers | Moderate | 1) Prepare an Emergency Preparedness and Response Plan (EPRP),<br>2) Prepare site-specific emergency response procedures for incidents such as landslides, machinery accidents, or hazardous material spills,<br>3) Firefighting equipment and first aid kits should be available and maintained at all construction sites and project-related delivery vehicles. Selected workers should be trained on their usage. | Low |
| Residents of the downstream communities | Moderate | 4) Conduct Dam Integrity Risk Assessment,<br>5) After completion of the dam integrity risk assessment and flood safety check, consider the need of an early-warning system and provision of the life-saving equipment in the local communities, with the requirement of regular maintenance and emergency evacuation drills,<br>6) Establish traffic and access management plans to reduce accident risks for workers and local residents. | Low |
| Monitoring: *according to the Emergency Preparedness and Response Plan.* | | | |
| OPERATION PHASE | | | |
| Operation phase staff | Moderate | 1) Carry out preventive maintenance of gates, valves, and pumps, and ensure staff are trained in emergency responce,<br>2) Protect workers by enforcing PPE use, confined space entry protocols, and safety training on electrical and mechanical hazards,<br>3) Develop and implement an Emergency Response Plan, including early warning systems, evacuation routes, and periodic drills with local authorities and communities (both for staff and local residents),<br>4) Develop and implement Operation and Maintenance Plan (OMP) for the reservoir. | Low |
| Residents of the | Moderate | 5) Enhance community safety with fencing, signage, and awareness programs on drowning risks, | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| downstream communities | | 6) Engage with local communities and provide grievance mechanisms to address concerns. | |

## 8.5 Cultural Heritage Impact

### 8.5.1 Impact on Tangible Cultural Heritage

*Construction phase*

As a result of the Project implementation, the northwestern part of the hill occupied by the "Vanqi Berd" archaeological complex will be partially affected, where, based on the archaeological findings, evidence of the remnants of a medieval habitation is still present. The documented cultural heritage units on the right slope and valley side of the Astghadzor River gorge, such as traces of structures and tombs, will also be negatively impacted (**Figures 6-24** and **6-25**).

An accumulation of structural remains, tombs, and individual wall segments has also been documented to the northeast of the "Vanqi Berd" complex, at the confluence of the Astghadzor River and its left tributary. Several structures with a livestock-related function, along with numerous fragments of medieval pottery found in this area, suggests that it may have formed part of the Zolaqar settlement, which is included in the state list of monuments under the ref. 4.34.6.

A portion of the site known as "Yerku Juri Arank," "Gomeri Arank," or "Mtnadzor" is included under ref. 4.34.6 and will be entirely submerged. A group of cross-stones (khachkars) located within the dam's impact zone also appears to be a continuation of the same monument complex, likely representing part of the cemetery associated with this historical village site. Evidence of additional livestock-related structures has also been identified in this area. Additionally, a modern monument of spiritual significance, the cross-stone dedicated to the memory of Artyom Mkhoyan (2009-2016) with shelter shed, is located within the Project implementation area and will also be submerged.

As for the units subject to indirect impact, they are located in the immediate vicinity of areas to be submerged. In addition to potential damage from increased humidity and changes to the water regime, parts of these sites may also become partially inundated. Some of these units will be directly affected during dam construction, as earthworks will require the establishment of construction sites, equipment movement, and related infrastructure. At the same time, these historical sites will fall within the reservoir’s restricted (protection) zone, limiting opportunities for access, study, and preservation.

Based on the considerations outlined above, the archaeological survey team recommends that, prior to the commencement of construction works, the selected construction contractor shall conduct an additional detailed archaeological survey and fieldwork, including:

1) Conducting test excavations (trial trenching).
2) Delineating the impacted areas, identifying the surface area and volume requiring safeguard excavations, and carrying out such excavations to preserve the affected units, if relevant.
3) Assessing the possibility of relocating monuments to areas outside the reservoir impoundment.
4) Assessing the structural resistance to vibration-generating activities,
5) Proposing specific protection measures to prevent damage during construction activities.
6) Recommending appropriate preservation measures for each of the identified cultural heritage sites.

The proposed archaeological survey could form part of the site-specific Cultural Heritage Management Plan (CHMP), to be developed by the Construction contractor and agreed upon by the Supervision engineer, the Client, and the Authorized state body (Ministry of Education, Science, Culture and Sport). Implementation of the CHMP shall be supervised by a cultural heritage expert to be engaged by the Construction contractor, who will be present on-site during earthworks and will support the implementation of the measures specified in the CHMP.

According to the archaeological survey team, the cost of the proposed measures above is estimated at 270,000 EUR.

*Operation phase*

No adverse impacts on tangible cultural heritage sites or units are anticipated during the project's operation phase. On the contrary, the presence of the reservoir may generate positive synergistic effects by enhancing the area's attractiveness and potentially increasing interest from both visitors and custodians in the "Vanqi Berd" archaeological complex, as well as in other cultural heritage sites identified during the archaeological survey and potentially relocated to areas surrounding the reservoir. However, increased humidity around the reservoir may negatively affect nearby cultural heritage units, potentially leading to their deterioration. This will require the implementation of mitigation measures proposed in **Table 8-30**.

*Impact assessment and mitigation measures*

The assessment and mitigation of the tangible cultural heritage impacts during the construction and operation phases of the reservoir are summarised in **Table 8-30**.

**Table 8-30. Summary of tangible cultural heritage impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Local communities, site visitors, custodians | Significant | ***Pre-construction phase***<br>1) Carry out a detailed archaeological survey before the start of construction works, including:<br>- Conduct test excavations (trial trenching),<br>- Delineate the impacted areas, identify the surface area and volume requiring safeguard excavations, and carry out such excavations to preserve the affected units, if relevant,<br>- Assess the possibility of relocating monuments to areas outside the reservoir impoundment,<br>- Assess the structural resistance to vibration-generating activities,<br>- Propose specific protection measures to prevent damage during construction activities, including construction of protection walls, restriction of vibration-generating activities, etc.,<br>- Recommend appropriate preservation measures for each of the identified cultural heritage sites.<br>2) Develop a Cultural Heritage Management Plan (CHMP) for the Project, to be agreed upon by the supervision engineer, the Client, the Bank and the authorized state body (the CHMP may include the measures proposed in item 1 above), | Low |

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| | | 3) Hire a qualified cultural heritage expert from an authorized institution to be present during the construction works and implement archaeological surveillance for all construction sites, as well as to help implement all heritage focused mitigations and reporting to Client/Bank,<br>4) Prior to construction works, develop a Chance Finds Procedure (CFP)[150] for the Project and train the relevant workers in applying it (so that they can identify the chance finds, stop the works and notify the management); keep the training log up to date and include reporting on it in monitoring reports,<br>5) Relocate the cross-stone dedicated to the memory of Artyom Mkhoyan (2009-2016), along with its shelter shed, to a location agreed upon by the relatives and the administrative head of the Astghadzor settlement.<br>***Construction phase***<br>1) Implement the CHMP,<br>2) Implement the CHP,<br>3) Deliver regular briefing to all workers involved in implementing heritage focused mitigations. | |
| OPERATION PHASE | | | |
| Local communities and site visitors | Low | 1) Relocate and reinstall the cultural heritage units on elevated terrain, such as hills, as high as possible to avoid the negative impacts of humidity and breezes from the reservoir, in case there is a risk of adverse humidity impacts,<br>2) Establish green buffer zones (e.g., planting trees or shrubs) between the reservoir and heritage structures to absorb excess moisture and reduce direct humidity transfer (this measure can be combined with TMP),<br>3) Apply conservation-grade coatings or treatments to protect against moisture absorption without harming historic materials, where relevant. | Negligible |

### 8.5.2 Impact on Intangible Cultural Heritage

*Construction and operation phase*

The implementation of the Project will not have any negative impact on intangible cultural heritage elements registered in both the UNESCO and national lists of ICH. During the construction phase, the local population will celebrate Christmas, New Year, Easter, and Trndez, as well as weddings and baptisms, with consideration for increased traffic along the community roads of Astghadzor and

[150]A template of this procedure can be found in the 2023 EBRD's guidance note for PR8 at https://www.ebrd.com/documents/environment/guidance-note-performance-requirements-8-cultural-heritage.pdf. In addition, the regulations with regards to 'chance finds' are defined by the RA Law №HO-261 (1998) "On the protection and use of immovable historical and cultural monuments and historical environment". Particularly, according to Article 11 of the Law, if during the construction, agricultural and other works, the unknown historical and cultural monument/heritage is discovered, the above-mentioned works must be stopped and the authorized state body must be immediately informed by the local self-government bodies.

Zolaqar villages. However, this impact is expected to be temporary and negligible provided that the provisions of the Traffic Management Plan are communicated with the local residents.

During the summer season, the landscape and climate of the project region are favourable and may attract people seeking locations for picnicking and recreation. Currently, local residents use a modern monument of individual spiritual significance dedicated to Artyom Mkhoyan, a cross-stone covered with a shelter shed and equipped with a table and benches, as such a place.

According to the national EIA study, 38 trees within the reservoir and dam area will be cut. As a compensation measure, 190 trees will be planted, primarily around the reservoir site and/or downstream of the dam. This will be implemented through a Tree Management Plan to be prepared by the construction contractor and is expected to enhance the landscape around the reservoir.

Taking into account the attractions discussed above, as well as the presence of the "Vanqi Berd" archaeological complex located on the hill near the reservoir, the planned reservoir area is expected to attract local residents and visitors for sightseeing and recreation purposes. Certain intangible cultural heritage elements, such as Lavash baking, can be promoted, contributing to the development of tourism and local trade in the Project region.

To support this potential, discussions should be held with the representatives of Martuni community, Astghadzor and Zolaqar rural settlements, local cultural NGOs, tourism organizations and other relevant stakeholders.

The assessment of the Project impact on cultural landscapes is embedded in **Section 8.2.5** 'Impacts on Landscape and Visual Amenity'.

*Impact assessment and mitigation measures*

The assessment and mitigation of the intangible cultural heritage impacts during the construction and operation phases of the reservoir are summarised in **Table 8-31**.

**Table 8-31. Summary of intangible cultural heritage impact assessment and mitigation measures**

| Receptor | Assessed Impact | Mitigation / management measures | Residual impact |
|---|---|---|---|
| CONSTRUCTION PHASE | | | |
| Local residents | Low | 1) Communicate the provisions of the Traffic Management Plan to the population of Astghadzor and Zolaqar rural settlements to help them plan Christmas, New Year, Easter, Trndez, weddings, and other celebrations and to avoid additional nuisance. | Negligible |
| OPERATION PHASE | | | |
| Local residents, tourists and visitors, cultural NGOs, tourism organizations, heads of settlements | Neutral | 1) Conduct consultations with relevant staff from the Martuni community, the administrative heads of the Astghadzor and Zolaqar villages, as well as with local cultural NGOs, tourism organizations, and other relevant stakeholders to explore the possibility of including the Astghadzor Reservoir and the 'Vanqi Berd' archaeological complex in the potential list of sightseeing sites featured in tours to Lake Sevan. | Positive |

## 8.6 Cumulative Impact Assessment

### 8.6.1 Introduction

This section summarizes the results of the Cumulative Impact Assessment (CIA), which examines the combined environmental and social impacts of the Project together with other existing or planned developments within its area of influence. The CIA includes activities for which sufficient publicly available information exists to identify potential temporal or spatial overlaps with the Project and to evaluate the resulting cumulative effects.

The CIA methodology follows the step-by-step process outlined in the *IFC Cumulative Impact Assessment and Management - Guidelines for the Private Sector in Emerging Markets* (2013)[151], and is aligned with the requirements of the EIA Directive. In accordance with these guidelines, the CIA is conducted in six steps:

Step 1 - Identification of Valued Environmental and Social Components (VEC)[152], establishment of spatial and temporal assessment boundaries,

Step 2 - Identification of other projects / activities affecting VECs included into the assessment,

Step 3 - Collecting data on and establishment of the baseline conditions of the identified VECs (this information is presented in Chapter 6 and is not repeated in the current section,

Step 4 - Assessment of the cumulative impacts on the identified VECs,

Step 5 - Assessment of significance for the predicted cumulative impacts,

Step 6 - Management of the cumulative impacts.

### 8.6.2 Step 1 - Identification of VECs, and Establishing Spatial and Temporal Assessment Boundaries

Valued Environmental and Social Components (VECs) are environmental and social features, processes, or components whose viability or sustainability may be affected by the Project. The focus of the CIA is on 'ultimate recipients of impacts' (IFC, 2013). For this assessment, the VECs correspond to the environmental and social receptors of Project's impacts identified in **Chapter 8**. Only VECs associated with adverse residual impacts of low to moderate significance, as well as those with positive residual impacts, are considered likely to be affected by cumulative effects and therefore are included in the CIA.

The VECs identified for consideration in the CIA include:

- **Local population**:
  - Residents of Astghadzor and Zolaqar villages whose houses located along the streets used for transportation of construction materials and equipment to the Project sites, affected by the emissions and noise from heavy vehicles,
  - Residents of Astghadzor and Zolaqar villages, particularly the elderly and children, exposed to increased road safety risks related to Project-related traffic crossing through settlements during construction phase,

[151] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_handbook_cumulativeimpactassessment.

[152] VECs may include: a) physical features, habitats, wildlife populations, b) ecosystem services, natural processes (e.g., water flow, microclimate), c) social conditions (e.g., health, income), or d) cultural aspects (e.g., recreation habits, local traditions).

  - Local communities affected by the increased risk of exposure to diseases including socially significant diseases related to migrant worker influx during the construction phase,
  - Occasional visitors (namely, shepherds and farmers) of the vicinities of the Project sites affected by noise and vibration and visual effects of the construction works,
  - Female residents of the villages exposed to security risks related to male migrant worker influx during the construction phase,
  - Downstream communities exposed to the risk of dam collapse and accidental flow release which will threaten their lives and property

- **Irrigation water users** in Astghadzor, Zolaqar, Vaghashen, Martuni villages, and all part of the Martuni community, who would be positively impacted by the sustainable supply of irrigation water for agriculture production.
- **Users of M10, M-11 highways and communal roads** affected by the increased traffic density and increased risks of traffic accidents during the construction phase.
- **Construction workers** exposed to:
  - Occupational safety risks associated with:
    - Performing high-hazardous works at the construction sites (earthworks, works at height, with high voltage, outdoors works in extremely hot weather conditions, works on or close to the open waterbodies, works with pressurized systems),
    - Handling of chemical and materials at the construction sites,
    - Risks of traffic accidents during construction phase.
  - Occupational health risks associated with:
    - Dust and ICE emissions and air pollution in the work zone,
    - Noise and vibration from operation of the construction machinery and equipment,
    - Potential spread of waterborne diseases (if construction activities disrupt the river and result in areas of stagnation water that favour the growth of bacterial pathogens),
    - Potentially insufficient sanitation at the construction sites / construction camps.
- **Operation and maintenance workers** during operation exposed to OHS associated with e.g. outdoors works at extremely hot weather conditions, works on or close to the open waterbodies.
- **Local workforce** that would benefit from Project-related new employment opportunities for skilled, semi-skilled, and unskilled construction workers during the construction phase.
- **Wildlife** within the Project sites that will either be relocated to safe areas (sedentary species) or forced to migrate from the Project sites and their vicinities (large mammals and birds) because of construction activities.
- **Vegetation cover and flora** within the Project sites that will be destructed and lost because of construction works.
- **Habitats** at the Project sites that will be destructed or lost due to construction works. Compensation and offsetting measures will be implemented to ensure that the Project achieves “no net loss” or “net gain” status.
- **Candidate Emerald Site Sevan National Park (AM 0000002),** since the reservoir site will create additional plot of the artificially altered land, contributing to the fragmentation of the site.

- **Natural landscape** of the Project area, which will be modified by the clearance of trees and occurrence of the temporary landscape forms (stockpiling of topsoil, clay and gravel, borrow pit) - during construction phase, and permanent change in land cover with new visual elements during operation.
- **Surface water resources** (the Astghadzor River) in terms of:
  - Potential negative impact on the river water quality from contaminated surface runoff, dust, and waste from the construction sites,
  - Positive impact on the river water quality downstream of the reservoir due to natural self-purification process during the operation phase,
  - Change of the river's hydrological regime once the reservoir is completed.
- **Soil resources** due to soil disturbance and risk of soil contaminations at construction sites.
- **Tangible cultural heritage,** comprising units of "Vanqi Berd" archaeological complex, some of which will be submerged, while other affected indirectly by potential damage, deterioration or restricted access.
- **Local and regional infrastructure facilities** will be exposed to additional load related to the Project activities during the construction phase, namely:
  - Power supply lines - by temporary increase in electricity consumption during Project construction,
  - Local healthcare facilities - by potential increase in demand for medical services generated by the temporary construction workers,
  - Regional waste management infrastructure – by increase in the volumes of household waste, hazardous waste (including waste collection, transportation, and utilization),
  - Roads comprising the main Project transportation route - M10, M-11 highways and communal roads - by increased heavy vehicle traffic for transporting construction materials and equipment, which may result in road deterioration.
- **Local and regional economies** that would benefit from:
  - Increased demand for certain goods and services, enabling some local and regional businesses to become Project suppliers during the construction phase (e.g. providing meal preparation and delivery, housekeeping services at the construction camps, construction machinery maintenance and repair, and construction waste transportation, etc.),
  - Reliable irrigation water supply, enabling farmers to cultivate additional land, diversify crops, and increase agricultural production, thereby enhancing economic opportunities for local communities.

The following VECs **were excluded from the CIA**, as the residual significance of the Project's impacts on them is predicted to be negligible or low to negligible:

- Local communities during the Project operation phase,
- Private land owners and users of community land to be withdrawn for the Project needs,
- Wildlife / flora of the Project site during operation phase,
- Groundwater resources,
- Intangible cultural heritage.

The CIA **spatial boundaries** are assumed to coincide with the boundaries of Gegharkunik Marz.

The CIA **temporal boundaries** are assumed to include Project construction and operation phases. The estimated duration of the construction phase is 36 months, while the operation phase is assumed to last at least 50 years.

### 8.6.3 Step 2 - Identification of Other Activities/Projects for the Inclusion in the CIA

The current CIA examines the interactions between the Project and other existing or planned activities that overlap with it spatially and temporally and can impact the same VECs. The following projects and programmes have been identified and reviewed:

1. **Local and regional development plans/programmes:**
   - 1.1. Martuni Community Five-Year Development Plan for 2022-2026,
   - 1.2. Harehas Development Programme[153] - a six-year social-educational strategy that aims to empower women and families in the Gegharkunik marz in four key areas: education and capacity building, local entrepreneurship and economic development, improvement of the community infrastructure, and rural tourism and social entrepreneurship (signed in October 2025).
2. **Concurrent projects in the Project area:**
   - 2.1. Solid Waste Management Program for Kotayk and Gegharkunik regions (launched in June 2025), which foresees development of the waste transfer stations in Martuni city[154],
   - 2.2. The Martuni Community Development Plan includes plans for the implementation of the following projects: i) construction of potable water and irrigation water networks in Astghadzor settlement, ii) reconstruction of House of culture in Astghadzor settlement, iii) asphalt pavement works in Martuni town and 16 settlements, and iv) street lighting of republican road between Yeranos and Artsvanist settlements (around 37 km long).

Implementation of the above-mentioned development programmes and projects may have both spatial and temporal overlaps with the Project. While the temporal overlaps are evident, the spatial overlap cannot be identified since specific locations of infrastructure objects / components have not been announced. Furthermore, temporal overlap with the Harehas Development Programme may generate beneficial synergies on the communities through capacity building, support of social inclusion and public participation.

### 8.6.4 Step 3 - Collecting data on and establishment of the baseline conditions of the identified VECs

This information is provided in **Chapter 6** and is therefore not repeated in the current section.

### 8.6.5 Steps 4 and 5 - Assessment and Evaluation of the Key Cumulative Impacts

*Construction phase*

During construction phase, cumulative impacts may result from the overlap between Project activities and concurrent projects in the Project area.

[153]Information about the programme is available at: https://rearmenia.com/en/fundraisers/educational-program-%22harehas%22-developing-88-villages-in-the-gegharkunik?tab=story

[154]Information is available at: https://www.primeminister.am/en/press-release/item/2025/07/08/Nikol-Pashinyan-visit-to-Kotayk-Marz/

The current CIA indicates that many of the Project's impacts are not significantly amplified by those of other activities or projects. As a result, the cumulative impacts are expected to remain at a similar level of significance as the Project's own residual impacts, including:

- Impacts of low significance:
  - Cumulative OHS risks for construction workers, except for those related to road safety,
  - Cumulative adverse impacts on fauna, including invertebrates, sedentary animals, birds and large mammals, resulting from disturbance, destruction of foraging and/or breeding habitats as a result of construction works,
  - Potential impacts on further fragmentation of the Candidate Emerald Site Sevan National Park,
  - Combined impact on local tangible cultural heritage sites/units due to temporary access restrictions and possible relocation. At the same time, positive synergistic may occur from enhancing the area's attractiveness and potentially stimulating interest to the local cultural heritage sites,
  - Cumulative adverse impact on the water quality of the Astghadzor River due to surface runoff and waste from the construction sites,
  - Cumulative adverse impacts on soil resources in the community due to multiple construction activities,
  - Cumulative visual impacts due to temporary (during construction) and permanent (during Project operation) landscape transformation by new visual elements including the planned transmission line,
  - Impacts on public infrastructure due to aggregated needs of the Project and concurrent construction activities in case of significant temporal overlap.
- Impacts of moderate significance:
  - Cumulative impact on habitats during Project construction, in particular fragmentation of natural habitats,
  - Loss of flora species as a result of construction works at the Project sites and along planned power line route.

  Note: "No net biodiversity loss" status, and when possible "net biodiversity gain" is expected to be achieved.

However, there are cumulative impacts that will amplify Project-related impacts. The significance of these cumulative impacts is assessed as low to moderate. These impacts include:

- Impact on Astghadzor and Zolaqar villagers, in particular those residents whose houses are located along the communal delivery road during construction phase due to potentially significant combined traffic increase, causing air pollution and noise. The impact on the structural stability of these houses is considered low, as no machinery generating high levels of vibration will be passed along the roads in these areas and only heavy vehicles will transport construction materials to the Project site.
- Cumulative risk of traffic accidents affecting construction workers, residents, and other road users on roads designated as primary transportation routes for the Project and concurrent activities.
- The cumulative impact on road conditions resulting from Project traffic and concurrent construction activities along same transportation routes.
- Positive cumulative impact on the local workforce through the creation of new employment opportunities, and development of new skills among construction workers.

- Positive aggregated impact on local and regional economic development, driven by increased demand for goods and services provided by local and regional businesses (e.g., meal preparation and delivery, maintenance and repair of construction machinery, removal of construction waste, etc.).

*Operation phase*

The operation of the Project may coincide with the routine household Waste Management (collection and disposal) Program, with the primary cumulative impact arising from combined traffic on the overlapping routes, causing noise and disturbance and increasing risk of road accidents.

### 8.6.6 Step 6 - Cumulative Impacts Management

As discussed above, the potential cumulative impacts on the VECs considered in this CIA are expected to remain largely unchanged or show only minor increases in the significance of the Project's residual impacts. Overall, the assessment did not identify any cumulative impacts of moderate or high adverse significance.

***Recommended Impact Prevention / Mitigation Measures to Reduce Adverse Cumulative Impacts:***

- Develop a Construction Traffic Management Plan, that accounts for the traffic flows of concurrent activities to minimize overlaps. The Plan should aim to reduce cumulative impacts on local communities and sensitive receptors (schools, hospitals, residential areas, other social infrastructure facilities), through measures including avoidance, scheduling adjustments, additional traffic signs, driver training etc.
- Conduct timely equipment maintenance, limit noisy operations to the daytime, and implement appropriate dust control measures to reduce potential cumulative noise and dust impacts on local communities. In addition, execution of blasting operation that may be required both for the reservoir and road (tunnels) construction, should be coordinated.
- Constantly engage with local communities and disclose relevant information, including on planned transportation routes.

The implementation of these measures **will reduce the significance of adverse cumulative impacts related to construction traffic to minor**.

## 8.7 Summary of E&S Impacts, Benefits and Opportunities

1) Astghadzor is a river located in the Gegharkunik Marz, within the Lake Sevan basin. It originates on the western slopes of Mount Batssar in the Vardenis mountain range, at an altitude of 2,599 masl. The river is 16.7 km long, with a catchment area of 43 $km^2$. The river valley is V-shaped in its upper reaches and becomes trough-shaped downstream. The river has a mixed feeding regime, and its average annual discharge is 43 $m^3/s$. Its water is primarily used for irrigation purposes.
2) A conservative evaluation of the planned reservoir' impacts downstream of the reservoir has been made possible through basic hydrological modelling (SWAT+) and expert judgment. The assessment indicates that the Astghadzor reservoir is unlikely to cause significant impacts. This conclusion is primarily based on the upstream positions relative to existing lakes or reservoirs, and the relatively small size of the rivers they impound.
3) The Project is assessed as aligned with the goals of the Paris Agreement and is included on the aligned list under the water supply and wastewater category. No project activities have

been identified on the 'non-aligned list'. The Project is also assessed as aligned with the mitigation goals of the Paris Agreement (BB1 aligned).

4) The Project does align with some of the targets outlined in Armenia's draft LT-LEDS and, therefore, the country's NDC in that it is designed to improve water supply and efficiency in irrigation. However, it is noted that GHG emission estimates at this stage show net positive carbon emissions for reservoir over 100 years. The total GHG emissions from the planned reservoir at year 1 are estimated 293 tCO2e/yr, while at year 50 - 65 tCO2e/year.

5) Approximately 65% of the total air emissions from construction activities are expected to consist of dust (PM2.5 and PM10). According to air emissions calculations, the maximum dust emission rate during the construction phase is estimated at 2.55 g/sec, which is unlikely to significantly impact ground-level dust concentrations in nearby residential areas, considering that the direct distances between the construction site with borrow pits and the project-affected rural settlements of Astghadzor and Zolaqar are 1,300 m and 2,200 m respectively.

   Therefore, air pollutants, as well as noise and vibration from construction machinery and operations, are not expected to affect the local population, although some negative impact on workers employed by the contractors may occur.

   The air emissions from the operated reservoir will be minimal and will primarily depend on the climatic conditions in the Project region. The noise and vibration impact during the Project operation phase is negligible.

6) A hill, whose right slope forms the riverbed of the Astghadzor River, obstructs the view of the reservoir for residents of Zolaqar and most parts of the Astghadzor rural settlement. Local villagers who cultivate agricultural land around the reservoir area or use these plots for cattle grazing, as well as occasional visitors, such as custodians of the "Vanqi Berd" archaeological complex, may experience visible changes to the landscape during the construction phase of the Project.

   The main sources of visual disturbance include construction machinery, heavy vehicles, borrow pits, and storage areas for construction materials and soil/topsoil. While this impact is unavoidable, it is short-term, limited to the construction period, and will affect only a small number of people.

7) As a result of the Project implementation, the landscape of the Project area will undergo a permanent transformation due to the formation of the reservoir and the presence of associated infrastructure. The main impacts include: Permanent change in land cover, New visual elements, Potential aesthetic value, Stabilization disturbances and Landscape adaptation. Overall, the visual impact during the operation phase is long-term and permanent. However, effective landscaping and environmental integration measures can help mitigate negative visual effects. Over time, the Project's visual impact may even become positive.

   Overall, the visual impact during the operation phase is long-term and permanent but is generally more stable and potentially less intrusive than during the construction phase. Effective landscaping and environmental integration measures can help mitigate negative visual effects and may even result in a net positive visual outcome, particularly in terms of the cultural landscape.

8) Prior to the start of construction, the planned reservoir area shall be cleared from all vegetation, including bushes and approximately 38 trees. According to calculations conducted in the frames of the national EIA study, around 190 trees shall be planted as a compensatory measure.

9) The northwestern section of the hill occupied by the "Vanqi Berd" archaeological complex, where evidence of medieval habitation has been identified, will be partially affected by the Project. Documented cultural heritage features on the right slope and valley side of the Astghadzor River gorge, including structural remains and tombs, will also experience adverse impacts. Additionally, a portion of the area known as "Yerku Juri Arank", "Gomeri Arank" or "Mtnadzor" will be completely submerged. To mitigate the Project's impacts on these cultural heritage values, a site-specific CHMP shall be developed and implemented prior to and throughout the construction phase.

   No adverse impacts on tangible cultural heritage sites or units are anticipated during the project's operation phase. On the contrary, the presence of the reservoir may generate positive synergistic effects by enhancing the area's attractiveness and potentially increasing interest from both visitors and custodians in the "Vanqi Berd" archaeological complex, as well as in other cultural heritage sites identified during the archaeological survey and potentially relocated to areas surrounding the reservoir.

10) Excavation and earthworks involve the movement of certain amount of soil, including topsoil and excavated subsoil. These activities can potentially trigger landslides, mass movements, and other erosion processes. Additionally, disturbed soils may become temporarily destabilized due to precipitation and surface runoff, increasing the risk of geological erosion. The combined effects on soil stability and changes in topography can create conditions that lead to temporary but harmful erosion and sedimentation. These impacts necessitate the implementation of appropriate mitigation measures.

11) The annual water infiltration volume from the reservoir body is estimated at approximately 1.8 mln. $m^3$ per year, which is significant and requires the implementation of anti-infiltration measures.

12) Construction works will begin with vegetation clearance and topsoil removal. According to the Project design study, 48,640 $m^3$ of topsoil will be stripped and stored in temporary topsoil storage areas located outside the reservoir area but within the construction site. The topsoil will later be used for landscaping activities.

13) Roughly 600,000 $m^3$ of ground material, mostly in a form of sandy loam, will be generated during excavation and earthworks. These materials will be temporarily stored in the construction site and will totally be used as backfill material for the reservoir and dam body. Therefore, designated spoil disposal areas will not be required for the Project. Proper management of waste streams generated during the construction phase will be ensured through a detailed Waste Management Plan.

14) The negative impacts occur mainly during the construction phase; they are caused by the dam construction and flooding of the reservoir footprint area. Some positive impacts on biodiversity will occur during the operational phase, associated with the emergence of the new habitats - such as large water surface and coastal vegetation - which will attract various animal species.

15) The reservoir construction works will destroy animals' habitats and may be the cause of death of the sedentary species of mammals and reptiles. The lost habitats also serve as foraging areas for certain bird and mammal species; as a result, these species will avoid or leave the area during construction.

16) Priority habitats of this area are the following habitats: C2.27 Mesotrophic vegetation of fast - flowing streams (0.31 ha), C3.2 Water fringing reedbeds and tall helophytes other than canes (0.1 ha), C3.55 Sparsely vegetated river gravel banks (1.87 ha) and C3.62 Unvegetated river gravel banks (0.25 ha). The total lost area of the habitats is 2.53 ha. The

habitats will be finally destructed by the reservoir filling; only C.3.2 habitat may restore along the reservoir shore.

17) The reservoir site is located 5 km from the border of Sevan National Park. No significant impacts of the reservoir on the National Park are expected; however, a potential impact may arise from a reduction in water discharge, as the Lake Sevan ecosystem is particularly sensitive to water shortages. To prevent a reduction in water discharge, an appropriate environmental flow should be maintained from the reservoir.

18) The reservoir site is located inside the Candidate Emerald site "Sevan" National Park. About 15 ha of native and partially disturbed habitats will be lost due to the reservoir footprint. This area includes a total of 2.53 ha of four priority habitats, three of which are listed among the habitats of the Candidate Emerald Site in Resolution No. 4 of the Bern Convention.

19) The reservoir area is located 1.5 km from the border of the IBA Lake Sevan and environs. The potential impact on this area is limited to the loss of foraging habitats for some far-ranging bird species, particularly birds of prey. However, the Project area does not appear to play a critical role in their foraging, as existing observations indicate that these species use it opportunistically rather than intensively. Therefore, this impact is considered minor or negligible.

20) The implementation of the Project will have a moderate impact on the traffic intensity within the rural settlements of Astghadzor and Zolaqar. A Traffic Management Plan shall be developed for the Project.

21) The nearby residents might be positively impacted by the new employment opportunities during the Project's construction phase, potentially leading to increased household incomes.

22) According to interviews with the residents, there is here a strong appreciation for the planned reservoir construction, which is expected to expand the area of cultivated land and enable the cultivation of higher-value crops such as green beans, cucumbers, cauliflower, broccoli. Residents also noted the potential to grow high-quality apricots and cherries. The reservoir is anticipated to increase the number of farmers, create additional employment opportunities, boost agricultural income, and reduce work migration from the settlements.

23) The reservoir's operation is likely to produce both positive and negative effects on public infrastructure. Positively, it will strengthen water security and upgrade irrigation systems. On the other hand, it could place additional demands on local roads, electricity networks, and waste management services.

24) The Astghadzor Reservoir is expected to affect 54 land plots with the area of 420,111.30 $m^2$ in Astghadzor and Zolaqar settlements (within Martuni Community). Of these, 19 are community-owned[155] and 35 are privately owned. The 19 community-owned plots are agricultural arable lands, totaling 353,510.10 $m^2$, however as noted in the baseline, the terrain and limited irrigation capacity do not create favorable conditions for municipality to cultivate this area. The 35 private plots cover 66,601.20 $m^2$, of these 27 plots (52,875.10 $m^2$) are classified as agricultural arable lands and 8 ones (13,726.10 $m^2$) as agricultural grasslands.

25) The influx of non-local male workers may increase the risk of Gender-Based Violence and Harassment (GBVH). Women engaged in small businesses, agriculture, or service provision around the construction area may face risks of harassment or coercion. A Worker Code of Conduct and GBVH Policy should be developed and conveyed to all construction workers

[155]Community-owned land means the land belonging to the municipality, as a word 'community" is a direct translation of an administrative unit from Armenia, which is equivalent to municipality.

and contractors. A grievance mechanism with a specific mandate on GBVH should be developed and disclosed, a dedicated person to manage / oversee it should be appointed.

26) The primary OHS risks during the Project construction phase are associated with large-scale earthworks, excavation, operation of heavy machinery and the transport and delivery of construction materials that require development and implementation of the occupational health and safety management plan.

27) The Cumulative Impact Assessment prepared for the Project did not identify any major negative cumulative impacts.

28) E&S Monitoring Plans for construction and operation phases will be developed, agreed with the Supervision engineer and Lenders, and implemented by the Construction contractor (during construction phase) and the Client (during the operation phase). Both observational and instrumental monitoring will be conducted as per the Monitoring Plans. Appropriate human and material resources for their implementation will be allocated.

# 9. Environmental and Social Management and Monitoring

## 9.1 Introduction

The Project's Environmental and Social Management Plan (ESMP) is a standalone document associated with this ESIA Report. It comprises a set of mitigation and management measures, criteria for their effective implementation, and institutional arrangements to be undertaken throughout the Project's life cycle to prevent, reduce and compensate adverse E&S impacts to acceptable levels. The ESMP has been prepared based on the findings of this E&S appraisal to ensure that the Project is implemented in compliance with applicable national E&S laws and regulations, the EBRD ESP (2019), relevant EU directives, and Good International Practices (GIP).

The ESMP is a key document that outlines the E&S requirements, including those related to cultural heritage (both tangible and intangible), land tenure, emergency situations, and community and occupational health and safety risks, and specifies the operational procedures necessary to manage significant issues that may arise during Project implementation.

The ESMP will be implemented during the construction (including pre-construction) and operation (including maintenance) phases of the Project. As such, it can be used as a standalone document throughout the different phases of the Project by key stakeholders, including:

- **Construction contractor(s)** - during the pre-construction and construction phases,
- **The Supervision engineer** - during the construction phase,
- **The Client (Water Committee with its PIU)**, in its capacity as Project owner and developer - throughout the Project construction phase,
- **"Jrar" CJSC**, in its capacity as reservoir operator - throughout the Project operation phase,
- **The Contractors** engaged by the Client or reservoir operator ("Jrar CJSC" under the MTAI) - during the maintenance phase,
- **EBRD** - during the active period of the loan agreement,
- **Other governmental authorities** (MTAI, ME) and inspection bodies,
- **Local self-governmental bodies** - Martuni municipality, administrative heads of Astghadzor, Zolaqar and Vaghashen rural settlements.

The Client holds the overall responsibility for the implementation and supervision of the E&S management and mitigation measures outlined in the Project's ESMP. The further development and effective implementation of these measures prior to and during the construction phase will be delegated to the Construction contractor(s) and supervised by the Supervision engineer, who will be appointed by the Client. The Client or the water reservoir operator - "Jrar" CJSC, will be responsible for and take ownership of the measures relevant to the operation and maintenance phase of the Project.

This chapter outlines the key objectives and fundamental principles of the ESMP, as well as its structure and content.

## 9.2 Objectives of Environmental and Social Management

E&S management and monitoring measures represent the primary outputs of the Project's ESIA process. They are intended to address identified E&S impacts and risks and to reduce them to acceptable levels in line with national regulatory and EBRD ESP requirements. The key objectives of the E&S management/monitoring are to:

- **Integrate environmental and social considerations** into all phases of Project design, construction and operation (maintenance),
- **Ensure compliance** with national legal requirements, EBRD PRs, and other applicable international standards,
- **Avoid, minimize, or mitigate adverse impacts** on the environment, workers, and affected communities through effective planning and implementation of mitigation measures,
- **Establish clear roles, responsibilities, and procedures** for the implementation of E&S mitigation and monitoring measures, as outlined in the Project's ESMP,
- **Promote continuous improvement** in E&S performance through adaptive management, regular monitoring, and corrective actions,
- **Enhance transparency and accountability** by ensuring timely reporting to the Client, EBRD, competent authorities, and other relevant stakeholders,
- **Facilitate stakeholder engagement** by ensuring that the concerns and expectations of affected communities and other stakeholders are considered and addressed throughout the Project life cycle.

## 9.3 Principles of Environmental and Social Management across the Project Life Cycle

*Pre-construction Phase*

Any requirement arising from the process of obtaining specific Project-related decisions (such as approvals, permits, or consents) from national and/or local self-governmental bodies (e.g., ministries, communities, inspection bodies, agencies) and/or the Client and EBRD during the pre-construction stage will be incorporated into the final construction documentation.

*Construction Phase*

In principle, the implementation of the key E&S mitigation measures related to the construction phase will be delegated to the Construction contractor(s). This delegation will be governed by the ESMP, which will form part of the tender documents, procurement process, and the Construction contractor's contract.

The Construction contractor(s) will develop their own Construction Environmental and Social Management Plans (CESMP), which must be aligned with this ESIA Report and the associated ESMP. The CESMP will include Site-Specific Environmental and Social Management and Monitoring Plans (SSESMPs) or procedures to address E&S issues during the construction period. The Supervision engineer, appointed by the Client, shall review and approve these documents.

It will be the responsibility of the appointed construction contractor(s) to further elaborate on the issues addressed in the ESMP as the Project planning progresses, both prior to and during construction. This includes, but is not limited to, the establishment of construction zones, temporary facilities for the workforce, details for storing construction and other materials, traffic and transport management, environmental protection and waste management, labour management, occupational and community health and safety, emergency preparedness, and other relevant matters.

*Operational Phase*

The operation phase will commence following the full commissioning of the reservoir and supporting infrastructure. At that stage, all works will have been handed over by the Construction contractor to the reservoir operator ("Jrar" CJSC), who will be responsible for implementing the majority of E&S management measures to ensure continued compliance with the Project's mitigation strategy. These

measures will be managed through "Jrar" CJSC's Environmental and Social Management System (ESMS), in alignment with applicable regulations and guidelines.

In addition, the implementation of key E&S mitigation measures related to maintenance activities may be delegated to a designated contractor (i.e. the reservoir maintenance contractor). Such delegation will be governed by specific contractual arrangements.

## 9.4 Site-Specific Environmental and Social Management and Monitoring Plans

The Consultant recommends a set of specific operational, management, and monitoring plans that should be prepared by the construction contractor in line with the Project's ESMP and implemented during the pre-construction and construction phases to effectively manage E&S impacts. At a minimum, the proposed SSESMPs shall include:

- Traffic Management Plan,
- Tree Management Plan,
- Biodiversity Management Plan,
- Topsoil Management Plan,
- Hazardous Materials Management Plan,
- Blasting Safety Management Plan,
- Spill Prevention and Management Plan,
- Waste Management Plan,
- Occupational Health and Safety Management Plan,
- Construction Camp Management Plan,
- Worker Code of Conduct,
- Labour and Working Conditions Management Plan,
- Borrow Pit Management Plan,
- Riverine Habitat Construction Plan,
- Cultural Heritage Management Plan,
- Chance Find Procedure,
- Emergency Preparedness and Response Plan,
- Air, Water, and Soil Quality Monitoring Plan,
- Noise, Vibration and Blasting Monitoring Plan,
- Resettlement Action Plan,
- Stakeholder Management Plan (that shall be updated at least once a year).

## 9.5 Organizational Structure of Environmental and Social Management

The organizational structure of the Project's E&S management is presented in the **Figure 9-1**.

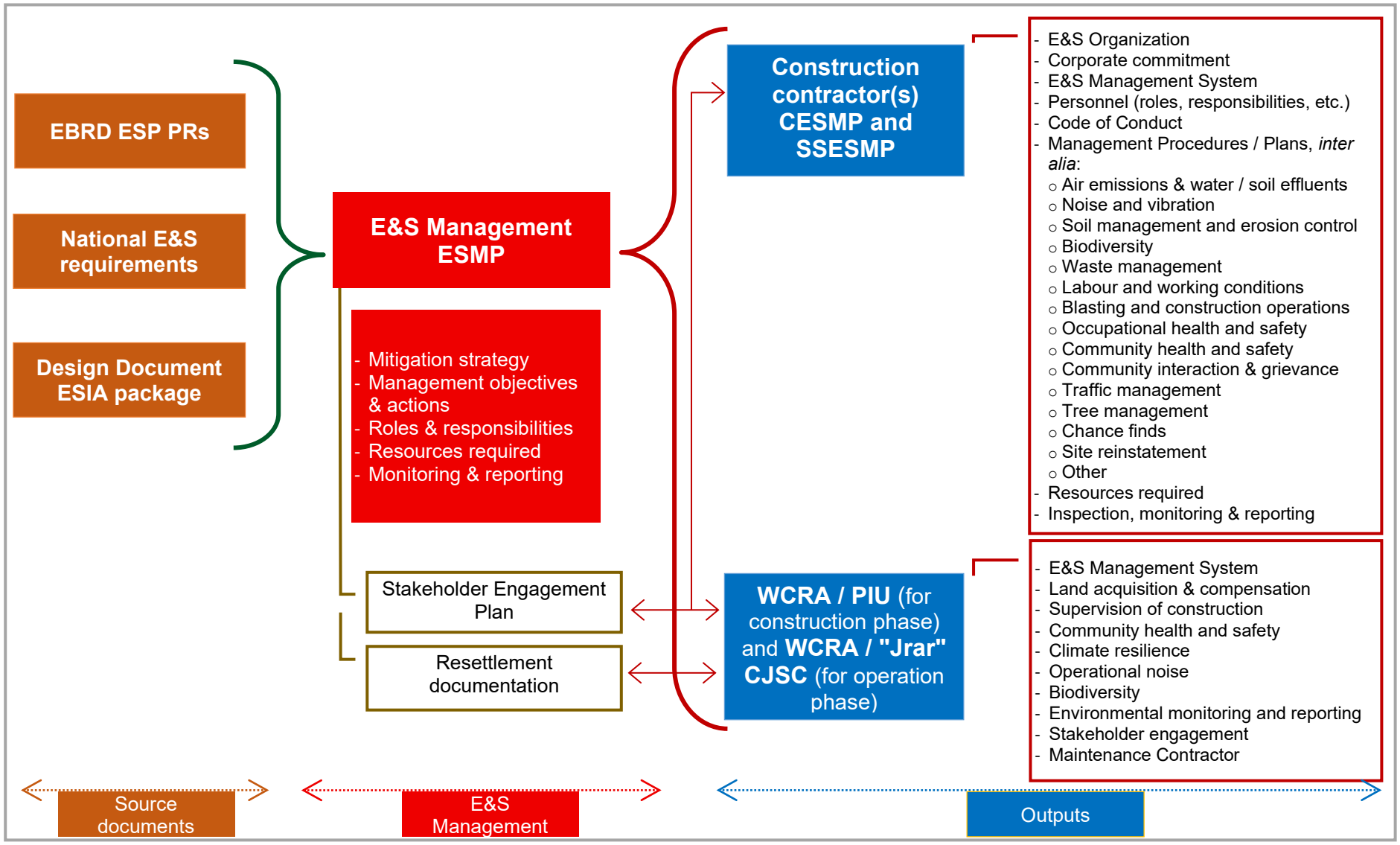
The source documents include:

- National legal act and regulations,
- EBRD ESP, applicable EU directives and GIPs,
- Design documents - to be prepared to meet national regulations as well as the best international practice,
- ESIA report (this document) and the accompanying documents (ESIA package), and upcoming updates.

The output documents are:

- The CESMP and SSESMPs to be prepared by the Construction contractor(s) to achieve the E&S performance objectives during the Project's construction phase,
- The Client's or PIU's ESMS, required to implement and monitor the management actions described in the ESMP,
- Detailed E&S management procedures necessary to address the mitigation and compensation measures identified through this E&S assessment, and
- Various documents to be produced and disclosed during Project implementation to provide information on construction and operation activities, as well as the results of E&S monitoring.

**Figure 9-1. Structure and organization of the Project's Environmental and Social Management**



13007

Annex 1

ՀԱՍՏԱՏՈՒՄ ԵՄ՝
Շրջակա միջավայրի նախարար
Հակոբ Սիմիդյան

«06» 12 2024թ.

# ՊԵՏԱԿԱՆ ՓՈՐՁԱՔՆՆԱԿԱՆ ԵԶՐԱԿԱՑՈՒԹՅՈՒՆ

## ՇՐՋԱԿԱ ՄԻՋԱՎԱՅՐԻ ՎՐԱ ԱԶԴԵՑՈՒԹՅԱՆ ՓՈՐՁԱՔՆՆՈՒԹՅԱՆ

**ԲՓ № 265 - 24**

***Նախաձեռնող՝*** «Քոնսեկոարդ» ՍՊԸ
ք. Երևան, Սեբաստիայի փողոց 31/2

***Գործունեությունը՝*** Աստղաձորի ջրամբարի կառուցում
Գեղարքունիքի մարզ

Առդիր՝ 12 թերթ

ՊԵՏԱԿԱՆ ՓՈՐՁԱՔՆՆԱԿԱՆ ԵԶՐԱԿԱՑՈՒԹՅՈՒՆ

ՇՐՋԱԿԱ ՄԻՋԱՎԱՅՐԻ ՎՐԱ ԱԶԴԵՑՈՒԹՅԱՆ ՓՈՐՁԱՔՆՆՈՒԹՅԱՆ

ԲՓ № 265 - 24

«06» դեկտեմբերի 2024թ.

**Գեղարքունիքի մարզի Մարտունի համայնքում Աստղաձորի ջրամբարի կառուցման շրջակա միջավայրի վրա ազդեցության գնահատման հաշվետվություն**

| | |
|---|---|
| Նախաձեռնող՝ | «Քոնսեկոարդ» ՍՊԸ |
| Փաստաթղթի տեսակ՝ | Շրջակա միջավայրի վրա ազդեցության գնահատման հաշվետվություն, նախագիծ |
| Գործունեության տեսակ՝ | «Բ» կատեգորիա |
| Տեղադրման վայրը՝ | Գեղարքունիքի մարզ, Մարտունի համայնքի, Աստղաձոր բնակավայր |

**Ներածական մաս.** «Քոնսեկոարդ» ՍՊ ընկերության /այսուհետ՝ Ընկերություն/ կողմից փորձաքննության ներկայացված նախագծային փաթեթով նախատեսվում է Գեղարքունիքի մարզի Աստղաձոր բնակավայրի վարչական տարածքում կառուցել Աստղաձորի ջրամբարը: Ներկայացվող ծրագրի պատվիրատուն ջրային կոմիտեն է, որը ֆինանսավորվում է Վերակառուցման և զարգացման եվրոպական բանկի /ՎԶԵԲ/-ի կողմից :

Համաձայն «Շրջակա միջավայրի վրա ազդեցության գնահատման և փորձաքննության մասին» (ՀՕ-150-Ն) օրենքի 12-րդ հոդվածի 4-րդ մասի 3-րդ կետի ա ենթակետի՝ նախատեսվող գործունեությունը հանդիսանում է «Բ» կատեգորիայի գործունեության տեսակ: Նախատեսվող գործունեության համար հիմք են հանդիսացել պատվիրատուի հայտը, Գեղարքունիքի մարզի Մարտունի համայնքի ղեկավարի կողմից 16/08/2023թ-ին տրված № 206 ճարտարապետահատակագծային առաջադրանքը:

**Նկարագրական մաս.** ՀՀ Կառավարությունը ԵՄ աջակցության «Վերականգնում, դիմակայունություն և բարեփոխում. Արևելյան գործընկերության առաջնահերթությունները 2020թ-ից հետո» նախաձեռնության «Լրացուցիչ «Բ» նախաձեռնության» շրջանակներում նախատեսում է կառուցել 17 ջրամբարներ: Ծրագրի իրականացման արդյունքում ոռոգման համակարգերը մեխանիկականից կփոխարինվեն ինքնահոսի՝ ինչը կնպաստի 1 մ$^3$ ոռոգման ջրի ինքնարժեքի զգալի նվազեցմանը, որն իր դրական ազդեցությունը կունենա գյուղատնտեսական արտադրության վրա: Աստղաձորի ջրամբարը նախատեսվում է կառուցել Գեղարքունիքի մարզի Աստղաձոր բնակավայրի վարչական տարածքում, Ասղաձոր գետի վրա, 2100 մ - 2160 մ բացարձակ նիշերի սահմաններում: Ջրամբարը ծառայելու է գետի հեղեղային ելքերը կուտակելու և սակավաջուր ամիսներին Գեղարքունիքի մարզի Աստղաձոր, Վաղաշեն, Մարտունի, Զոլաքար բնակավայրերի 740 հա գյուղատնտեսական հողատարածքների կայուն ոռոգում իրականացնելու համար: Գեոմորֆոլոգիական տեսանկյունից՝ հետազոտվող տեղամասը բնութագրվում է տիպին

լեռնային, խիստ կտրտված ռելիեֆով: Տարածքի ցածր կետը համարվում է Սևանա լիճը (1900մ), որտեղից դիտարկվում է հարավային ուղղությամբ ռելիեֆի բարձրացում: Հետազոտվող տեղամասը ներկայացված է ներքևից վերև միջին էոցենի, օլիգոցենի, միոցեն-պլիոցենի, պլիոցենի, չորրորդական և ժամանակակից նստվածքների ապարներով: Շրջանը հարավից սահմանափակվում է Վարդենիսի լեռներով, որոնք տարածվում են հարավ-արևմուտքից հյուսիս-արևելք: Այն ձգվում է Գեղամա լեռների Գնդասար գագաթից մինչև Մեծ Ծարասարի լեռնահանգույցը: Դաշտային ինժեներա-երկրաբանական աշխատանքների արդյունքում բացահայտվել և քարտեզագրվել են սողանքային մարմնի հիմնական ու երկրորդական պոկման պատերը-սկարպները (landslide scarp), պարզաբանվել են սողանքը կազմող տարրերը, ինչպես նաև որոշվել է սողանքային մարմնի ծավալը և չափերը: Սողանքային երևույների վտանգը նվազեցնելու նպատակով ջրամբարի պատվարի առանցքը գետի հունով բարձրացվել է սողանքի վայրից դեպի վեր մոտավորապես 100 մ: Հիդրոերկրաբանական տեսակետից՝ տվյալ տեղամասերում տարածված են գրունտային ջրերը: Դրանք բավական բարձր տեղադրում ունեն և հիմնականում կապված են Աստղաձոր գետի ավազանի հետ: Ստորերկրյա ջրերը հայտնաբերվել են 1.2-2.2 մ խորություններում: Դրանք կապված են ժամանակակից նստվածքների՝ մասնավորապես ճալաքարային գրունտների հետ: Ստորերկրյա ջրերի հորիզոնն առաջանում է Աստղաձոր գետի ֆիլտրացիայի արդյունքում: Ստորգետնյա ջրերի մակարդակը կարող է փոփոխվել կապված գետի հոսքի հետ: Նախատեսվող ջրամբարի տարածքը գտնվում է բնական վիճակում, որոշ տարածքներ մարդկանց կողմից օգտագործվել են որպես արոտավայրեր: Տարածքը հիմնականում քարքարոտ է, մասնատված, տեղ-տեղ հանդիպում են երկրաբանական հետազոտությունների համար կատարված հորատանցքեր: Ջրամբարի համար առաջարկվող տարածքները հանդիսանում են մասամբ համայնքային հողեր, իսկ մյուս մասը՝ սեփականաշնորհված: Հողամասերը գյուղատնտեսական նշանակության են՝ արոտավայրեր կամ վարելահողեր: Ջրամբարի ջրածածկման տարածքի կորդինատները՝ ARM WGS-84 կորդինատային համակարգով հետևյալն են՝

| Հ/Հ | X [մ] | Y [մ] |
|---|---|---|
| 1 | 4440783.1546 | 8530473.1461 |
| 2 | 4440916.5290 | 8530866.2238 |
| 3 | 4440566.2310 | 8531114.7176 |
| 4 | 4440109.3661 | 8531489.2814 |
| 5 | 4439988.3001 | 8531483.2480 |
| 6 | 4439977.8310 | 8531336.5428 |
| 7 | 4440347.1290 | 8530897.5109 |
| 8 | 4440319.1842 | 8530845.6761 |
| 9 | 4440162.5742 | 8530875.4205 |
| 10 | 4440153.6796 | 8530765.3338 |
| 11 | 4440608.7702 | 8530574.5889 |
| 1 | 4440783.1546 | 8530473.1461 |

Աստղաձոր գետի վրա նախատեսվող ջրամբարի պատվարի տեղամասում Աստղաձոր գետի ջրհավաք ավազանի մակերեսը 37,8 կմ$^2$ է, ջրամբարի լրիվ ծավալը 1.55 մլն մ$^3$ է, օգտակար ծավալը՝ 1.53 մլն մ$^3$, մեռյալ ծավալը՝ 18 հազ մ$^3$, պատվարի բարձրությունը՝ 39 մ: Ջրամբարի հիմնական հիդրոտեխնիկական կառույցը պատվարն է, որի ուղղահատածքն ընտրվել է ելնելով մի շարք նկատառումներից՝

- ջրի անհրաժեշտ ծավալով թասի ստեղծում,
- համեմատաբար կարճ երկարության կատարով պատվարի առկայություն,
- ներքին բիեֆում չլայնացող գետահունի առկայություն

Ջրամբարը ծառայելու է գետի հեղեղային ելքերը կուտակելու և սակավաջուր ամիսներին գյուղատնտեսական հողատեսքերը ոռոգման ջրով ապահովելու նպատակով:

Նախատեսվող պատվարային հիդրոհանգույցը բաղկացած է՝

- պատվարից,
- հեղեղային ջրհեռից,
- շինարարական ջրհեռից,
- ոռոգման ջրթողից:

Պատվարի մարմինը նախատեսվում է իրականացնել տեղական շինարարական նյութերով՝ կոպճա-ճալաքարային բնահողի պրիզմաներով: Որպես հակաֆիլտրացիոն միջոցառում նախատեսվում է իրականացնել կենտրոնական ավազակավե միջուկ: Նախատեսվում է պատվարի վերին շեպն ամրացնել քարե շարվածքով, իսկ ներքին շեպը ճմապատել կամ կատարել բազմամյա խոտացանք: Հողային պատվարի կառուցման համար պահանջվող քարանյութի, ճալաքարակոպճի և կոպճավազի պաշարները գտնվում են ջրամբարի թասում և պատվարի առանցքից մինչև 1 կմ ներքև ընկած գետահունում և գետի աջ ափին գտնվող տարածքներում, իսկ միջուկի համար պահանջվող 100000 մ$^3$ ավազակավի պաշարները, ինչպես նաև անհրաժեշտ այլ շինանյութերը ձեռք կբերվեն համապատասխան լիցենզիա ունեցող կազմակերպություններից: Հաշվի առնելով ջրամբարի առաջարկվող ծավալն և տեղանքի ռելիեֆի առանձնահատկությունները՝ հանվող հողագրունտի ծավալը կազմելու է մոտավորապես՝ 550000 մլն. մ$^3$, հանվող հողագրունտը հիմնականում տեղադրվում է պատվարի մարմնում, ավելցուկային բնահողը օգտագործվելու է շինարարական աշխատանքներից հետո տարածքների բարեկարգման նպատակով:

Ջրամբարի, պատվարի և նրա օժանդակ կառուցվածքների տակ ընկնում է 13.53 հա հողատարածք, այդ թվում ջրամբարի տակ՝ 11.6 հա: Անմիջապես գործունեության տարածքում հողաբուսական շերտը հիմնականում քարքարոտ է: Դիտարկվող տարածաշրջանում գերակշռում են սևահող տիպիկ ալրային կարբոնատային հողային տիպերը: Մթնոլորտային տեղումների տարեկան գումարային տեղումների քանակը տատանվում է 500-1000 մմ-ի սահմաններում: Հատկապես մեծ մակերես են զբաղեցնում 600-ից 800 մմ տեղումներով տարածքները, 900 մմ և ավելի տեղումներ թափվում են ավազանի բարձրադիր, համեմատաբար փոքր մակերեսի վրա: Հիմնական տեղումները թափվում են ապրիլ-հունիս ամիսներին, ինչն էլ, ձմռան ժամանակահատվածում ձյան տեսքով կուտակված ջրի պաշարի հետ, առաջացնում է գարնանային վարարումներ:

Տեղումների քանակի մեծացման երկրորդ շրջանը հոկտեմբեր-նոյեմբերն է, որի ընթացքում թափվում է 40 մմ, իսկ բաձրադիր գոտում մինչև 90 մմ տեղումներ: Ջրամբարի ջրհավաք ավազանում տարեկան գումարային գոլորշունակությունը տատնվում է 400-ից 700 մմ-ի սահմաններում: Ցածրադիր գոտիներում այն 700 մմ-ի սահմաններում է և համընկնում է 500-600 մմ տեղումներով գոտու հետ, ինչը նշանակում է, որ այս գոտին մեծ հավանականությամբ հոսքառաջացնող չէ, սակայն երկու արժեքները մոտ են: Բարձրադիր

ՀՀ ԲՆԱՊԱՀՊԱՆՈՒԹՅԱՆ ՆԱԽԱՐԱՐՈՒԹՅԱՆ ՓՈՐՁԱԳԻՏԱԿԱՆ ԿԵՆՏՐՈՆ
ЗАКЛЮЧЕНИЕ ЭКСПЕРТИЗЫ
COMMISSION OF EXPERTS

գոտիներում, որտեղ գոլորշունակությունը փոքր է, 500 մմ-ից ձևավորվում է հոսքառաջացման հիմնական պաշարը:

Ավազանում ջերմաստիճանի ներտարեկան բաշխումն ըստ մոտակա՝ Մարտունի դիտակետի (շուրջ 1950 մետր բարձրություն) միջինում տատանվում է -5°C-ից +16°C-ի սահահմաններում: Բացարձակ նվազագույնը -31.7°C է, իսկ բացարձակ առավելագույնը՝ 33.6°C:

Միջին ջերմաստիճանը 0°C-ից բարձր է ապրիլ-նոյեմբեր ամիսներին: Սա նշանակում է, որ այս ժամանակահատվածի տեղումները անձրևի տեսքով են և անմիջապես ազդում են գետային հոսքի վրա: Օդի ջերմաստիճանը +5°C-ից բարձր է մայիս-հոկտեմբեր ամիսներին, իսկ 10°C-ից բարձր մայիս-սեպտեմբեր ամիսներին:

Նախատեսվող ջրամբարի տարածքում մթնոլորտային օդն աղտոտող խոշոր արտադրական ձեռնարկություններ չկան, հիմնականում ավտոտրանսպորտի արտանետումներն են:

Ջրամբարի տեղամասում հիդրոլոգիական հաշվարկների կատարման համար որպես բազային հիմք վերցվել է Վարդենիս գետի Վարդենիկ դիտակետի տվյալները, քանի որ վերջինս ունի 95 տարվա դիտարկումների շարք, ինչպես նաև Աստղաձոր գետի Աստղաձոր դիտակետը, քանի որ գտնվում է ջրամբարի պատվարի տեղամասում: Աստղաձոր դիտակետն ունի 10 տարվա տվյալների շարք, որոնք ունեն 97% լրիվություն:

Այսպիսով, Վարդենիկ և Աստղաձոր դիտակետերում տարեկան միջին ելքերը՝ համապատասխան 0,28 և 0,25 վարիացիայի գործակիցներով, 95 և 10 տարվա դիտարկումների շարքի պարագայում կունենան 2,59% և 7.99% հարաբերական միջին քառակուսային սխալի չափ: Ինչը հիմնավորում է Վարդենիկ դիտակետի օգտագործումն Աստղաձոր դիտակետի շարքերի երկարացման համար: Աստղաձոր գետն ունի ՀՀ գետերին բնորոշ հոսքի ներտարեկան բաշխում: Գետն ունի հստակ արտահայտված գարնանային վարարումների փուլ, ձմեռային և ամառային սակավաջրության փուլ և աշնանային հորդացումների փուլ: Գարնանային վարարումներն առավելապես առաջանում են ձնհալի և անձրևների շնորհիվ, աշնանային հորդացումներ կարող են լինել անձրևային տեղումների հետևանքով, այն էլ կարճ և ոչ հստակ արտահայտմամբ: Սակավաջուր սեզոնին գետը հիմնականում սնվում է աղբյուրներից, ամառային սակավաջրությունը երբեմն կարող է ուղեկցվել հանկարծակի հորդառատ անձրևներով: Աստղաձոր գետի Աստղաձոր դիտակետի (դիտակետն ընդունվել է որպես պատվարի տեղամաս) տարեկան միջին ելքերի ուսումնասիրության համար օգտագործվել է Վարդենիս գետի Վարդենիկ դիտակետի դիտարկումների շարքի տվյալները: Վարդենիկ դիտակետում Վարդենիսի գետի տվյալներն Աստղաձոր դիտակետի համար որպես համանման (անալոգային) դիտարկելու համար հիմք է հանդիսացել ՍՆԻՊ-ում (СНИП 2.01.14-83, 1985) ներկայացված պայմանների բավարարումը: Երկու դիտակետերի համար ընդհանուր դիտարկումների տարիներն են 1953-ից 1962 թվականները:

Քանի որ Վարդենիկ դիտակետն ունի երկար տարիների դիտարկման շարք, ապա հիդրոլոգիական հաշվարկները կատարվել են այս դիտակետի հիման վրա, այնուհետև, ըստ ՍՆԻՊ-ի, կատարվել է հաշվարկ Աստղաձոր դիտակետի հիդրոլոգիական վիճակագրական ցուցանիշները ստանալու համար: Աստղաձոր գետի Աստղաձոր դիտակետի հոսքի հիդրոլոգիական հաշվարկի ցուցանիշներից միջին տարեկան ելքը և միջին քառակուսային շեղումը հաշվվել է նաև դիտակետի դիտարկումների շարքի հիման վրա:

*50%, 75% և 95% ապահովվածության ելքերը Աստղաձոր դիտակետում*

| P | Ելք, ըստ էմպիրիկ կորի, մ³/վ | Ելք, ըստ տեսական կորի, մ³/վ |
|---|---|---|
| 50% | 0.25 | 0.24 (≈ 7.6 մլն մ³/տարի) |
| 75% | 0.20 | 0.20 (≈ 6.3 մլն մ³/տարի) |
| 95% | 0.13 | 0.15 (≈ 4.7 մլն մ³/տարի) |

Հոսքի ներտարեկան բաշխման տվյալների սեզոնային կուտակային պատկերը ցույց է տալիս, որ 50% ապահովվածությամբ ելքերով տարիների դեպքում Աստղաձոր գետի հոսքի 62,5%-ն անցնում է գարնանային վարարումների ընթացքում: Իսկ 95% ապահովվածություն ունեցող տարիներին (սակավաջուր տարիներ, օր.՝ 1998, 1999, 2000, 2001, 2008) գարնանային վարարումների կշիռը դառնում է 49,4%, ինչը ցույց է տալիս, որ սակավաջուր տարիներին հատկապես վարարային հոսքերի գումարային ծավալն էականորեն նվազում է: Այսպիսով, ելնելով Աստղաձոր դիտակետում Աստղաձոր գետի հոսքի նորմայի հաշվարկային արժեքից (0,25 մ³/վ), 50% ապահովվածությամբ ելքերով տարիների դեպքում գումարային հոսքի ծավալը գարնանային վարարումների սեզոնին կարող է հասնել շուրջ 5 մլն մ³-ի, իսկ 95% ապահովվածությամբ ելքերով տարիների դեպքում՝ շուրջ 1,6 մլն մ³: Աստղաձոր դիտակետում առավելագույն ելքերի հիդրոլոգիական հաշվարկների համար ևս հիմք է հանդիսացել Վարդենիկ դիտակետի դիտարկումների շարքը, ըստ որի Աստղաձոր դիտակետում 0,01% ապահովվածության դեպքում կազմում է 27,2մ³/վ, իսկ ըստ Գամբլի բանաձևի՝ 33.6մ³/վ: Վարդենիկ դիտակետում նվազագույն ելքի միջին արժեքը 0,41մ³/վ է, միջին քառակուսային շեղումը՝ 0,17, վարիացիայի գործակիցը՝ 0,42, ասիմետրիայի գործակիցը՝ 0,1: Համաձայն ՍՆԻՊ-ի հաշվարկային է համարվում նվազագույն ելքի 80% ապահովվածություն ունեցող ելքը: Ըստ այդմ, Վարդենիկ դիտակետում էմպիրկի կորի հիման վրա $P_{80\%}$ ելքը ստացվում է 0,25 մ³/վ, իսկ ըստ տեսական կորի՝ 0,26 մ³/վ: Եվ Աստղաձոր դիտակետի հաշվարկային նվազագույն ելքը 80% ապահովվածության համար կազմում է 0,19 մ³/վ: Ջրամբարի շահագործման ընթացքում ջրի պարտադիր թողքեր իրականացվում են ոռոգման ջրթողից՝ գյուղատնտեսական հողերի ոռոգման և ներքևի բիեֆում բնապահպանական հոսքն ապահովելու նպատակով: Պարապ բացթողումների նվազագույն ծավալը պայմանավորված է պարտադիր բնապահպանական հոսքով, որը կազմելու է մոտավորապես 0,709 մլն մ³/տարի:

Պատվարի տեղամասում բնապահպանական թողքը հաշվվել է՝ համաձայն Կառավարության 2018 թվականի հունվարի 25-ի N 57-Ն որոշման: Բնապահպանական թողքի հաշվարկի համար հիմք են հանդիսացել ինչպես Վարդենիկ դիտակետի, այնպես էլ Աստղաձոր դիտակետի տվյալները: Համաձայն որոշման՝ յուրաքանչյուր ամսվա բնապահպանական թողքը հաշվելու համար պետք է տվյալ ամսվա նվազագույն ելքի 33%-ին գումարել ձմեռային սակավաջուր սեզոնի իրար հաջորդող 10 օրերի նվազագույն ելքի միջինը: Տասնօրյակային նվազագույն ելքի ցուցանիշը Վարդենիկ դիտակետում 0,045 մ³/վ է: Աստղաձոր դիտակետում, որը և պատվարի տեղամասն է, բնապահպանական թողքը հաշվելու համար, ըստ որոշման, սահմանված է K գործակից, որը երկու դիտակետերի միջին ելքերի հարաբերակցությունն է:

*Բնապահպանական թողքը Աստղաձոր դիտակետում ըստ Վարդենիկ դիտակետի տվյալների*

| | Ամիսներ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| նվազագույն ելք [Վարդենիկ] | 0.10 | 0.11 | 0.12 | 0.30 | 2.83 | 1.32 | 0.46 | 0.17 | 0.18 | 0.15 | 0.16 | 0.11 |
| բնապահպանական թողք [Վարդենիկ] | 0.077 | 0.081 | 0.085 | 0.144 | 0.979 | 0.481 | 0.197 | 0.101 | 0.104 | 0.095 | 0.098 | 0.081 |
| բնապահպանական թողք [Աստղաձոր] | 0.01 | 0.01 | 0.01 | 0.02 | 0.14 | 0.069 | 0.03 | 0.014 | 0.015 | 0.01 | 0.01 | 0.01 |

Քանի որ Աստղաձոր դիտակետում ևս կա նվազագույն հոսքի ինը տարվա դիտարկումների շարք, իսկ N 57-Ն որոշումը չի սահմանում դիտարկումների շարքի առկայության նվազագույն շեմ, ապա Աստղաձոր դիտակետում բնապահպանական թողքի հաշվարկը կատարվել է նաև իր իսկ տվյալների հիման վրա: Դիտակետում ձմեռային ժամանակահատվածի նվազագույն տասնօրյակային ելքը 0,005 մ$^3$/վ է, որի հիման վրա հաշվակված բնապահպանական թողքը ներկայացված է աղյուսակում:

*Բնապահպանական թողքը Աստղաձոր դիտակետում*

| | Ամիսներ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| նվազագույն ելք | 0.015 | 0.016 | 0.018 | 0.14 | 0.11 | 0.16 | 0.088 | 0.054 | 0.011 | 0.013 | 0.017 | 0.015 |
| Բնապահպա-նական թողք | 0.01 | 0.01 | 0.01 | 0.05 | 0.04 | 0.06 | 0.03 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 |

Երկու դիտակետերի հիման վրա կատարված հաշվարկները ցույց են տալիս գրեթե նույն պատկերը և հաշվարկային բնապահպանական թողքի տարբերությունը մեծ է վարարումների սեզոնին (ապրիլ-հունիս): Քանի որ որոշմամբ սահմանվում է որպես բնապահպանական թողք ընդունել հաշվարկային ավելի փոքր արժեքներն, ուստի պատվարի տեղամասի համար որպես բնապահպանական թողք ընդունվել է Աստղաձոր դիտակետի բնապահպանական թողքը: Բնապահպանական թողքն իրականացվելու է ոռոգման ջրթողից սկիզբ առնող 159x4 մմ պողպատե խողովակով, որը կահավորված է հեռակառավարվող սողնակով: Ակտիվ ջրառի դեպքում ջրի մակարդակն իջնի մեռյալ ծավալի մակարդակից ցածր և բնապահպանական թողքն կարող է իրականացվել ջրընդունիչի մաքրման ջրթող-խողովակով: Ջրթողերի վրա տեղադրվելու են հոսքաչափեր, որոնց միջոցով կվերահսկվի բաց թողնվող ջրի ելքերը: Հեղեղային ելքերի հեռացման համար նախագծվել է բաց ափային խրամուղային ջրհեռ՝ բաղկացած 6 հիմնական

մասերից՝ 1. կողային ջրթափ, 2. խրամուղի, 3. անցումային մաս, 4. ստորասրահ պատվարի կատարի տակով, 5. հեռացնող հատված (արագահոս), 6. արագահոսի ելքամաս տրամպլինի տեսքով: Շինարարական ջրհեռը, որը ժամանակավոր էծառայելու է հիդրոհանգույցի շինարարության ընթացքում գետով եկող շինարարական ելքերը ներքին բիեֆ տեղափոխելու և շինհրապարակը չոր պահելու համար:

Նախատեսվող գործունեությունը շինարարական աշխատանքների ընթացքում իր բացասական ազդեցությունները կունենա շրջակա միջավայրի վրա, որոնք կկրեն ժամանակավոր բնույթ:

Հողային աշխատանքներ իրականացնելիս կառաջանա փոշի, որը կարող է ցրվել քամու միջոցով՝ փորման աշխատանքների տեղամասից 100 մ տարածքի վրա: Օդի որոշակի աղտոտում տեղի կունենա նաև շինարարական նյութերի փոխադրման ընթացքում՝ մանրախճով պատված մոտեցող ճանապարհներով բեռնատար մեքենաների տեղաշարժից: Շահագործման փուլում օդի որակի վրա ազդեցություն չի լինի:

Մեխանիզմների և տրանսպորտային միջոցների աղմուկի մակարդակը շինարարության ընթացքում էականորեն տարբերվում է և կախված է առաջացող աղմուկի տեսակից և գործունեության մակարդակից: Շահագործման փուլում աղմուկի ազդեցությունը կլինի ժամանակավոր և կունենա ոչ զգալի ազդեցություն:

Շինարարության փուլում ջրային ռեսուրսների վրա (մակերևութային/ստորերկրյա ջրեր) կլինեն հետևյալ հնարավոր բացասական ազդեցությունները՝

- ստորգետնյա ավազանի աղտոտում՝ շինհրապարակից հոսող կեղտաջրերի միջոցով,
- մակերևութային ջրերի հոսքի և դրանց որակի փոփոխություններ՝ աղտոտիչների արտահոսքի պատճառով,
- գետի ջրի որակի փոփոխություն՝ ոչ պատշաճ կերպով պահված շինարարական նյութերի և թափոնների, կենցաղային թափոնների արտանետումների, վառելիքի արտանետումների, յուղերի և քսանյութերի արտահոսքից:

Շինարարության փուլում հողի աղտոտման պատճառ կարող են հանդիսանալ նավթամթերքի արտահոսքը, նավթամթերքի ոչ ճիշտ պահեստավորումը, նավթի և վառելիքի չհեռացված թափոնները՝ ներառյալ օգտագործված յուղերի, հիդրավլիկ թունավոր հեղուկների, դատարկ նավթի տարաների ոչ պատշաճ հեռացումը: Թափոնների վատ կառավարումը կարող է հանգեցնել հողի աղտոտման: Բույսերի կորուստը շինհրապարակի մաքրման հետևանքով կարող է հանգեցնել բնական միջավայրի և կենդանական աշխարհի տեսակների կորստի: Թռչուններին և փոքր կենդանիներին անհանգստացնելը կարող են հանգեցնել բնակության վայրի կորստի: Աստղաձորի ջրամբարի կառուցման համար նախատեսվող տարածքում կատարված դաշտային այցելությունների դիտարկումների համաձայն՝ բուն ջրամբարի և մերձակա տարածքներում առանձնահատուկ պահպանության կարիք ունեցող, վտանգված, խոցելի, անհետացման եզրին գտնվող և ՀՀ Կարմիր գրքում կամ ԲՊՄՄ կարմիր ցուցակում գրանցված այլ բուսատեսակները և կենդանիները բացակայում են համաձայն գնահատման հաշվետվությամբ ներկայացված համապատասխան մասնագետների կողմից տրված եզրակացության: Ջրամբարի թասում առկա են մի շարք պատմամշակութային արժեք ներկայացնող կառուցվածքներ:

Շինարարական աշխատանքների իրականացման ժամանակ Աստղաձորի ջրամբարի կառուցման համար անհրաժեշտ կլինի հատել մոտավորապես 38 ծառ, որոնք գտնվում են պատվարի տեղամասում: Հասցված վնասը փոխհատուցելու նպատակով՝ հատված ծառերի փոխարեն համայնքի կողմից տրամադրված վայրերում կիրականացվի ծառատունկ՝ մեկը հինգի հարաբերակցությամբ: Տնկվող ծառերի քանակը հաշվարկվել է հետևյալ կերպ՝

մինչև 10 սմ բնի հաստությամբ հատվող ծառերի դիմաց տնկել 1:1 հաշվարկով, իսկ 10 սմ-ն գերազանցելու դեպքում՝ 1:5 հաշվարկով: Ծառատունկի և դրանց խնամքի համար ծախսերի խոշորացված հաշվարկը կկազմի 16,71,660 ՀՀ դրամ:

Ջրամբարի կառուցման շինարարական աշխատանքների ընթացքում նախատեսվում է իրականացնել **բնապահպանական ազդեցությունները մեղմող հետևյալ միջոցառումները՝**

Շինարարական հրապարակում առաջացած փոշու և աղմուկի նվազեցման նպատակով նախատեսվում է՝

- շինարարական նյութերի և թափոնների տեղափոխման համար անհրաժեշտ է օգտագործել փակ կամ ծածկով բեռնատար մեքենաներ.
- հողային աշխատանքներն, ըստ հնարավորության, կատարել փոշեորսիչով կահավորված տեխնիկական միջոցներով և սարքավորումներով,
- տրանսպորտային միջոցները և տեխնիկան պարբերաբար ստուգել, կարգավորել և ապահովել ձայնի խլացուցիչներով,
- շինարարական տարածքը և մոտեցնող ճանապարհները պարբերաբար ջրել, իսկ խիճը, պահեստավորված և տեղափոխվող հողային զանգվածները խոնավացնել՝ փոշին նվազեցնելու նպատակով (բացի ձմեռային և տեղումներով առատ ամիսներից):

Ջրային ռեսուրսների վրա հնարավոր բացասական ազդեցությունները շինարարության ընթացքում մեղմելու կամ կանխարգելելու, վնասակար նյութերի արտահոսքը բացառելու համար նախատեսվում է՝

- փոշենստեցման համար ջրցանը կատարել ըստ անհրաժեշտության՝ հնարավորինս չառաջացնելով մակերևութային հոսքեր,
- քսայուղերի և այլ նյութերի համար հատկացված վայրերի հատակները բետոնապատել,
- անձրևաջրերի և արտադրական հոսքաջրերի հեռացման և հավաքման համար նախատեսել ժամանակավոր պարզարաններ,
- շինարարական տրանսպորտային միջոցների և սարքավորումների սպասարկումը կատարել մոտակա մասնագիտացված կետերում,
- ավտորտանսպորտային միջոցների անիվների լվացումը կատարել փրփուրային եղանակով՝ կանխելու համար աղտոտված արտահոսքի ներթափանցումը ջրային ռեսուրսներ,
- որպես ափապաշտպան միջոցառում՝ շինարարական գալերեայի ելքամասում և հեղեղային ջրհեռի վերջում, ջրի էներգիան մարելու և գետի հունը ողողումից պաշտպանելու նպատակով՝ նախատեսվել են ջրծեծ հորեր, որոնց շեպերն ու հատակն ամրացվելու են քարով,
- դեպի Աստղաձոր գետ կեղտաջրերի արտահոսքը կանխելու նպատակով՝ շինարարության փուլում աշխատողների համար տարածքում տեղադրել կեղտաջրերի հավաքման հոր կամ բիոզուգարան, որի մաքրումը կատարվելու է համապատասխան մասնագիտացված կառույցների կողմից՝ պայմանագրային հիմքունքներով:

Կենսաբազմազանության վրա ազդեցությունը մեղմելու նպատակով նախատեսվում է՝

- ըստ հնարավորության՝ բացառել ծառահատումները, առկա թփերի մաքրումը կատարել մասնագետների մասնակցությամբ,
- գործունեության և հարակից տարածքներում ՀՀ Կարմիր գրքերում գրանցված բուսատեսակների նոր պոպուլյացիաների կամ կենդանիների բնադրավայրերի հայտնաբերման դեպքում դադարեցնել շինարարական աշխատանքները,
- շինարարական աշխատանքներն իրականացնել ցերեկային ժամերին՝ որոշ կենդանիների կենսակերպի վրա ազդեցությունից խուսափելու համար,

- հնարավորինս նվազեցնել տարածքի գիշերային լուսավորությունը՝ կենդանիների որոշ տեսակների բնականոն վարքին չխանգարելու նպատակով:

Շինարարական աշխատանքների ժամանակ ՀՀ Կարմիր գրքում գրանցված բուսատեսակների պոպուլիացիաների հայտնաբերման դեպքում դրանց պահպանության նպատակով նախատեսվում է.

- Կարմիր գրքում գրանցված բուսատեսակների նոր պոպուլյացիաների կենսունակության ապահովման նպատակով նախատեսել հատուկ միջոցառումներ օրենքի համապատասխան կարգով և աշխատանքները իրականացնել Հայաստանի Հանրապետության բուսական աշխարհի օբյեկտների պահպանության և բնական պայմաններում դրանց օգտագործման կարգը սահմանելու մասին (2014 թվականի հուլիսի 31-ի N 781-Ն որոշման) հիմնադրույթներին համապատասխան,
- Շինարարական աշխատանքների ընթացքում իրականացնել մշտադիտարկման աշխատանքներ:

Շինարարական և հողային աշխատանքների ժամանակ օգտագործվելու է ջրցան՝ փոշենստեցման նպատակով, ինչն աղտոտումից կպահպանի օդային ավազանը և բնական էկոհամակարգերը, մասնավորապես՝ տեղի բուսականությունը: Ջրամբարի շինարարությունից հետո նախատեսվում է իրականացնել կանաչապատման աշխատանքներ՝ հատուցելով տարածքին հասցված վնասը: Կանաչապատման ծրագիրը կմշակվի շինարարության կապալառուի կողմից՝ համայնքի կողմից հատկացված տեղամասերի համար:

Նախատեսվող շինարարական աշխատանքների իրականացման ընթացքում, ծրագրի ազդակիր տարածքում առաջացող տարբեր տեսակի թափոնները կարող են բացասաբար անդրադառնալ շրջակա միջավայրի վրա, մասնավորապես՝ առաջացնելով լանդշաֆտի փոփոխություն, աղտոտել ջրային և հողային ռեսուրսները և մթնոլորտային օդը, ինչպես նաև ազդել մարդկանց առողջության վրա:

Հողային ռեսուրսների պահպանության հիմնական միջոցառումը բերրի հողաշերտի պահպանումն է: Ջրամբարի թասից դուրս՝ պաշտպանիչ գոտում՝ կազմակերպվելու է բերրի հողի պահեստներ՝ ծածկի տակ շրջանցող առուներով: Բերրի հողն ամբողջությամբ օգտագործվելու է տարածքի բարեկարգման և կանաչապատման նպատակով: Շինարարության տարածքից հանվելու է մոտ 4000մ$^3$ բուսահող, տեղափոխվելու է համայնքի կողմից նախանշված մինչև 500 մ հեռավորության վրա գտնվող վայր և պահեստավորվելու է համաձայն Կառավարության 2017 թվականի նոյեմբերի 2-ի N 1404-Ն որոշման պահանջների: Բուսահողը պահեստավորվելու է և հետագայում կօգտագործվի՝ ըստ գործող օրենսդրության պահանջների:

Հողային ռեսուրսների վրա հնարավոր բացասական ազդեցությունները և վերջինիս մեջ վտանգավոր նյութերի և քսայուղերի ներթափանցումը կանխելու նպատակով նախատեսվում է՝

- ճանապարհից դուրս տեղակայվող սարքավորումների վայրում փռել ավազ կամ մանրախիճ,
- բուն գործունեության տարածքում յուղի, վառելիքի կամ այլ վտանգավոր հեղուկների պահման տեղամասեր չնախատեսել,
- շինարարական նյութերը տեղադրել հատուկ տակդիրների վրա,
- հողային գրունտը տարածքում պահպանել ծածկված վիճակում՝ անջրթափանց թաղանթով,
- առաջացող շինաղբը տեղափոխել համայնքի կողմից նախատեսված աղբավայր,

- հանվող հողային զանգվածն օգտագործել որպես հետլիցք և տարածքի բարեկարգման համար,
- շինարարության փուլում օգտագործվող տրանսպորտային միջոցների լիցքավորումը և տեխնիկական սպասարկումը կատարել տարածքից դուրս՝ հատուկ մասնագիտացված կազմակերպություններում:

Շինարարական աշխատանքերի ընթացքում, առաջացող թափոնատեսակներն են՝ կենցաղային աղբը /ծածկագիրը՝ 9120040001004/, որը կհավաքվի աղբամաններում, շինարարական աղբը /ծածկագիրը՝ 9120060101004/՝ կհավաքվի համապատասխան կոնտեյներներում, և չաղտոտված հող /ծածկագիրը՝ 3140110008995/: Շինարարական թափոնները և կենցաղային աղբն ամբողջությամբ կանոնավոր կերպով կտեղափոխվի համայնքի կողմից հատկացված աղբավայր: Հաշվի առնելով տարածքի զգայուն էկոհամակարգը՝ շինարարական տեխնիկայի և ավտոտրանսպորտի բոլոր սպասարկման աշխատանքները, քսայուղերով և վառելիքով լիցքավորումը կիրականացվի մասնագիտացված կայաններում, ինչը թույլ կտա բացառել վտանգավոր հեղուկ թափոնների առաջացումը:

Իրականացվող ծրագրի տեղամասերում աշխատանքների մեկնարկն իրականացվելու է հնագետի հսկողությամբ: Շինարարական աշխատանքների ընթացքում որևէ անհայտ հնագիտական շերտի, անհայտ ծագման իրերի, բնության հուշարձանի հայտնաբերման դեպքում շինարարական ախատանքներն անմիջապես դադարեցվելու են և տեղեկացվելու է համապատասխան պետական մարմնին՝ հետագա գործողությունները ՀՀ գործող օրենսդրությանը համապատասխան կազմակերպելու համար:

Ռիսկերի նվազեցումը կարելի է ապահովել՝ իրականացնելով մի շարք բնապահպանական և սոցիալական միջոցառումներ, որոնց արդյունավետության ապահովման նպատակով պետք է կազմակերպել աշխատանքների մշտադիտարկումներ:

Հաշվի առնելով նախատեսվող ջրամբարի տարածքի ռելիեֆային և բնահողային պայմանները, նախատեսվող պատվարի բարձրությունը (39 մ), ինչպես նաև ձկնաբանի կողմից իրականացված ուսումնասիրությունները և տրված եզրակացությունը (որոնք առկա են գնահատման հաշվետվության մեջ,) և այն հանգամանքը, որ ջրամբարը նախատեսվում է կառուցել ոռոգման նպատակով, հետևաբար ջրի հորիզոնը կլինի փոփոխական, ուստի նախագծող կազմակերպության կողմից հիմնավորվել է, որ ջրամբարի ընտրված տարածքում ձկնուղին տեխնիկապես հնարավոր չէ այնպես նախագծել, որ ապահովվի ձկների միգրացիան:

**Պատճառաբանական մաս**. ՀՀ օրենսդրությանը համապատասխան՝ հանրային ծանուցումը և լսումներն իրականացվել են Գեղարքունիքի մարզի Մարտունի համայնքի Աստղաձոր բնակավայրում: Հանրային լսումներում գործունեության իրականացումը մասնակիցների կողմից արժանացել է հավանության: Հաշվետվության վերաբերյալ փորձաքննական գործընթացում ստացվել են կարծիքներ՝ առողջապահության, ներքին գործերի, կրթության, գիտության, մշակույթի և սպորտի նախարարություններից, քաղաքաշինության կոմիտեից, կադաստրի կոմիտեից, ինչպես նաև շրջակա միջավայրի նախարարության ստորաբաժանումներից: Ստացված դիտողությունները և առաջարկությունները հաշվի են առնվել գնահատման հաշվետվության լրամշակումներում: Ամփոփելով հաշվետվության բնապահպանական և սոցիալական ազդեցությունների վերլուծությունները՝ կարելի է եզրահանգել, որ նախատեսվող գործունեության իրականացման արդյունքում շրջակա միջավայրի վրա հնարավոր բացասական ազդեցությունները, որոնք առնչվում են շինարարական աշխատանքների հետ, կլինեն ժամանակավոր և տեղայնացված բնույթ և կլինեն թույլատրելի նորմայի սահմաններում:

Դրանք կարող են բացառվել կամ մեղմվել գործունեության ընթացքում բնապահպանական միջոցառումների արդյունավետ իրականացմամբ: Աստղաձորի ջրամբարի կառուցմամբ հնարավոր կլինի ապահովել սակավ ոռոգման ջրի կայուն և արդյունավետ օգտագործում՝ խթանելով գյուղատնտեսության զարգացումն, ինչպես նաև նվազեցնելով թիրախային խմբի խոցելիությունը կլիմայական փոփոխությունների ազդեցության հանդեպ: Ծրագրի իրականացումը հնարավորություն կտա լուծել մի շարք արմատական հիմնախնդիրներ՝

- կուտակել գետի օգտագործելի հոսքի մի մասը, կարգավորել ջրահոսքերը՝ ապահովելով բնապահպանական թողքերը,
- հրաժարվել մեխանիկական եղանակով ոռոգման ջրի մատակարարումից և հողերի ոռոգումը փոխադրել ինքնահոս եղանակի, խնայել զգալի չափով էլեկտրաէներգիա, կրճատել շահագործման ու պահպանման ծախսերը,
- բարձրացնել ներկայումս ինքնահոս եղանակով ոռոգվող հողերի ջրապահովվածությունը՝ ապահովելով կայուն ջրամատակարարում ողջ ոռոգման շրջանում:

## Փորձաքննական պահանջներ

1.Շինարարության ընթացքում ապահովել բնապահպանական կառավարման և մոնիթորինգի պլաններում նախատեսված միջոցառումների իրականացումը՝ սահմանված ժամանակահատվածում:

2.Շինարարական աշխատանքների իրականացման ընթացքում առաջացող մնացորդային գրունտի, շինաղբի և տարբեր տեսակի թափոնների հեռացումն ու տեղափոխումն իրականացնել ՀՀ օրենսդրությամբ սահմանված կարգով՝ տեղական ինքնակառավարման մարմինների կողմից հատկացված վայր:

3.Կանաչապատումն իրականացնել տարածաշրջանին և տեղի կլիմայական պայմաններին բնորոշ ծառաթփային բուսականությամբ՝ Կառավարության 2018 թվականի փետրվարի 8-ի N108-Ն որոշման պահանջներին համապատասխան:

4.Կառուցապատման աշխատանքների ընթացքում պահպանել «Մթնոլորտային օդի պահպանության մասին» օրենքի 11-րդ հոդվածով սահմանված պահանջները:

5.Անհրաժեշտ է առաջնորդվել ՀՀ կառավարության 2005 թվականի հունվարի 20-ի «Ջրաէկո-համակարգերի սանիտարական պահպանման, հոսքի ձևավորման, ստորերկրյա ջրերի պահպանման, ջրապահպան, էկոտոնի և անօտարելի գոտիների տարածքների սահմանման չափորոշիչների մասին» N 64-Ն որոշման պահանջներով:

6. Շինարարական աշխատանքների իրականացման ընթացքում հողաբուսական շերտի (հողի բերրի շերտ) հեռացումը և պահպանումը կատարել ՀՀ Կառավարության 08.09.2011թ-ի թիվ 1396-Ն և Կառավարության 02.11.2017թ-ի թիվ 1404-ն որոշումների պահանջներին համապատասխան:

7.Աստղաձորի ջրամբար համար նախատեսված տարածքը՝ ծրագրի իրականացման դեպքում պատմա-մշակութային միավորների վրա հնաարավոր բացասական ազդեցության տեսանկյունից ունի որոշակի ռիսկեր, քանի որ դրանց մի մասը մնալու է ամբարված ջրի տակ կամ վնասվելու է ամբարտակի կառուցման ընթացքում, հետևաբար մինչև շինարարական աշխատանքների մեկնարկն անհրաժեշտ է իրականացնել լրացուցիչ ուսումնասիրություններ և պատմամշակութային արժեքներ հայտնաբերելու դեպքում դրանք տեղափոխել համայնքի կողմից հատկացված վայր, կամ լիազոր մարմնի կողմից առաջարկվող պահպանվող տարածք: Շինարարական աշխատանքների իրականացման

ЗАКЛЮЧЕНИЕ ЭКСПЕРТИЗЫ COMMISSION OF EXPERTS

ընթացքում անհրաժեշտ է առաջնորդվել ՀՀ կառավարության 2002 թվականի ապրիլի 20-ի N 438 որոշման 43-րդ կետի պահանջով՝ աշխատանքների կատարման ժամանակ պատմական, գիտական, գեղարվեստական և այլ մշակութային արժեք ունեցող հնագիտական և մյուս օբյեկտների հայտնաբերման պահից դադարեցնել աշխատանքները և դրա մասին անհապաղ հայտնել լիազորված մարմնին:
8. Աշխատանքների իրականացման ընթացքում առաջնորդվել 2022 թվականի դեկտեմբերի 8-ի «Սևանի ջրավազանային կառավարման տարածքի» 2022-2027թթ կառավարման պլանը հաստատելու մասին N 1912-Ն որոշմամբ:

## ԵԶՐԱՓԱԿԻՉ ՄԱՍ

«Քոնսեկոարդ» ՍՊԸ-ի կողմից փորձաքննության ներկայացված Գեղարքունիքի մարզի Մարտունի համայնքում Աստղաձորի ջրամբարի կառուցման շրջակա միջավայրի վրա ազդեցության գնահատման հաշվետվությանը տրվում է դրական եզրակացություն՝ վերը նշված փորձաքննական պահանջների պարտադիր կատարման պայմանով:

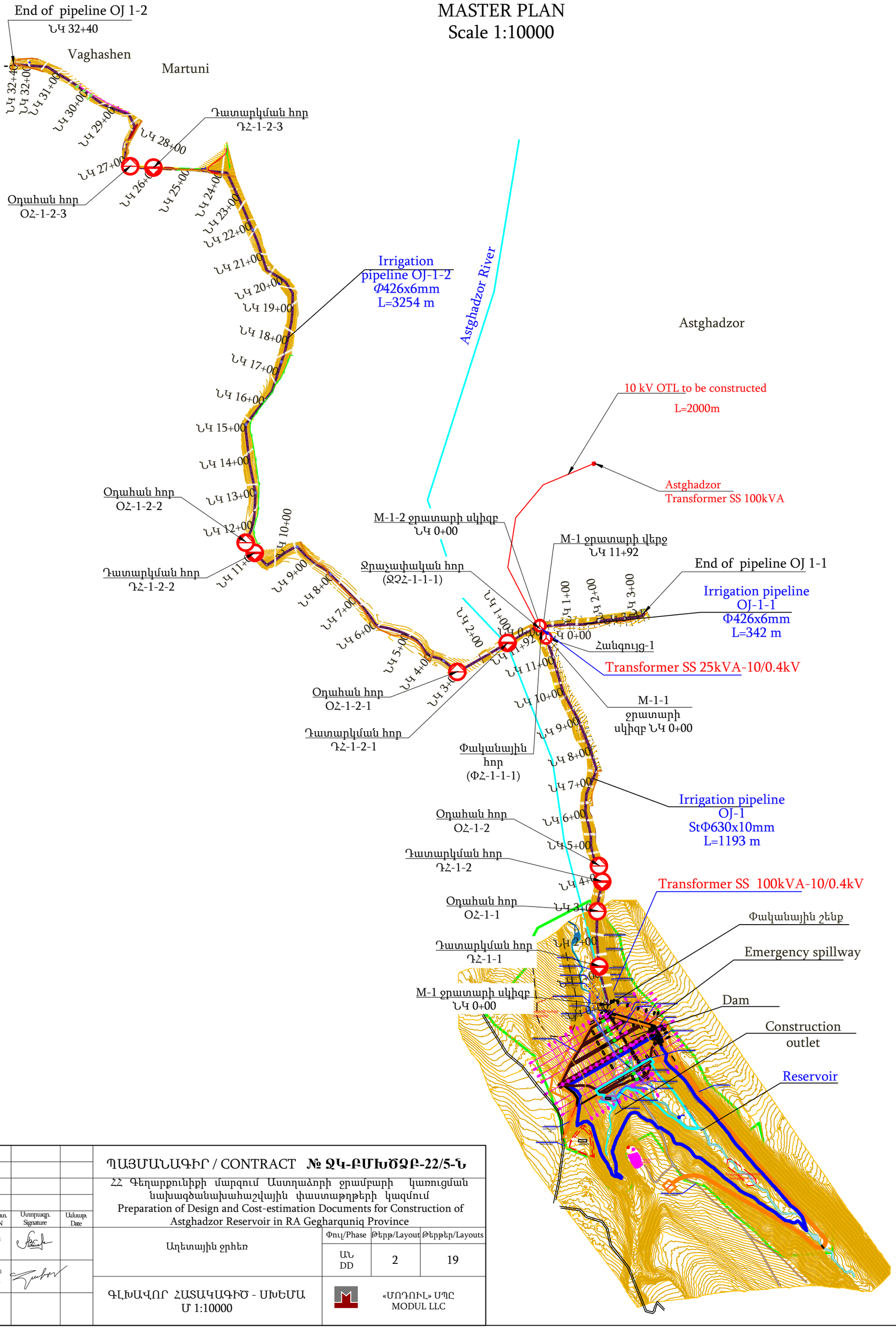
«Շրջակա միջավայրի վրա ազդեցության փորձաքննական կենտրոն» ՊՈԱԿ-ի տնօրեն՝ Խաչիկ Մարտիրոսյան

«Շրջակա միջավայրի վրա ազդեցության փորձաքննական կենտրոն» ՊՈԱԿ-ի տնօրենի տեղակալ՝ Հերիքնազ Մկրտչյան

«Շրջակա միջավայրի վրա ազդեցության փորձաքննական կենտրոն» ՊՈԱԿ-ի գլխավոր մասնագետ՝ Նելլի Նասիբյան

# MASTER PLAN
Scale 1:10000

**Annex 2**

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|---|---|---|---|---|
| Փոխ. Rev. | Քանակ Quantity | Թերթ Layout / Ինվատ. Doc.N | Ստորագր. Signature | Ամսաթ. Date |
| ՆԳՃ CDE | | Վ. Ավագյան V. Avagyan | | |
| Նախագծեց Designed by | | Հ. Հակոբյան H. Hakobyan | | |

ՊԱՅՄԱՆԱԳԻՐ / CONTRACT **№ ՋԿ-ԲՄԽՍՁԲ-22/5-Ն**

ՀՀ Գեղարքունիքի մարզում Աստղաձորի ջրամբարի կառուցման նախագծանախահաշվային փաստաթղթերի կազմում
Preparation of Design and Cost-estimation Documents for Construction of Astghadzor Reservoir in RA Gegharquniq Province

Աղետային ջրհեղեղ

| Փուլ/Phase | Թերթ/Layout | Թերթեր/Layouts |
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| ԱՆ DD | 2 | 19 |

ԳԼԽԱՎՈՐ ՀԱՏԱԿԱԳԻԾ - ՍԽԵՄԱ
Մ 1:10000

«ՄՈԴՈՒԼ» ՍՊԸ
MODUL LLC