ARMENIA NEW NUCLEAR UNIT ENVIRONMENTAL BACKGROUND INFORMATION DOCUMENT

PROGRAM TO STRENGTHEN REFORM AND ENHANCE ENERGY SECURITY IN ARMENIA

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Environmental Background Information Document

Executive Summary

October 2008

EXECUTIVE SUMMARY

The "Environmental Background Information Document" (EBID) for a new unit at the Armenian Nuclear Power Plant (ANPP) site has been prepared as part of the U.S. Government's support to Armenia, provided under the U.S. Agency for International Development (USAID) energy project for providing support to the Ministry of Energy and Natural Resources of Armenia, entitled "Program to Strengthen Reform and Enhance Energy Security in Armenia." The EBID was developed in parallel with "Initial Planning Studies to Assess Feasibility of a Replacement Nuclear Power Unit in Armenia" (IPS).

The format and content of the EBID is based on the U.S. Nuclear Regulatory Commission's "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", NUREG-1555. NUREG-1555 was used as a guide for development of the EBID because it describes a comprehensive environmental assessment process generally consistent with Armenian laws and international conventions and guidance on environmental impact assessment.

The EBID introductory chapter describes the potential project in conceptual terms as it has been evaluated in the EBID assessments, describes the requirements for compliance with environmentally-related authorizations required by GoA agencies and identifies the laws, regulations, standards, and international guidelines that are applicable to the environmental impact assessment process.

<u>Actions are identified for the Government of Armenia to:</u>

- Develop a national strategy for management of radioactive waste and spent nuclear fuel;
- Complete the human resource study for a new unit currently in progress with IAEA and identify the preferred approaches to housing of temporary construction workers;
- Establish acceptable levels of risk and accident dose criteria for siting of a new reactor in Armenia;
- Determine the minimum flow necessary to maintain the ecosystems of the Sevjur River;
- Determine how the water of the Sevjur River will be allocated among the water users and what amount can be allocated to ANPP Unit 3;
- Establish appropriate water quality standards applicable to the Sevjur River; and
- Evaluate feasibility of alternative actions to assure adequate supply of water to Unit 3.

Baseline data for the ANPP site and vicinity are presented, including data on the station location, land use, water resources, ecology, socioeconomics, geology, meteorology and air quality.

<u>Studies by qualified experts or collection of suitable data</u> with modern technologies are necessary for additional baseline data on:

- Seismic suitability and design earthquake levels for a new unit at the ANPP site (Ministry of Energy and Natural Resources is conducting a tender for this work);
- Meteorological conditions at the ANPP site;
- Routing of the new 400 kV transmission line between ANPP and Hrazdan-5 substation;
- Site-specific inventories of flora and fauna at the construction sites for the plant, intake and discharge structures on the Sevjur River, and along the new transmission line route;
- Traffic flow and noise levels in the vicinity of the ANPP site;
- Surveys of available housing in the site vicinity;
- Surveys of population dependent on food and water from within 10 km of the site;
- Inventory of meat- and milk-producing animals and poultry within 10 km of the site; and
- Statistics on income levels within 16 km of the site.

The EBID describes the structures and systems for the new unit. The EBID does not provide the detailed design of the reactor considered for ANPP Unit 3; but provides a plant parameter envelope with bounding parameters and characteristics of these components so that an assessment of potential environmental impacts of a new nuclear unit can be made. The reactor plants considered are the Westinghouse AP1000 (U.S. design), the AECL CANDU EC-6 (Canadian design), and the Atomstroyexport VVER-1000 (Russian export Model AES 91 or AES 92). All three types of reactor are considered acceptable. The base configuration evaluated assumes a single secondary (steam cycle) circuit with a nominal output of 1,117 MWe, a single natural-draft cooling tower for condenser cooling, and a system of spray ponds to provide for cooling of safety-related and reactor auxiliary heat exchangers.

Impacts due to construction are best controlled by using construction practices that do not produce impacts or at least minimize impacts. Construction activities should be planned and conducted in a manner that results in minimal environmental impact. Suggestions for such practices are provided in the EBID. Impacts of construction are expected to be small, with the exception of noise, traffic, and the social pressures of the in-migrating workforce.

Other than potential impacts on housing prices and social services in Metsamor Town, the impacts of station operation are expected to be small (these impacts may have already occurred during the construction period and may be offset by reductions in ANPP staffing due to shutdown of Unit 2).

Based on accident analysis results for an AP1000 plant and meteorological data from Zvartnots International Airport, the impact of postulated accidents involving radioactive materials on the population near the site are shown to be well within expected acceptance criteria for siting of a new reactor.

The ANPP site is considered suitable for a new reactor, in that there are no conditions that indicate that the site is not suitable. (Seismic studies mentioned above are required to confirm that the site is suitable from a seismic standpoint.)

The EBID evaluates alternatives to a new NPP, concluding that a new NPP is the most environmentally suitable option for providing power to replace ANPP Unit 2 generation which currently provides 40% of Armenia's electricity.

The final chapter of the EBID summarizes the assessment conclusions and provides a list of assumptions, committed actions to minimize environmental impacts, and actions necessary to support the final environmental assessment required by the EIA process.

Environmental Background Information Document

Acronyms

October 2008

1	**INTRODUCTION**
LCGP	Least Cost Generation Plan
GoA	Government of Armenia
MoENR	Ministry of Energy and Natural Resources
USAID	United States Agency for International Development
ANPP	Armenian Nuclear Power Plant
EBID	Environmental Background Information Document
US NRC	United States Nuclear Regulatory Commission
EIA	Environmental Impact Assessment
UNECE	United Nations Economic Commission for Europe
OECD	Organization for Economic Cooperation and Development
IAEA	International Atomic Energy Agency
CJSC	Closed joint-stock company
IPS	Initial Planning Studies
IPP	Independent Power Producer
O&M	Operation and Maintenance
NNEGC	National Nuclear Energy Generating Company
EBRD	European Bank for Reconstruction and Development
GENCO	Generating Company
1.2	**STATUS OF REVIEWS, APPROVALS, AND CONSULTATIONS**
EBID	Environmental Background Information Document
ANPP	Armenian Nuclear Power Plant
ANPP cjsc	ANPP closed joint-stock company
RoA	Republic of Armenia
GoA	Government of Armenia
EIA	Environmental Impact Assessment

ANRA	Armenian Nuclear Regulatory Authority
NPP	Nuclear Power Plant
WRMA	Water Resources Management Agency
BMOs	Basin Management Organizations
NWP	National Water Program
MNP	Ministry of Nature Protection
RoA	Republic of Armenia
MTC	Ministry of Transport and Communication
SNIPs	Construction norms and laws
GOSTs	State standards
WUP	Water Use Permit

1.3 APPLICABLE LAWS, REGULATIONS, STANDARDS, AND GUIDELINES

US NRC	United States Nuclear Regulatory Commission
SAR	Safety Analysis Report
IAEA	International Atomic Energy Agency
MAC	Maximum Allowable Concentrations
UNECE	United Nations Economic Commission for Europe
PSA	Probabilistic Safety Assessment
INSAG	International Safety Advisory Group
ESRPs	Environmental Standard Review Plans
EBRD	European Bank for Reconstruction and Development
IBRD	International Bank for Reconstruction and Development
IDA	International Development Association
IFC	International Finance Corporation
EC	European Commission
ADB	Asian Development Bank

MFI	Multilateral Financial Institutions
EC	European Commission
IAIA	International Association for Impact Assessment
MFI-WGE	Multilateral Financial Institution Work Group on Environment
OECD	Organization for Economic Cooperation and Development
UNFCCC	United Nations Framework Convention on Climate Change
2.1	**ENVIRONMENTAL DESCRIPTION/STATION LOCATION**
ANPP	Armenian Nuclear Power Plant
CJSC	Closed joint-stock company
2.2	**LAND**
NPP	Nuclear Power Plant
GoA	Government of Armenia
RoA	Republic of Armenia
2.3	**WATER**
RoA	Republic of Armenia
NPP	Nuclear Power Plant
ANPP	Armenian Nuclear Power Plant
UK	United Kingdom
2.4	**ECOLOGY**
RoA	Republic of Armenia
IUCN	International Union for Conservation of Nature
BSAP	Biodiversity Strategy and Action Plan
ANPP	Armenian Nuclear Power Plant
CEPF	Critical Ecosystem Partnership Fund
NTAFP	Network of Topical Aquaculture and Fisheries Professionals
2.5	**SOCIOECONOMICS**

ANPP	Armenian Nuclear Power Plant
NPP	Nuclear Power Plant
UN	United Nations
RoA	Republic of Armenia
AR	Armenian Railway
IBRD	International Bank for Reconstruction and Development
RZD	Russian Railway
WWTP	Wastewater Treatment Plant
PID	Project Information Document
2.6	**GEOLOGY**
ANPP	Armenian Nuclear Power Plant
NPP	Nuclear Power Plant
pga	peak ground acceleration
IAEA	International Atomic Energy Agency
PSHA	Probabilistic seismic hazard analysis
QA	Quality Assurance
UHRS	Uniform Hazard Response Spectra
2.7	**METEOROLOGY AND AIR QUALITY**
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
NPP	Nuclear Power Plant
MPC	Maximum Permissible Concentration
UNECE	United Nations Economic Commission for Europe
ERMC	Environmental Research and Management Center
AUA	American University of Armenia
UNEP	United Nations Environmental Program

CJSC	Closed joint-stock company
3.1	**PROJECT DESCRIPTION**
PPE	Plant Parameter Envelope
ANPP	Armenian Nuclear Power Plant
MCR	Main Control Room
SCA	Secondary Control Area
3.2	**REACTOR POWER CONVERSION SYSTEM**
ANPP	Armenian Nuclear Power Plant
PPE	Plant Parameter Envelope
NEI	Nuclear Energy Institute
US NRC	United States Nuclear Regulatory Commission
AP	Advanced Passive Reactor
CANDU	Canadian Deuterium Uranium Reactor
AECL	Atomic Energy Canada Limited
ACR	Advanced CANDU Reactor
EAB	Exclusion Area Boundary
LPZ	Low Population Zone
3.3	**PLANT WATER USE**
PPE	Plant Parameter Envelope
RWS	Raw Water supply System
ANPP	Armenian Nuclear Power Plant
CWS	Circulating Water System
SWS	Service Water System
DWS	Demineralized Water System
3.4	**COOLING SYSTEM**
ANPP	Armenian Nuclear Power Plant

CWS	Circulating Water System
SWS	Service Water System
RWS	Raw Water supply System
CCS	Component Cooling water System
DGs	Standby Diesel Generators
ESW	Essential Service Water
3.5	**RADIOACTIVE WASTE MANAGEMENT SYSTEM**
RCS	Reactor Coolant System
RoA	Republic of Armenia
PPE	Plant Parameter Envelope
CVS	Chemical and Volume Control System
WGS	Gaseous Radwaste System
WSS	Solid Waste management System
LRW	Liquid Radwaste
IAEA	International Atomic Energy Agency
3.6	**NON RADIOACTIVE WASTE SYSTEMS**
ANPP	Armenian Nuclear Power Plant
CWS	Circulating Water System
SWS	Service Water System
DWS	Demineralized Water System
FPS	Fire Protection System
3.7	**POWER TRANSMISSION SYSTEM**
ANPP	Armenian Nuclear Power Plant
CANDU	Canadian Deuterium Uranium Reactor
3.8	**TRANSPORTATION OF RADIOACTIVE MATERIAL**
ANPP	Armenian Nuclear Power Plant

US NRC	US Nuclear Regulatory Commission
4	**ENVIRONMENTAL IMPACTS OF CONSTRUCTION**
ANPP	Armenian Nuclear Power Plant
4.1	**LAND- USE IMPACTS**
ACR	Advanced CANDU Reactor
4.2	**WATER RELATED IMPACTS**
ANPP	Armenian Nuclear Power Plant
4.3	**ECOLOGICAL IMPACTS**
ANPP	Armenian Nuclear Power Plant
US NRC	United States Nuclear Regulatory Commission
4.4	**SOCIOECONOMIC IMPACTS OF CONSTRUCTION**
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
MoH	Ministry of Health
IAEA	International Atomic Energy Agency
SAR	Safety Analysis Report
4.5	**RADIATION EXPOSURE OF CONSTRUCTION WORKERS**
ANPP	Armenian Nuclear Power Plant
NPP	Nuclear Power Plant
EBID	Environmental Background Information Document
IAEA	International Atomic Energy Agency
ANRA	Armenian Nuclear Regulatory Authority
4.6	**MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION**
US EPA	United States Environmental Protection Agency
US FHWA	United States Federal Highway Administration
TVA	Tennessee Valley Authority

5.1	**LAND- USE IMPACTS**
ANPP	Armenian Nuclear Power Plant
CJSC	Closed joint-stock company
NEI	Nuclear Energy Institute
IEA	International Energy Agency
5.2	**WATER – RELATED IMPACTS**
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
BMO	Basin Management Organization
5.3	**IMPACTS OF COOLING SYSTEM OPERATION**
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
EPRI	Electric Power Research Institute
SACTI	Seasonal and Annual Cooling Tower Impacts
5.4	**RADIOLOGICAL IMPACTS OF NORMAL OPERATION**
NPP	Nuclear Power Plant
PPE	Plant Parameter Envelope
IAEA	International Atomic Energy Agency
GoA	Government of Armenia
ANPP	Armenian Nuclear Power Plant
TLD	Thermo- Luminescent Detectors
CED	Committed Effective Dose
5.5	**ENVIRONMENTAL IMPACTS OF WASTE**
ANPP	Armenian Nuclear Power Plant
CWS	Circulating Water System
SGBS	Steam Generator Blowdown System

SWS	Service Water System
DWS	Dematerialized Water System
FPS	Fire Protection System
CSN	Contaminated Sewage Network
RoA	Republic of Armenia
SNW	Solid Non-radioactive Waste
RO	Reverse Osmosis
PPE	Plant Parameter Envelope
IAEA	International Atomic Energy Agency
US NRC	United States Nuclear Regulatory Commission
5.6	**TRANSMISSION SYSTEM IMPACTS**
ANPP	Armenian Nuclear Power Plant
TPP	Thermal Power Plant
EBID	Environmental Background Information Document
US NRC	United States Nuclear Regulatory Commission
EMF	ElectroMagnetic Fields
TVA	Tennessee Valley Authority
5.7	**URANIUM FUEL CYCLE IMPACTS**
ANPP	Armenian Nuclear Power Plant
5.8	**SOCIOECONOMIC IMPACTS OF STATION OPERATION**
ANPP	Armenian Nuclear Power Plant
IAEA	International Atomic Energy Agency
RoA	Republic of Armenia
PPE	Plant Parameter Envelope
IPS	Initial Planning Study
SAR	Safety Analysis Report

5.9	**DECOMMISSIONING IMPACTS**
GEIS	Generic Environmental Impact Statement
NPP	Nuclear Power Plant
RoA	Republic of Armenia
5.10	**MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION**
ES	Erosion and Sedimentation
AQ	Air Quality
SW	Surface Water
WS	Wastes
L	Land Use
W	Water Use and Quality
TE	Terrestrial Ecosystems
AE	Aquatic Ecosystems
S	Socioeconomic
A	Aesthetics
N	Noise
T	Traffic
R	Radiation Exposure
EBID	Environmental Background Information Document
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
US NRC	US Nuclear Regulatory Committee
6	**ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS**
RoA	Republic of Armenia
ANPP	Armenian Nuclear Power Plant

EIA	Environmental Impact Assessment
EIMC	Environmental Impact Monitoring Center
7	**IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE**
ANPP	Armenian Nuclear Power Plant
RoA	Republic of Armenia
IAEA	International Atomic Energy Agency
BSS	Basic Safety Standards
TEDE	Total Effective Dose Equivalent
NCRP	National Council on Radiation Protection
EAB	Exclusion Area Boundary
LPZ	Low Population Zone
DCD	Design Control Document
OCA	Owner-Controlled Area
DBAs	Design Basis Accidents
LOCA	Loss of Coolant Accidents
CEDE	Committed Effective Dose Equivalent
GEIS	Generic Environmental Impact Statement
8	**EVALUATION OF THE NUCLEAR POWER PLANT SITE**
IAEA	International Atomic Energy Agency
EPZs	Emergency Planning Zones
EBID	Environmental Background Information Document
LPZ	Low Population Zone
PPM	Preventive Protective Measures Zone
UPMP	Urgent Protective Measures Planning
LTPMAP	Long-Term Protective Actions Planning Zone
TNT	Trinitrotoluene

9	**ALTERNATIVES TO THE PROPOSED ACTION**
ANPP	Armenian Nuclear Power Plant
NPP	Nuclear Power Plant
PSRC	Public Services Regulatory Commission
GHG	Greenhouse Gas
RoA	Republic of Armenia
PGA	Peak Ground Acceleration
MBE	Maximum Basis Earthquake
CC	Combined Cycle
PES	Possible Earthquake Source
10	**ENVIRONMENTAL ASSUMPTIONS, COMMITMENTS, ASSESSMENT OPEN ITEMS, AND CONCLUSIONS**
EBID	Environmental Background Information Document
MoENR	Ministry of Energy and Natural Resources
ANPP	Armenian Nuclear Power Plant
US NRC	US Nuclear Regulatory Commission
PPE	Plant Parameter Envelope
RoA	Republic of Armenia
CWS	Circulation Water System
WRMA	Water Resources Management Agency

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Chapter 1: Introduction

October 2008

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1. INTRODUCTION

Armenia is highly dependent on its ageing, Soviet-built nuclear plant which provides approximately 42% of its electric needs. International donors, including the U.S. Government, are concerned about the safety of its operation and thus have asked the Government of Armenia (GoA) for closedown of the plant. The GoA has decided to close down ANPP Unit 2, contingent upon building replacement generating capacity (Ref. [1.0-1]).

The 2006 Least Cost Generation Plan (LCGP - Ref. [1.0-2]) considered a comprehensive suite of measures to replace the ANPP Unit 2 generating capacity, including energy efficiency measures and new generation resources: thermal, renewable, and nuclear. The 2006 LCGP concluded that a new nuclear unit is the least cost option for replacing ANPP Unit 2. In 2007, the 2006 LCGP was adopted by the GoA as consistent with its energy strategy (Ref. [1.0-1]).

The GoA requested U.S. Government assistance in further assessing the feasibility of a replacement nuclear unit, as well as initial planning needed to accomplish such an undertaking. The U.S. Government and the Ministry of Energy[1] of the Republic of Armenia signed a Statement of Cooperation (Ref. [1.0-3]) agreeing to cooperation in development of planning studies for a new nuclear power generation unit in Armenia. The intent of these studies is to assist the GoA for the purposes of decision-making with respect to the best technical solutions, project logistics, and negotiations with potential suppliers and international financing institutions.

The U.S. Government's support to Armenia, in accordance with the Statement of Cooperation, is provided under the U.S. Agency for International Development (USAID) energy project for providing support to the Ministry of Energy and Natural Resources of Armenia, entitled "Program to Strengthen Reform and Enhance Energy Security in Armenia." In accordance with a Work Plan (Ref. [1.0-4]) signed in conjunction with the Statement of Cooperation, PA Consulting Group and their subcontractor Scientech have prepared two documents:

1. Initial Planning Studies to Assess Feasibility of a Replacement Nuclear Power Unit in Armenia (IPS)[2]; and
2. Environmental Background Information Document (EBID)[3].

The relationships among these two documents, key governmental decisions related to a new nuclear power plant, and the environmental assessment processes outlined in international conventions are illustrated in Figure 1-1.

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[1] The Ministry of Energy has since been renamed The Ministry of Energy and Natural Resources.

[2] The Work Plan uses the term "Feasibility Study". Since preparation of the Work Plan, it was concluded that the scope of work described in the Plan related to feasibility is more accurately titled "Initial Planning Studies", consistent with language in the Statement of Cooperation.

[3] The Work Plan uses the terms "Environmental Impact Assessment" and "EIA". Since EIAs are defined in international conventions as a product of a governmental decision process, it was concluded that the environmental studies described in the Work Plan would be best titled "Environmental Background Information Document".

The scope of work for the EBID is defined in the Work Plan based on the U.S. Nuclear Regulatory Commission's "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", NUREG-1555 (Ref. [1.0-5]). Although NUREG-1555 was written to address requirements in the U.S., it was used as a guide for development of the EBID because it describes a comprehensive environmental assessment process generally consistent with international conventions and guidance on environmental impact assessment (see Refs. [1.0-6] and [1.0-7]).

The preparation of the EBID did not include the conduct of a full set of new environmental studies. The EBID is based primarily on publicly available data and information gathered from the ANPP and from various Government of Armenia entities with the assistance of the MENR. In some cases, the available information fell short of what would be required to complete an in-depth environmental assessment. The additional studies and data collection recommended to support a full assessment are identified in EBID Section 10.3.

Baseline data for the ANPP site and vicinity are presented in EBID Chapter 2. Information on existing radioactivity in the environment is detailed in Section 5.4.

No attempt was made to independently validate the data relied upon in the EBID. Additional studies to support the final environmental assessment should be done by qualified experts following current standards and guidelines. These studies should be performed under a management system that conforms to IAEA requirements to ensure quality (Refs. [1.0-8], [1.0-9] and [1.0-10]). The results of such studies should be subjected to a program of independent review to assure that the data are applicable and of high quality.

EBID Section 1.1 describes the potential project in conceptual terms as it has been evaluated in the EBID assessments, including:

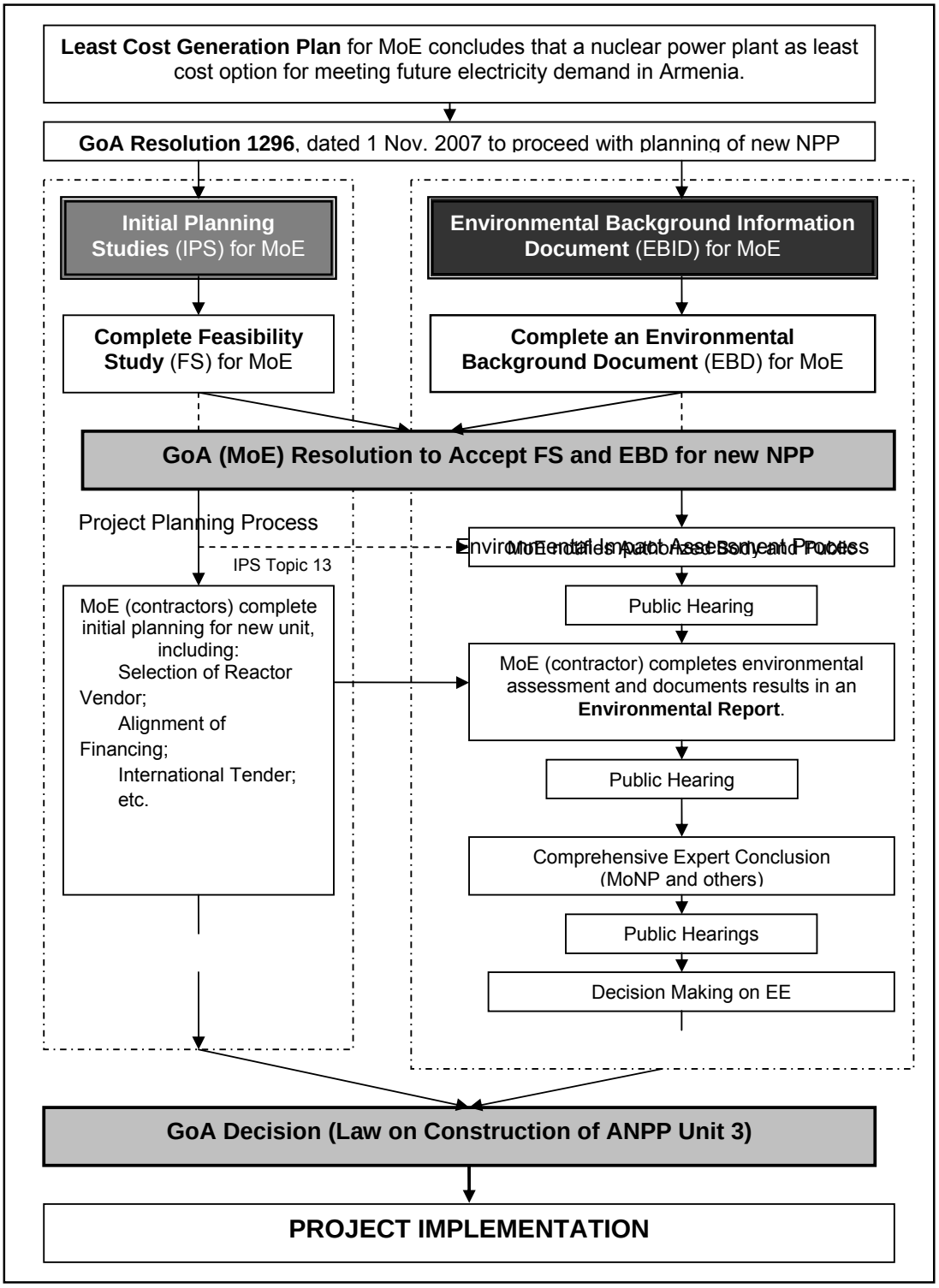
- the need for power and summary of alternatives;
- the site location,
- the type of reactors and key parameters considered;
- cooling system descriptions; and
- transmission system description.

In addition, Section 1.1 includes a summary discussion of potential organizations for construction, operation, and ownership of Unit 3.

EBID Section 1.2 describes the requirements for compliance with environmentally-related authorizations required by GoA agencies as a prerequisite to nuclear plant licensing and construction. Section 1.2 includes a listing of the authorizations (and the authorizing agencies) that address environmental issues, along with a description of the authorization processes.

EBID Section 1.3 identifies the laws, regulations, standards, and guidelines that are applicable to the environmental impact assessment process. Section 1.3 also describes the environmental requirements of potential financiers of the project and identifies international environmental agreements that may pertain to the project.

Figure 1-1, Relationship of EBID to IPS and Government of Armenia Decisions



REFERENCES:

[1.0-1] GoA Resolution № 1296, dated 1 November 2007, *On Action Plan of the Ministry of Energy developed based on provisions of the RoA National Safety Strategy (07.02.07)*.

[1.0-2] PA Consulting, 2006, *Armenia Power Sector Least Cost Generation Plan*.

[1.0-3] *Statement of Cooperation between the Government of the United States of America and the Ministry of Energy of the Republic of Armenia*, signed 21/11/07 by Joseph Pennington, Charge d'Affaires, a.i., and Armen Movsisyan, Minister of Energy.

[1.0-4] *Work Plan for the development of the New Armenia Nuclear Unit(s) Environmental and Feasibility Studies 2007 – 2008*, signed 21 November 2007 by Igor Zakharov, Chief of Party, PA Consulting Group, and Areg Galstyan, Deputy Minister of Energy of Armenia.

[1.0-5] United States Nuclear Regulatory Commission (US NRC), 1999, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, NUREG-1555.

[1.0-6] United Nations Economic Commission for Europe (UNECE), 1991, *Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991) – the 'Espoo (EIA) Convention'*.

[1.0-7] Organization for Economic Cooperation and Development (OECD), 2006, *Applying Strategic Environmental Assessment, Good Practice Guidance for Development Co-Operation.*

[1.0-8] International Atomic Energy Agency (IAEA), 2006, *The Management System for Facilities and Activities*, IAEA Safety Standards Series No. GS-R-3 (supercedes IAEA Safety Series No. 50-C/SG-Q that is referenced in [1.0-10]).

[1.0-9] IAEA, 2006, *Application of the Management System for Facilities and Activities*, IAEA Safety Standards Series No. GS-G-3.1.

[1.0-10] IAEA, 2003, *Site Evaluation for Nuclear Installations*, IAEA Safety Standards Series No. NS-R-3, Section 6.

1.1 PROJECT DESCRIPTION

The objective of this EBID section is to provide a summary description of the proposed Armenian Nuclear Power Plant (ANPP) Unit 3 project, including:

- the need for power and summary of alternatives;
- the site location,
- the type of reactors and key parameters considered;
- cooling system descriptions; and
- transmission system description.

In addition, this section includes a summary discussion of potential organizations for construction, operation, and ownership of Unit 3 (see subsection 1.1.5).

The site location and its environment are described in detail in EBID Chapter 2. A summary of this information is included in Subsection 1.1.2. Information on radioactivity in the environment is detailed in EBID Section 5.4.

The plants considered in this assessment, including cooling systems and the transmission system, are described in detail in EBID Chapter 3. Subsection 1.1.3 briefly describes the plant systems evaluated, including cooling systems. The transmission system is described in Subsection 1.1.4.

The evaluation of alternatives to a new unit at ANPP are discussed in EBID Chapter 9 and summarized below in Subsection 1.1.1.

1.1.1 Need for Power and Comparison to Alternatives

The 2006 LCGP (Ref. [1.1-1]), prepared by the Ministry of Energy of the Republic of Armenia (RoA) with support from PA Consulting Group identifies the need for new generation capacity and considers various alternative means to meet that need.[4] The LCGP reports:

- Annual growth for peak load and energy is forecasted to be about 2.6% per year starting from initial values of 5,529 GWh (energy) and 1,293 MW (peak load) in 2005;
- Forecasted generating capacity requirements (excluding reserve) are 1,293 MW in 2005, increasing to 2,198 MW in 2025;
- Coal, wind and solar are not viable generation options to meet base load requirements for Armenia;
- Gas-fired, hydro, and nuclear generation options were analyzed, including ANPP Unit 2 life extension through 2036.

[4] The 2006 LCGP was a continuation of efforts made to produce Least Cost Generation Plans published in 2002 and 2005; this portion of the EBID is merely repeating the results of the LCGP, without changes.

Key findings of the 2006 LCGP include:

- There is no economic alternative to continued operation of ANPP Unit 2 through 2015.
- Armenia would need roughly 2,000 MW of new capacity by 2020, if ANPP is retired in 2016 and the existing ageing thermal capacity is retired.
- ANPP Unit 2 life extension past 2016 is not feasible because of investment cost and additional spent fuel disposal cost.
- The least cost generation option for the Armenian power sector, when base load capacity is needed, is nuclear or combined cycle gas turbine generation.
- Higher gas prices make the replacement of existing thermal units attractive and critical due to their age and inefficiency.
- Diversity of generation mix should be maintained for economic and electric system security.
- New nuclear generation is the least cost option, provides for diversity in the fuel mix, and from the fuel supply standpoint is the most reliable.

The 2006 LCGP also focuses on continued investment in safety upgrade projects at ANPP Unit 2 and its retirement, decommissioning, and replacement, consistent with "Energy Sector Development Strategies in Context of Economic Development in Armenia" which was adopted by the Government of Armenia (GoA) in June 2005 (Ref. [1.1-2]).

Further comparison of alternatives is provided in EBID Chapter 9, including:

- The "no-action" alternative, where no new generating source is built to replace the capacity lost when ANPP Unit 2 is shut down;
- The "no new generation" alternative, where projected demands are met without constructing new generation capacity in Armenia; and
- The "new generation" alternative, where projected demands are met with new non-nuclear generating sources in Armenia.

The conclusions of Chapter 9, for each alternative, are summarized below.

1.1.1.1 THE "NO-ACTION" ALTERNATIVE

- On Unit 2 shutdown, its generation capacity would be replaced with increased generation from existing thermal power plants, including the combined cycle gas turbine thermal power plants at Hrazdan and Yerevan TPPs;
- After 2020 when the older existing thermal power plants are retired, the power system capacity would be seriously deficient;
- Power system stability could be assured only by reducing demands for electricity; and
- Demand reductions could be achieved by increasing tariffs substantially, placing an unacceptable burden on the domestic economy.

1.1.1.2 THE "NO NEW GENERATION" ALTERNATIVE

- Lost capacity cannot be replaced by import of power from Georgia because their system lacks sufficient capacity to serve their own, internal demands;
- Imports of power from Russia or Turkey would be inconsistent with current energy security strategies and existing transmission system capacities[5];
- Imports of replacement power from Iran may be possible due to existing generation capacity there and planned increases in transmission capacity between Armenia and Iran, but Iran's domestic load growth exceeds their new generation capacities and the resulting economic dependence on Iran could strain relationships between Armenia and other nations who oppose actions by the Iranian government;
- Compensating for lost ANPP capacity with power from the Hrazdan-5 thermal power plant currently being developed may be feasible in the short term, but since Hrazdan-5 is intended to replace older thermal units scheduled for retirement, this would result in serious capacity shortages beginning by 2020;
- Life extension of ANPP Unit 2 or reactivation of ANPP Unit 1 would not only be more expensive (per kWh) than a new NPP, but also contrary to the international community's opposition to continued operation of these older generation plants.

1.1.1.3 THE "NEW GENERATION" ALTERNATIVE

- New large hydroelectric generation could be developed, but would be unable to meet the peak demands in winter because that coincides with the time of year that river flows are at minimum;
- New, additional natural-gas thermal power plants (most likely combined cycle gas turbine plants for greatest efficiency) could easily be developed to replace ANPP Unit 2, but would create a high dependence on high-cost and uncertain gas supplies, reduce fuel mix diversity, make Armenia susceptible to threats of gas cutoffs, and be contrary to global initiatives to improve air quality and reduce emissions of "greenhouse gasses".
- According to the US Environmental Protection Administration, the average emissions from gas-fired generation in the US is 0.6 kg CO_2/kwh. A new gas-fired CCGT would have better efficiency than that average, so emissions would be about 0.4 kg CO_2/kwh. On this basis, operating a 1000 MW NPP at 90% capacity avoids approximately 3.2 billion kg of CO_2 emissions per year.

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[5] Recent reports (see http://ans-dx.com/nid87568.html) of an agreement between Turkey and Armenia indicate that high voltage transmission capabilities may be completed between Armenia and Kars Province of Turkey in the near future; however, the intent is to export power to Turkey, where there is a deficit of available power. It is unlikely that there will be excess generation capacity for Turkey to export power to Armenia.

1.1.2 Environmental Description

EBID Chapter 2 describes in detail the ANPP site location and its relationship to nearby towns and natural features. Chapter 2 provides background data for analysis of environmental (including socioeconomic) impacts of the proposed project.

ANPP Unit 3 will be located on a parcel of land owned by the Government of Armenia, with rights of use granted to the Closed Joint Stock Company "Armenian Nuclear Power Plant" and occupied in part by the existing Armenian Nuclear Plant units. The land is in the Trans-Caucasus region in Armavir marz (province) in western Armenia, as shown in Figure 1.1-1. The ANPP site, at an elevation of approximately 930 m above sea level, is 9.2 km east-northeast of the town of Armavir and 32 km west of Yerevan. Metsamor Town, ANPP's satellite city, is 4.6 km from the site and Vagharshapat, home of the Echmaidzin cathedral and grounds that serve as the seat (Mother See) of the Armenian Orthodox (Apostolic) church, is approximately 13 km away. ANPP is approximately 16 km from the Turkish border, which runs along the Araks River south of the site.

The ANPP site currently has two power-generating units with Soviet-designed VVER-440 (V-270) reactors, each with installed power capacity of 407.5 MWe. Both units were shutdown in early 1989 as a safety measure following the 1988 Spitak earthquake. Unit 1 remains in a shutdown condition. Unit 2 was restarted in 1995 following extensive inspections, safety upgrades, and refurbishment of equipment. Unit 2 is slated for permanent shutdown in 2016, as discussed above.

The ANPP site was originally planned to include four total units of VVER-440 reactors, with Units 3 and 4 to be situated to the west of Units 1 and 2. Preliminary site clearance for Units 3 and 4 was conducted in the early 1980's, but construction of further units at ANPP was not completed. ANPP Unit 3 will occupy the area previously planned for Units 3 and 4.

The ANPP site is in the desert and semi-desert landscape zone. Nearby is the transition to the dry mountain steppe zone. Flora and fauna typical of the desert and semi-desert landscapes are likely in the plant vicinity, but a specific inventory has not been conducted on the site. Impacts to the ecosystem, if expected anywhere, will be most pronounced at and near the site. Much of the area surrounding the site has been disturbed by agricultural activities. The portion of the land under the control of CJSC ANPP and proposed for the new unit has been disturbed by previous construction activity. The Sevjur River, source of cooling water for the site, is fed primarily by springs bringing water from underground aquifers to the surface that creates wetlands in the site vicinity. The Sevjur River supports many aquatic and marshland species, including nationally and regionally rare species, but specific inventories at the plant intake and discharge locations have not been conducted.

An estimated population of approximately 204,000 resided within 16 km of the site in 2006, over 51% of whom lived in rural communities. In 2006, almost 2 million people were estimated to live in Armenia within 50 km of the site, 57% of whom were in Yerevan City, 29% in rural communities, and 15% in urban communities other than Yerevan. The population of Turkish territory within 50 km of the site was estimated to be approximately 124,000 in 2005, slightly less than half of which were in the city of Igdir.

The current ANPP unit takes cooling water from the Sevjur River and a nearby groundwater collection pond. These same sources, approximately 7 km from the site, will be employed for ANPP Unit 3. Without the influence of irrigation withdrawals, the flow in the Sevjur River would be fairly steady year round. Permits have been issued for

withdrawal of 18.8 m^3/sec from the Sevjur River for fisheries, agriculture, industry and ANPP Unit 2, with a net available flow of 12.4 m^3/sec.

1.1.3 Project Description

EBID Chapter 3 describes the known and expected features of ANPP Unit 3, highlights of which are discussed below.

1.1.3.1 REACTOR PLANT DETAILS

The EBID does not provide the detailed design of the reactor considered for ANPP Unit 3. Rather, it provides bounding parameters and characteristics of these components so that an assessment of potential environmental impacts of a new nuclear unit can be made. This is done by use of a plant parameter envelope (PPE) as a surrogate for the design parameters of the nuclear power plant and its associated facilities. The reactor plants considered are: the Westinghouse AP1000 (U.S. design), the AECL CANDU EC-6 (Canadian design), and the Atomstroyexport VVER-1000 (Russian export Model AES 91 or AES 92).

The base configuration evaluated assumes a reactor plant with a pressurized primary circuit and maximum nominal thermal power rating of 3,430 MWth and a nominal net output of 1,117 MWe.

The construction site plan is shown in Figure 1.1-2 (see Table 2.1-1 for a legend to the existing buildings on the ANPP site). Figure 1.1-3 illustrates the visual impact of ANPP Unit 3 from Metsamor Town.

1.1.3.2 COOLING SYSTEM DESCRIPTION

The base configuration evaluated assumes a single secondary (steam cycle) circuit with a nominal output of 1,117 MWe[6]; a single natural-draft cooling tower for condenser cooling[7]; and a system of spray ponds to provide for cooling of safety-related and reactor auxiliary heat exchangers.

ANPP Unit 3 will draw an average of 1,950 l/s of water from the Sevjur River pumping station and nearby groundwater settling pond to provide makeup to the circulating water and service water cooling systems. Blowdown from these systems will return an average of 990 l/s to the Sevjur River. The blowdown flow rates will be controlled such that principal constituents in the makeup water are concentrated by a factor of 2 prior to discharge.

The plant discharge pipe, which currently empties into the Sevjur River via the Kosh-Ujan storm water drainage canal, will be extended to discharge directly into the Sevjur River. The extended discharge pipe will carry blowdown from the cooling water systems and steam generators, as well as wastes from the demineralized water system, miscellaneous drains, and the liquid radwaste system.

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[6] The MoENR considers that the plant may use two half-capacity turbine generators, similar to existing Soviet-designed VVER plants.
[7] Cooling water impacts are bounded by mechanical draft cooling towers, although other configurations, including dry cooling towers or hybrid systems, are possible.

1.1.3.3 GOVERNMENT OF ARMENIA ACTIONS ON WATER

In order to employ the existing technical water infrastructure (intake structure, pump house, piping corridors, etc.) currently used by ANPP Unit 2, it is planned that Unit 3 will take cooling water from the Sevjur River. Based on bounding values of water needs, during normal operation ANPP Unit 3 would withdraw 1.95 m^3/s total from the Zeiva irrigation dam on the Sevjur and the groundwater collection pond (which draws from the same sources of groundwater as the Sevjur), and discharge 0.992 m^3/s approximately 0.8 km downstream (see EBID Sections 3.2, 3.3, 3.4, and 3.6). This would result in a net usage of water of approximately 0.96 m^3/s. This compares with Sevjur River flow values of 6 m^3/s (low flow during 2004-2006) to 20 m^3/s (historic average). The average flow at the site is lower than the historic average flow because of authorized withdrawals. The average annual flow near the site is approximately 11 m^3/s.

There should be ample water available to meet water needs in the ANPP vicinity. Within the water balance for all of Armenia, about 0.7 billion m^3/y (assuming water usage equivalent to the historical peak usage), or an average of 22 m^3/s, is uncommitted (see EBID Section 2.3.1). In addition to the Sevjur River, water could be supplied to the area via canal or pipeline from the Akhurian, Araks, Kasakh, and Hrazdan rivers.

Permits have been issued for eleven (11) agricultural intakes on the Sevjur taking water at annual average rates totaling 10 m^3/s (see table 2.2-10). The permits, however, are issued for annual volumes of water without accounting for when the water is withdrawn. This could result in a situation where total water withdrawals from the Sevjur equal the available flow even without the withdrawal of water by the ANPP. The ANPP Unit 2 Safety Analysis Report (SAR) states that during summer months, supply of water to Unit 2 has required curtailment of water withdrawals by agricultural users. Most irrigation is gravity fed, often through concrete channels that are in poor repair. Water losses are high. Irrigation practices include occasional flooding of fields to control buildup of salts in the soil. Modern irrigation technologies could reduce irrigation water usage.

Regulations to protect aquatic life impose an additional constraint on water allocation. The RoA has accepted the concept of a minimum environmental flow as one important means to ensure the protection of aquatic life. In accordance with Armenian law, the environmental flow (minimum) in the Sevjur is 12 m^3/s (see discussion in EBID subsection 2.3.3.3), greater than the annual average flow during recent years.

The National Water Program of Armenia assigns a higher priority to supply water for agriculture and drinking water uses than for power generation. Therefore the Water Resources Management Agency may not be able to issue a water permit for the amounts of water needed by ANPP Unit 3, even though as evaluated in EBID Section 2.3, sufficient water should be available within Armenia to support operation of the new unit.

The water quality of the Sevjur does not meet current applicable norms based on 1975 Soviet water standards. The power plant will not alter water quality greatly. However, water quality norms are another means of protecting other users.

In order for the Government of Armenia to reach a conclusion regarding the cooling water supply of a new nuclear unit, the following determinations must be made:

1. The Ministry of Nature Protection must determine the minimum flow in the Sevjur River to sustain aquatic ecosystems near the ANPP (by current law, the Akhurian Basin Management Organization is to establish the environmental flow values for the Sevjur).

2. The Water Resources Management Agency must determine how the water of the Sevjur will be allocated among competing demands. The Agency must further determine whether a water use permit can be issued for ANPP Unit 3. This will require a review of existing water permits and a survey of Sevjur River water users to:

    a. Quantify the Sevjur River water consumption by the permittees annually (m^3/y), month-by-month (m^3/mo), and equivalent maximum instantaneous withdrawals (m^3/s).

    b. Assess whether irrigation system efficiencies can be improved to reduce water needs.

    c. Determine the feasibility of issuing permits setting monthly withdrawal limits.

    d. Determine whether alternate sources of water can supply some of the irrigation needs.

    e. Conclude what volume of water can be allocated for a future water permit for ANPP Unit 3.

3. The Water Resources Management Agency must determine the water quality norms that will be applied to the Sevjur River in the vicinity of Unit 3 and what conditions, if any, must be included in a discharge permit for the new Unit.

4. The Ministry of Energy and Natural Resources must evaluate the feasibility of alternative actions to ensure adequate water availability for the new unit such as:

    a. Employment of alternative cooling system technologies (dry or hybrid wet-dry cooling towers); and/or

    b. Compensation of agricultural water users for improving the efficiency of their irrigation systems and obtaining water from other sources.

Considering the strategic importance of continued availability of power to the economy of Armenia, these actions should be undertaken as a priority with joint cooperation among the Ministries of Nature Protection and Energy and Natural Resources.

1.1.4 Transmission System Description

High voltage overhead transmission lines of 110 kV and 220 kV currently connect the ANPP site to the Armenian power grid. The main (220 kV) transmission lines connect with:

- Ararat-2 substation in Ararat Marz to the southeast of ANPP;
- Marash substation in the eastern part of Yerevan City, to the east of ANPP;
- Ashnak substation in Aragatsotn Marz to the northwest of ANPP (two lines); and
- Shaumyan-2 substation in the southwestern part of Yerevan City.

These same transmission lines will serve ANPP Unit 3.

In addition, a new 400 kV overhead transmission line has been proposed to ensure adequate connections between the new plant and the Armenian power grid. The new transmission line will connect ANPP with a substation for the Hrazdan-5 Thermal Power Plant, but the routing of the proposed line has not yet been defined.

1.1.5 Organizations for Construction, Ownership, and Operation of ANPP Unit 3

When ANPP Units 1 and 2 were built, they were a state-sponsored project funded by the government of the U.S.S.R. After dissolution of the U.S.S.R., ownership of ANPP reverted to the Republic of Armenia.

Currently, ANPP is operated by the state Closed Joint Stock Company "Armenian Nuclear Power Plant" (CJSC "ANPP")[8]. By GoA Decree № 1211, adopted on October 1, 2003 (Ref. [1.1-3]), the management contract between the GoA, represented by the Ministry of Energy, and the Russian Closed Joint Stock Company "Inter RAO UES " was approved. By this contract, the Russian company is given all rights secured by the shares of CJSC "ANPP", including the right to receive dividends from the profits of the CJSC "ANPP", the right of making changes in the Charter of CJSC "ANPP", issuance of resolutions regarding the reorganization of CJSC "ANPP", appointment and dismissal of the Director and the managers of CJSC "ANPP", approval of the Auditor, and approval of major contracts, etc.[9] Although Decree № 1211 complicates the description of ANPP ownership and operation, for all intents and purposes, the facility is owned and operated by the state (GoA).

The RoA Law on Safe Utilization of Atomic Energy for Peaceful Purposes stipulates that Nuclear facilities and nuclear materials are the property of the RoA, but after entering of the law into force nuclear installations being constructed may be the property of legal entities. In addition, it is stipulated in the Law that spent nuclear fuel and radioactive waste generated in nuclear facilities located on the territory of RoA are the property of the RoA. Ref. [1.1-4]

Thus, under current Armenian law, the owner of ANPP Unit 3 may be the state or a private legal entity. (As of December 2007, this Law was under review and revision by the State Committee for Regulation of Nuclear Safety – previously ANRA. It is not known if the referenced provision of the law was to be changed.)

Initial Planning Studies (IPS) Chapter 6 describes three possible ownership and financing scenarios for ANPP Unit 3:

1) Public (State) Investment;
2) Public-Private Partnership; and
3) Independent Power Producer (IPP).

The ownership structure under each of these scenarios, including various options within them, are discussed further below. Under each of the scenarios, IPS Chapter 6 recommends employment of a separate company for management of station operations and maintenance (O&M). This could be analogous to the arrangement with CJSC "Inter RAO UES" for management of ANPP Units 1 and 2.

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[8] All stock in the CJSC is owned by the GoA.

[9] The Contract is concluded for a five-year period without transfer of ownership rights. It will be prolonged for the same period, if after its expiration no written notification on its termination is provided by the GoA.

1.1.5.1 STATE OWNERSHIP

State ownership falls under the IPS scenario of Public Investment. State ownership and operation of nuclear facilities is common in many countries.

Ukraine, with five Soviet state-sponsored nuclear plants in operation at the time of the dissolution of the U.S.S.R., has transferred ownership and operating responsibility of their NPPs to a state utility, the state enterprise National Nuclear Energy Generating Company "Energoatom" (NNEGC Energoatom). With four operating nuclear plants[10] and fifteen operating units, Energoatom's assets and capabilities are much greater than those available in Armenia. Nevertheless, Energoatom borrowed $215 million from the European Bank for Reconstruction and Development (EBRD) to finance completion and startup of the two partially constructed nuclear plants, Khmelnytsky Unit 2 and Rivne (Rovno) Unit 4 (Ref. [1.1-5]).

A principal challenge for many countries considering building a new nuclear plant is financing. Capital in developing countries is often scarce, and energy projects must compete for capital with other national investment needs including health care, education, transportation and industrial development. Government budgets as well as the resources of state-owned utilities are often inadequate even for small investment projects.[11] All investments carry risks. For nuclear power, risks include cost overruns and delays during construction, unsatisfactory technical operating performance, and low subsequent demand for the product (electricity) in the market place. Ref. [1.1-6]

If the GoA decides that state ownership and operation of ANPP Unit 3 is the best approach for Armenia, there are several approaches for GoA to consider that can reduce the financial risks of such a project.

1.1.5.1.1 Regional or Multi-Country Sponsorship/Ownership Option

Regional or multi-country sponsorship of a nuclear project can reduce the costs and risks borne by any one country. Regional integration would have an additional advantage – the creation of a larger grid allowing countries with small national grids to still take advantage of the economies of scale represented by the large units currently offered by vendors. Ref. [1.1-6]

As discussed in Initial Planning Studies Chapter 3, a new 1,000 MW nuclear unit will generate significantly more electricity than can be used to meet Armenia's domestic load. Because of large seasonal and daily variations in the domestic load, the plant would operate well below the expected 90% capacity factor if only domestic load is served. Therefore, electricity export is necessary for economical operation of a 1,000 MW plant.

Given that connection to electrical grids in neighboring countries is critical to economical, baseload operation of a large NPP, and that the larger region will benefit from the cost

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[10] The fifth NPP in Ukraine, Chernobyl, is not part of Energoatom because the last operating unit, Unit 3, was permanently shutdown in 1999.

[11] This true for Armenia, where a proposal to develop a deep well system to supply ANPP with potable water and completion of a partially built replacement sanitary sewage treatment facility at ANPP are on hold for lack of financing.

advantages and stability of such a large generation resource, shared sponsorship and ownership of ANPP Unit 3 could make sense.[12]

With the plant located within Armenia, and subject to regulation by Armenian norms, an Armenian organization, such as the CJSC "ANPP" should be the operating organization. In the case of shared ownership, safety and financial management is overseen by committees comprised of representatives from all owners.

1.1.5.1.2 Turnkey Plant Option

Exposure to the up-front risks of cost overruns and construction delays can be reduced by arranging turnkey contracts with vendors, in which all risks are borne by the vendor until the plant is completed and connected to the grid. Ref. [1.1-6]

The project sponsor(s) can reduce the upfront risks by contracting with a reactor vendor to supply the plant on a turnkey basis. In such an approach, the vendor supplies or subcontracts for all equipment, construction, construction management, and plant startup activities, turning over the assets of the plant to the sponsor(s) following completion of commissioning activities.

The scope of a turnkey contract can include such important services such as development of operating procedures and training and qualification of the operating staff.

1.1.5.2 ALTERNATIVES TO FULL STATE OWNERSHIP

In many cases, governments attach high priority to providing affordable electricity based on their socio-political priorities. Government guaranteed long term feed-in tariffs could alleviate investor concerns about short term returns on their investments. In this case, several commercial concepts could be applied. The strategy of build-own-operate relieves the host country of investment risks while creating less pressure to develop the necessary local skilled labor force and infrastructure. Build-own-operate-transfer is similar, but includes the eventual transfer of the plant to the local utility or authority, including all assets and liabilities. Ref. [1.1-6]

1.1.5.2.1 Public-Private Partnership Alternative

This approach is being used for the new Belene plant in Bulgaria.

A Public-Private Partnership is a joint venture between the government sponsor(s) and private sector investors to form a generating company (GenCo). Under this alternative the government sponsor(s) obtain loans and/or grants for a small percentage of the Project costs, and applies the proceeds to fund a portion or all of its equity contribution to the GenCo as minority shareholder(s). Private investors take on the majority of equity funding of the GenCo.

Under this alternative, the GenCo owns the assets, repays project lenders, and pays dividends to the shareholders. The electricity network pays the GenCo for delivered

[12] Another advantage unrelated to the technical aspects of shared ownership might be improvement in the investment ratings of the project compared with a project solely sponsored by Armenia.

energy. To support acquisition of adequate financing for the project, the electricity network's payments are guaranteed by the government sponsor(s).

One variation on the Public-Private Partnership approach would be for the joint venture agreement to provide for transfer of the plant assets to the government sponsor(s) at some point in the future, basically the build-own-operate-transfer scenario discussed above.

1.1.5.2.2 Independent Power Producer Alternative

This alternative is similar to most projects in the U.S.A., where a generating company is formed to build and operate a generating plant with the intent to make a profit as an Independent Power Producer (IPP) selling energy to electrical network operators at market prices. This is basically the build-own-operate strategy discussed above.

An IPP is wholly owned and financed by the private sector. With this alternative, the IPP owns all assets for the life of the plant and is paid by the electricity network for delivered energy. The government sponsor(s) guarantees the electricity network's payments. With this alternative, a government entity may also finance spent nuclear fuel facilities and agree to take ownership of spent fuel after a suitable decay period.

Figure 1.1-1, Map of Republic of Armenia

Figure 1.1-2, ANPP Unit 3 Construction Layout

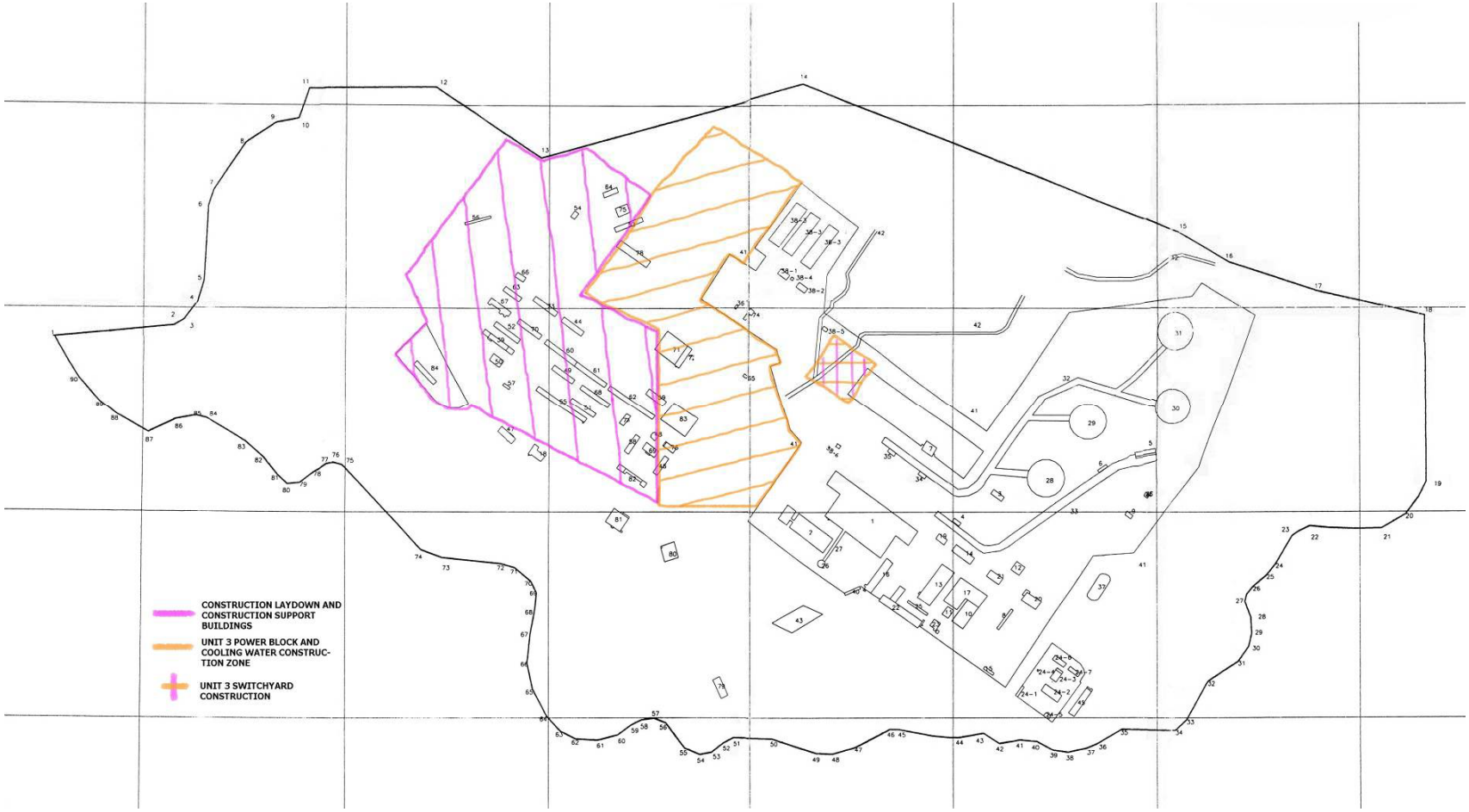
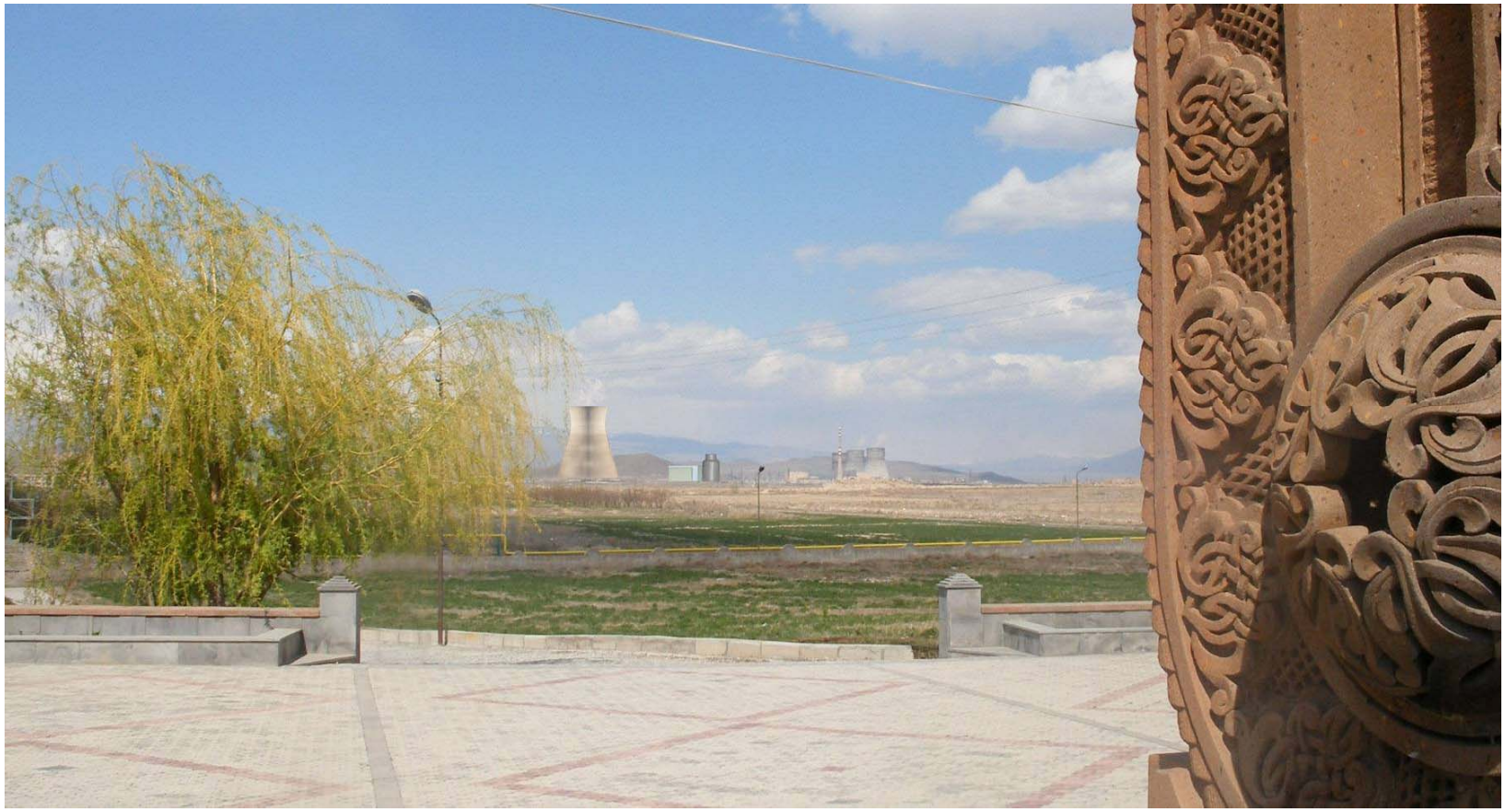


Figure 1.1-3, Photo from Cultural Vantage Point – Metsamor Town Church



REFERENCES:

[1.1-1] PA Consulting Group, 2006, Armenia Power Sector 2006 Least Cost Generation Plan.

[1.1-2] Resolution № 1 of Protocol № 24, adopted by the Government of Armenia at June 23, 2005 Session, *Energy Sector Development Strategies in Context of Economic Development in Armenia*.

[1.1-3] GoA Decree № 1211, dated October 1, 2003, *On Transfer of Management Responsibilities Provided by Armenia Nuclear Power Plant Closed Joint Stock Company's Shares*.

[1.1-4] *Law of the Republic of Armenia for the Safe Utilization of Atomic Energy for Peaceful Purposes*, 01 February 1998, Art.6.

[1.1-5] European Bank for Reconstruction and Development (EBRD), 2001, press release *EBRD President recommends loan approval for K2R4 be confirmed*, 7 November 2001.

[1.1-6] IAEA, 2006, 50th IAEA General Conference (2006), Information Document *Nuclear Power in Developing Countries,* URL: www.iaea.org/About/Policy/GC/GC50/GC50InfDocuments/English/gc50inf-3-att3_en.pdf

1.2 STATUS OF REVIEWS, APPROVALS, AND CONSULTATIONS

The objective of this section is to document the requirements for compliance with any environmentally-related authorizations required by government agencies as a prerequisite to plant licensing and construction. This section includes a listing of the authorizations (and the authorizing agencies) that address environmental issues. For each authorization, the section summarizes the process and estimated schedule for obtaining the authorization and identifies any areas of potential environmental concern. Table 1.2-1 summarizes the authorizations and permits required for a new unit at ANPP. (Note: related laws of the Republic of Armenia and resolutions of the Government of Armenia are listed in Appendix 1.3A, along with reference notations to Appendix 1.3A in the form [1.3-n] that identify the official date, title and other relevant details needed to clearly identify the item.)

{Most permits and approvals cannot be obtained at this time and many consultations are yet to be held; therefore, Table 1.2-1 is incomplete. The final environmental assessment produced for the Government of Armenia should reflect the latest status of reviews, approvals and consultations related to the environmental assessment.}[13]

1.2.1 Site Selection License

In accordance with the Law on Licensing [1.3-12] and the Law for the Safe Utilization of Atomic Energy for Peaceful Purposes [1.3-9], GoA Resolution № 609-N [1.3-35a] establishes the licensing procedure and specifies the license form for selection of the site for nuclear installations. Such licensing is carried out by the State Regulatory Committee for Nuclear and Radiation Safety (SRCNRS – previously the Regulatory Body of the Atomic Energy Use Sector – ANRA). To obtain a site selection license, an organization must submit an application, including specific information related to site suitability and environmental impacts.

The regulatory body must consider the application within 30 days after registration of the application (¶ 6). The regulatory body may request additional safety justifications, design documents, reports on results of the research activities and other documents necessary for the safety assessment (¶ 7). Experts of the Republic of Armenia or international organizations may take part in the discussions of the application for issuing a license for selection of the nuclear installation site, based on the regulatory body's resolution (¶ 8).

1.2.2 Nuclear Facility Environmental Report

The Law of the Republic of Armenia on Environmental Impact Assessment [1.3-1], Article 6, requires that the initiator of an intended activity requiring environmental impact assessment notify the authorized body[14] of the intended activity, including basic data on the impact of the intended activity on the environment, the degree of possible impact and danger for individual components of the environment. In addition, Article 7 requires that the initiator submit documents required for the environmental assessment (strategic

[13] {Text that should be removed or substantially revised as part of the final environmental assessment report is enclosed in curly brackets.}
[14] The authorized body is: Republic of Armenia Environmental Expertise, State Non-Commercial Organization of the Ministry of Nature Protection.

documents – those documents needed by the government to complete the environmental impact assessment process).

The first step in the environmental impact assessment process is notification of interested parties. This is followed by public comment and review of strategic documents by the authorized body, which typically takes up to 120 days, but may take up to 180 days for a complicated, strategically important action such as an NPP. The strategic documents are typically provided by the developer and the developer is responsible for accuracy of the information provided. The environmental impact assessment process involves receipt and response to comments from affected communities, the public, and non-government organizations. For trans-boundary matters, the GoA must approve and carry out all necessary actions.

{This Environmental Background Information Document (EBID) is intended to serve as basic data that can accompany notification of the authorized body and the public and to constitute, to the best of our judgment, the basis[15] for strategic documents necessary for preparation by the authorized body of an expert conclusion regarding environmental assessment.}

[15] As discussed in EBID Section 1.0 and Chapter 10, this EBID does not provide a complete assessment of potential environmental impacts and additional work is needed to complete the developer's input to the assessment process.

1.2.3 Land Use Permits

Land use is governed by the Land Code [1.3-11] and related laws and resolutions. State and community land located within the administrative boundaries of communities are allocated by the heads of the communities. Lands located outside administrative boundaries of a community are allocated by the Governors of marzes (Marzpets). All the contracts come into effect through the State registration and are subject to notary ratification. The land use rights application process is presented in Figure 1.2-1.

Acquiring a land use permit appears simple and easy, however complications may occur if the applicant would have to go through the procedure of changing the land use category to energy generation. In such cases, applicants apply to the GoA through the Marzpet. This is a major challenge for applicants, since the process often takes upwards of six months and requires outlays of financial resources.

The targeted use of the land and its structure should be determined in accordance with land use and zoning plans. The targeted use of the land must be clearly stated in the land use documents (permit/contract). If the land was initially allocated for purposes other than energy, e.g. agriculture, the Government should adopt a Decision changing the targeted use of the land and this change must be reflected in the general plans of the location. It means that the whole package of documents for the lease for the project must be submitted by the Marzpet to the Government, which then adopts the corresponding decision.

The GoA must draft the Decision and send it for approval to the following Ministries:

- The Ministry of Nature Protection;
- The Ministry of Agriculture;
- The Ministry of Urban Development;
- The Ministry of Territorial Administration;
- The Ministry of Culture, Historical and Cultural Monuments Protection Agency; and,
- The State Committee of the Real Estate Cadastre (State Cadastre)

In fact, there are Ministerial Committees in each of the aforementioned Ministries that deal with defining and changing the targeted use of lands and other related issues and present the proposed changes to the Government. During this process each Ministry may request some supporting documentation. Both positive and negative conclusions shall be delivered to the Government from the mentioned Ministries with the draft Decision. In the case of positive solution, the State Cadastre must change the type of targeted use of the land in the maps and all the related documents and respond to the Marzpet. After that, developer may apply to the State Cadastre to get the map with indication of the new targeted use of the land.

The main problem at this level is the absence of specific procedure for changing the land use category. The relevant Articles are scattered all over the Land Code. Existing procedure refers to numerous governmental agencies and provides no timeframes for the whole process.

1.2.4 Civil Construction Permits

The Republic of Armenia Law on Urban Development [1.3-5] provides for approving civil construction of industrial facilities. A new ANPP unit would qualify as an industrial facility and listed as a "highly important object." GoA resolution No. 812 [1.3-40] specifies the procedure for approval of designs for industrial buildings. For a complex construction such as an NPP, the design documentation is prepared in two stages: 1) conceptual documents; and 2) working documentation. In this case while preparing the conceptual documents, construction permission should be obtained to perform land development, architectural, and building/assembly jobs. After that, at the working documentation preparation stage, design documents are developed based on pre-approved solutions and project documents.

GoA Resolution No. 96 [1.3-21] provides the procedure for examination of civil construction documents, including formation of a Temporary Examination Body for review of construction documents of especially hazardous or complex facilities, such as a new NPP. The Temporary Examination Body would involve representatives of appropriate ministries, including the Ministry of Nature Protection. If the decision of the examination of construction documents is positive, the expert opinion, project design documents and application for construction permission are submitted to the head of the community where the project should be implemented.

Within ten (10) days upon submission of the design documents the project should be approved by the local self-government bodies. In cases it is a subject of public notification, the final decision is made on the twenty-first (21st) day. In case of comments and recommendations, the final decision should be made within five (5) days from second/subsequent submission of documents. Along with approval of the project, the local community should also issue construction permission to the developer.

GoA resolutions No. 660 [1.3-38] and No. 1001 [1.3-44] provide details on managing public awareness of changes to the biological environment due to civil construction.

In accordance with the resolutions mentioned above, the public in the Republic of Armenia is notified on the planned changes of biological environment in administrative territories of communities (village, city) by self-government bodies, corresponding state government territorial bodies beyond administrative borders of communities and by Yerevan Mayor in Yerevan city. Notification shall be implemented through:

- Mass Media (local and state radio, television, newspapers);
- Demonstrations of programs and projects, publications;
- Public discussions.

No restrictions exist currently, but a law has been drafted and is due for issuance by the end of 2008 that will address permitting for disposal of solid waste from construction. The project for construction of ANPP Unit 3 should account for the requirements of that law.

1.2.5 Water-related Permits

Water-related permits, as discussed below, may be issued for a five-year period[16], and thus, officially must be applied for in the years immediately prior to unit operation. Within the current permitting process, however, water use permits should be applied for as soon as bounding parameters for water use and likely discharges can be defined, with the intent to maintain and renew such permits during the period of project design and construction. Applying for water use permits early in the design phase will allow setting of limiting parameters for withdrawals and discharges, essentially "reserving" future allocation of water for use by Unit 3.

{Advance consultation with the Water Resources Management Agency (WRMA) may serve useful to ensure that water use permits can be obtained without unforeseen difficulties and to realize the process for routine renewals. The appropriate timing of such consultation would be as part of the efforts to finalize the environmental assessment. EBID Section 1.1.3.3 outlines a number of actions related to water allocation and setting of water quality standards that must be met by Unit 3. Completion of these actions would constitute advance consultation with the WRMA.}

1.2.5.1 WATER USE PERMITS

Chapter Four (Water Use Permits, Articles 21- 37) of RoA Water Code [1.3-14] and a number of governmental decrees provide for pre-conditions, the application process and content of water permits, as well as terms of validity, suspension, revocation and conditions to make amendments to water permits. Article 1 of the Water Code defines a water use permit as "a document that includes the rights and responsibilities of a person related to the extraction of water from and discharge of water into a water resource." According to Article 32 of the Water Code, along with general information on the permit holder, the water use permit needs to indicate the period of water use permit validity; types of water use allowed (i.e. irrigation, industrial, etc.); quantity of water to be used; and control (monitoring) mechanisms to support compliance with water use permit requirements.

The water use permit application process is illustrated in Figure 1.2-2.

Water Use Permits are issued and enforced by Water Resources Management Agency (WRMA) and the Basin Management Organizations (BMOs), which will take over that role in the future.[17]

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[16] The current practice of the Water Resources Management Agency is to issue permits for 3 years.
[17] For a national strategic resource such as ANPP, water use permits are likely to be issued by the WRMA; the BMOs are primarily intended to issue permits for local water uses.

To receive the water use permit to build a power station on a given watercourse, an application should be submitted to the Water Resources Management Agency or the Basin Management Organizations[18] with the following documents attached:

1. General information (a State registration certificate of a company or passport data if the applicant is a physical entity; information on previous water use permits; public announcement in the local press regarding the application; and, a certificate of payment for State duty).
2. Positive decision of Environmental Expertise on the environmental impact assessment[19];
3. Documents verifying land use rights and right of way;
4. Document verifying capacity/capability and quality of a spring and/or water source;
5. Norms of water use and drainage approved by the procedure on water intake and use regimes;
6. Location plan with the precise indication of water use points given by the local self-government bodies; and,
7. Marginal outflow criteria of polluters in wastewater as defined by the governmental decree.

Within thirty (30) days of receiving a water use permit application, the WRMA shall make an initial assessment of acceptance or rejection of the application and provide initial findings to the applicant. Thirty (30) days after receipt of the initial assessment, the WRMA should provide adequate public notice of the pending water use permit application. After completing all the preliminary assessments and reviews, the WRMA shall complete the final review of the permit application.[20]

As soon as the final review is completed (the Law provides maximum 30 days for that), the WRMA will return copies of the permit application[21], the final decision, and, as needed, the completed and signed water use permit with comments/recommendations, conditions and instructions to the permit applicant. The applicant should return the signed water use permit to the WRMA within thirty (30) days of receipt.

Upon submission of the signed water use permit by the applicant to the WRMA, within ten (10) days the water use permit and any attached conditions shall be registered in accordance with the recording requirements of the Code.

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[18] There are five basin management organizations in Armenia now: Southern, Northern, Akhuryan, Araratyan and Sevan-Hrazdan BMOs. Current makeup water sources for ANPP are in the territory of the Akhuryan BMO, although the ANPP site itself is within the territory of the Sevan-Hrazdan BMO.

[19] EBID 5.2 proposes obtaining water use permit for ANPP Unit 3 as soon as possible. To do this may require obtaining a positive decision on a preliminary environmental impact assessment; the specific processes and order of decisions should be agreed by all the involved agencies of the GoA.

[20] The Water Code states that in some cases provided by law the Water Resources Management and Protection Body shall submit water use permit applications to the National Water Council for review. In this case, the application process may be extended for up to sixty (60) additional days.

[21] Should the terms and conditions not be satisfactory to the applicant, the applicant has the right to file a complaint against Water Resources Management and Protection Body's decision according to procedures established by law.

Cumulatively, the shortest possible time to receive a water use permit is 100 days, and the longest time period, if the WRMA or BMOs would spend maximum terms provided by the Law is 190 days.

Paragraph 6 of Article 30 of the Water Code (on Water Permit Process) states that in the cases provided by law the application shall be sent to the National Water Council (in such cases revision of the application by the Water National Council takes additional 60 days). But neither the Law, nor any Governmental Decree indicates what the cases are for the application to be sent to the Council. In addition to that, the Law provides 30 days for both initial assessment by the WRMA and review and return of the signed copy of the water use permit by the developer.

Article 33 of the Water Code states that prior to the approval of the National Water Program (NWP), a water use permit may be valid for no more than three (3) years. In locations where a Water Basin Management Plan exists, a water use permit may be valid for a maximum of twenty-five (25) years. In locations where a Water Basin Management Plan does not exist, after adoption of the NWP the water use permit are given for a maximum of five (5) years[22]. In case of the positive conclusion of the National Water Council, the Water Resources Management and Protection Body based on the water basin management plans may allocate a water use permit for a longer duration, but not exceeding forty (40) years.

The National Water Program was adopted by the National Assembly on November 27, 2006. It is a policy document that provides certain requirements on quantity, quality, and criteria for effective conservation and management of water resources. Based on the NWP the Water Basin Management Plans shall be developed by the WRMA. That has not been accomplished so far for the region of ANPP (Akhuryan and Sevan-Hrazdan BMOs). So, at this moment the water permits are given for three (3) or five (5) years only[23], which clearly is not enough for any project implementation. {Should a permit be issued for a validity of less than plant lifetime, permit renewals shall be processed – limitation to 5 year validity could cause a problem because the conditions of the permit could be altered during the term of construction and invalidate design bases.}

The Water Use Permit standard form (see Resolution 218 [1.3-26], “On Approval of a Water Use Permit Standard Form and Water Use Permitting Standard Forms”) provides for extraction of both groundwater and surface waters, amounts and types of water discharges, characterization and limits on effluents, and oversight mechanisms for ensuring compliance with permit conditions.

Resolution No. 354 [1.3-28] “On Approval of the Procedure for Determination of Rates and Regime of Water Withdrawal from Water Resources Allocated to Water Users,” specifies formulae for calculation of rates of water withdrawal and water withdrawal regime (limits on withdrawal).

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[22] Although the NWP has been adopted, the WRMA continues to use three years for permit validity; this is in part due to past practice and in part because the BMO plans have yet to be developed.

[23] As noted, current practice of the WRMA is to issue water use permits with a three-year period of validity.

Resolution No. 1060 [1.3-45], "On Approval of the Procedure for Registration of Documents with State Water Cadastre and Provision of Information," specifies data that must be provided to the Water Cadastre in connection with Water Use Permits.

Resolution No. 1182 [1.3-48] "On Approval of Procedure for Control of Impacts on Water Resources in Watersheds and Wetlands," states that control of impacts on water resources in watersheds and wetlands is implemented by the Republic of Armenia Ministries of Nature Protection, Health, Agriculture, State Committee of Water Systems under the Government of the Republic of Armenia, Emergency Department under the Government of the Republic of Armenia, bodies of territorial administration and local self-governance within the scope of their responsibilities. The Resolution assigns the responsibility to the Ministry of Nature Protection for control of the quality and quantity parameters of water resources (surface and ground waters), flow formation zone, flora and fauna and their natural habitats, the assessment of natural and anthropogenic impacts on water resources of specially protected areas, as well as to coordinate and summarize data received from the stakeholder authorities to be incorporated in the National Water Program.

Resolution No. 612 [1.3-36], "On Approval of Procedures for Provision of Information on Trans-Boundary Water Resources," provides for the RoA government to inform the media and foreign countries of potential impacts on transboundary water resources.

1.2.5.2 WATER SYSTEM USE PERMITS

The Water Code [1.3-14] also provides for Water System Use permits. The system(s) for supply of process and cooling water to and for treatment of waste water from the new unit could be considered water systems subject to permitting; however the Water System Use permitting process defined in Chapter 5 of the Water Code specifically applies to *non-competitive water suppliers*, defined as: "a legal entity (person) who is the owner of commercial supply of drinking or irrigation water or wastewater treatment services to the public and who has no competitors." On this basis, it appears that a separate water system use permit would not be needed for a new unit at ANPP, unless such a system also provides water or waste water treatment on a commercial basis to the public (e.g. replacement of the abandoned waste water treatment system that served Armavir Town, Metsamor Town and Norapat village, along with ANPP or development of a deep-well system to supply potable water to the site and Metsamor Town). In any case, a water system as defined in the Code is also subject to the Water Use permitting process described above, which is the limiting process as far as evaluating and permitting environmental impacts.

1.2.5.3 WATER DISCHARGE PERMITS

1.2.5.3.1 Thermal/Chemical discharges to water

Discharges to water are covered by the Water Use Permit, discussed above. As part of the application process, the applicant proposes parameters for the discharges and includes as part of the supporting documentation a report by a licensed scientific institute to support the proposed discharge limits.

1.2.5.3.2 Radioactive discharges to water

Radioactive discharges to water are also covered in the Water Use permit discussed above. However, limits on radioactive discharges are provided for in GoA Resolution No. 1219 [1.3-49], "On Approval of Norms of Radioactive Safety" (see Art. 41).

1.2.6 Atmosphere-related Permits

Atmospheric emission permits are issued for a term of five years and application for permits related to operation of Unit 3 would be submitted in the years just prior to plant operation, no sooner than 2010.

1.2.6.1 EMISSIONS TO THE ATMOSPHERE

The main legal acts regulating air emissions in Armenia are the Law on Air Protection [1.3-2a] and the Law on Environmental Payment Rates [1.3-8].

General requirements on the application process for air emissions are established by GoA Resolution 192 [1.3-24] approving the procedure on issuance of a permit for allowed quantity of pollutants and emissions into atmosphere. According to this Resolution, the Ministry of Nature Protection in coordination with the Ministry of Health develops and then approves: (a) norms of maximum permissible value of emissions and methodologies for determination of these norms; and (b) list of objects subject to permission for emissions to air and procedures for development, coordination and submission of the requested norms (within the limits of maximum permissible value) of emissions for approval.

Norms of maximum permissible value of emissions, methodologies for determination of these norms and types of objects and facilities that are subject to permission are approved and enacted by the Government of Armenia. Government Resolution 67 defines the classification of atmospheric emissions by composition and maximum permitted emission of hazardous materials from the atmosphere-polluting sources, calculation and monitoring methods. GoA Resolution 160 specifies maximum allowable concentration for (non-radioactive) emissions in residential areas. GoA Resolution 1219 [1.3-49] specifies permissible levels of irradiation of personnel and the public due to airborne radioisotopes (see Art. 55).

The Ministry of Nature Protection is the authorized body that issues permits for emissions to air. Specific requirements on the application process are provided by the Decree No. 63 of the Minister of Nature Protection (MNP).

Pursuant to MNP Decree No.63, an application should be submitted to the Division of Atmosphere and Land Protection (under the Department of Environmental Protection of the MNP) which within ten (10) days sends it to the State Environmental Inspectorate for an opinion. Upon receiving it, the documents should be sent to the Environmental Expertise state non-commercial organization (under the MNP) for approval to be provided within five (5) days. After that, the Division of Atmosphere and Land Protection has to make final review of the package. If there are no comments or recommendations for changes to the documents, the permit is issued for a five-year period.

For newly constructed, expanded and restructured objects/facilities a one-year permit should be given within seven (7) days after application.

The Decree provides model forms in which responses (opinions) from the State Environmental Inspectorate and Environmental Expertise should be presented. As an attachment it also contains a model form of the emission permit.

Maximum thirty (30) days are provided by law for the emission permit application process.

1.2.6.2 RADIOACTIVE DISCHARGES TO THE ATMOSPHERE

These discharges may be covered under the air emission permits discussed above. In any case, limits on radioactive discharges are specified in GoA Resolution 1219 [1.3-49], "On Approval of Norms of Radioactive Safety".

1.2.7 Fish and Wildlife Impact

Resolution No. 1182 [1.3-48] (see discussion above) indicates that impacts of water use on flora and fauna are to be assessed in connection with the Water Use permit.

1.2.8 Historic and Cultural Site Preservation

The Ministry of Culture of the Republic of Armenia was consulted to identify historic and cultural sites and monuments in the vicinity of the ANPP. The results of that consultation are provided in this Environmental Background Information Document, Section 2.5. It is not planned that any of these sites be disturbed in connection with construction, operation or decommissioning of a new unit at ANPP; however a process will be developed for further consultation with this Ministry in the event that these sites, or any newly discovered culturally significant sites, are potentially affected by the new unit or its ancillary systems, in accordance with the Law of the Republic of Armenia on Protection and Use of Historical and Cultural Immovable Monuments and Historic Sites [1.3-7], Article 22.

1.2.9 Road Use Permits

On December 5, 2006 the RoA National Assembly adopted the Law on Automobile Roads [1.3-17], which determines main provisions on design, construction, reconstruction and maintenance of roads. According to this law, all roads in Armenia are grouped into roads of general use (urban and country) and roads of not general use. The roads of general use, depending on their importance, are divided into the following three groups: *roads of intergovernmental importance*; *roads of state importance*; and *roads of community importance*. All roads leading to the large settlements, airports, trans-shipment points and historical monuments are also either of *intergovernmental* or *state importance.* According to GoA Resolution No. 475 [1.3-32] on "Approval of the List of Roads of Intergovernmental and State Importance", Highway M-5 (Yerevan- Armavir- Armenia/Turkey border Highway) is of *intergovernmental importance.*

Management/control of *intergovernmental roads* is carried out by the RoA Ministry of Transport and Communication (MTC). The Ministry has to prepare, implement and oversee programs on the development, construction, reconstruction and maintenance of networks that are under its control.

Transportation of major components for the new unit may require use of special transport vehicles needing special permits.

There are no restrictions for use of roads of general use except (a) by track- type caterpillar vehicles and (b) road-freight transport. Special "Traffic Rules for Vehicles Used for Transportation of Heavy Loads or Having Sizes Exceeding the Sizes Set by Traffic Rules or Operating as a Part of a Road-Train along with two and More Trailers" are provided by the GoA Resolution No. 1106 [1.3-47]. For traffic safety and provision of established road utilization requirements the MTC issues one- time or multi-use (for a set period of time) permits. The MTC has to examine technical and other characteristics of the vehicle and conditions/parameters of existing roads and suggest the best option for the route. The permit issued to the vehicle owner contains special conditions on transportation and traffic safety. The MTC coordinates permitting

process for transportation of heavy loads with the State Police Department, which based on MTC permit issues transportation pass. The latter is an inseparable part of the permit.

The permit should be issued within fifteen (15) days upon submission of the application, along with the certificate verifying state duty payment and other supporting documentation. The Resolution provides special conditions on organization of transportations (e.g. when and how it should take place) and technical requirements for the vehicle. It also prescribes rights and obligations of the authorized state body (MTC) and the applicant, as well as model forms of the application, the transportation permit and the pass.

Utilization of roads of general use is free of charge except for passenger and truck vehicles registered in foreign countries, as well as truck vehicles registered in Armenia. The rates of charges and fares for different categories of vehicles and loads, as well as the rate calculation and payment procedures are provided by the "Law on Road Fees" [1.3-4].

1.2.10 Construction in the Vicinity of Roads

Construction activities may be restricted in the vicinity of roads.

According to legislation, all roads should have alienation zones; those located out of settlements should also have safety zones. By GoA Resolution No. 2404 [1.3-57] "On Regulation of Territories Adjacent to the Intergovernmental and State Importance Roads", special regime is established for the territories within seventy (70) meters from the edge of the roads located outside settlements and fifty (50) meters for roads passing through the settlements. No construction is allowed within eighteen (18) meters from the edge of intergovernmental roads. For first-rate roads the safety zone is seventy (70) meters; for second and third rate roads, fifty (50) meters; for fourth rate roads, thirty (30) meters from the center of the road.

Alienation zones of the roads of state and intergovernmental importance are also under the management of the MTC. In the alienation/safety zones it is strictly prohibited to implement construction, mining works or any activity that may result in adverse hydrological changes of environment or affect stability of the roads.

Construction of transmission and connection lines, pipelines and irrigation systems over and under the roads, as well as in the safety and alienation zones should be carried out in accordance with the existing norms (SNIPs and GOSTs, i.e., construction norms and standards) in collaboration with the MTC. Such construction should not hinder utilization of the roads or pose any threat to public safety. Therefore, although the legislation does not provide for a specific permit, the MTC should be consulted if any construction related to the new NPP unit involves such activities that could impact roads.

1.2.11 Construction Waste Permits

No process exists currently, but a law has been drafted by the MNP and is due for adoption by the end of 2008 that will address permitting for disposal of solid waste from construction. The project for construction of ANPP Unit 3 should account for the requirements of that law.

Table 1.2-1, Permits and Authorizations for a New Unit at ANPP

Agency	Authority	Requirement	Date Due[24] / Date Submitted	Auth. or Permit Issued	Stat-us	Notes:
SRCNRS (ANRA)	RoA Law on Licensing [1.3-12] and GoA Resolution № 609-N [1.3-35a]	Application for Selection of a Site for a Nuclear Installation	1 November 2009[25]			Includes an assessment of the natural phenomena influencing on the site (site suitability) and assessment of the man-caused factors influencing the site (environmental assessment).
RoA Environmental Expertise, of the Ministry of Nature Protection	RoA Law on Environmental Impact Assessment [1.3-1]	Notification, Basic Data, Strategic Documents				Environmental Background Information Document provides Basic Data for Strategic Documents.
Marzpet (Governor) for Armavir marz	RoA Land Code [1.3-11]	Land Use Rights Application				Needed only if land use designation change is required.
Mayor of Metsamor Town	RoA Land Code [1.3-11] and GoA Decree № 609 [1.3-35]	Application for approval of construction, urban plans, and/or zoning				Apply in advance of construction or need of changes to plans or zoning. (see next item)

[24] Most due dates are based on an assumed date of 1/1/2016 for Commercial Operation and an eight-month startup period.
[25] Assuming site selection license is needed by January 2010 to allow site preparations for Unit 3.

Table 1.2-1, Permits and Authorizations for a New Unit at ANPP

Agency	Authority	Requirement	Date Due[24] / Date Submitted	Auth. or Permit Issued	Stat-us	Notes:
Temporary Examination Body	GoA Decree № 96 [1.3-21]	Special Examination for approval of Civil Construction Plans for complex facilities				Procedure for public awareness in approval of civil construction is addressed in GoA Decrees No. 660 and 1001-N.
Water Resources Management Agency (or applicable Basin Management Organizations[26])	RoA Water Code [1.3-14], Ch. 4	Water Use Permit application, with positive conclusion on EIA, data on sources and marginal outflows	1 Aug 2014[27]			Application should address capacity of sources and evaluation of impacts, including those on fish and wildlife. Separate permits are required for separate sources such as: the Sevjur River; the ground water collection pond; and the deep well pumping station.

[26] BMOs are not yet functioning as permitting organizations. Akhuryan BMO (with jurisdiction over Sevjur River and its drainages) issues permits as directed by the WRMA. The ANPP site itself is on territory which is within the jurisdiction of the Sevan-Hrazdan BMO.

[27] In order to settle critical issues such as withdrawal and discharge limits early in the project design stages, application for water use permits should be submitted much earlier – as soon as bounding design parameters can be determined – with the realization that the permits will require renewal during the design and construction periods. See discussion in EBID Sections 1.1.3.3 and1.2.5.

Table 1.2-1, Permits and Authorizations for a New Unit at ANPP

Agency	Authority	Requirement	Date Due[24] / Date Submitted	Auth. or Permit Issued	Stat-us	Notes:
WRMA / BMO	RoA Water Code [1.3-14], Ch. 5	Water System Use Permit application	(May be n/a)			Water System Use Permit only needed if ANPP water systems also serve to supply water or water treatment services to the public.
Ministry of Nature Protection, Division of Atmosphere and Land Protection under Department of Environmental Protection	RoA Law on Air Protection [1.3-2a]; GoA Decree No. 192 [1.3-24]; and MNP Decree No. 67.	Air Emissions Permit application	1 Mar 2015			Ministry of Health sets norms for emission limits and monitoring.
Ministry of Transport and Communication	GoA Decree No. 1106 [1.3-47].	Road Use Permit Applications	15 days before need			Special permit needed for track- type caterpillar vehicles and road-freight transport (e.g., two or more trailers).
Ministry of Transport and Communication (MTC)	GoA Decree No. 2404 [1.3-57].	Consultation with MTC	Prior to construction			Consultation with MTC if construction of transmission and connection lines, or pipelines over and under the roads, or other construction in the safety or alienation zones of roads.
Ministry of Nature Protection (division not yet designated)	Pending (end of 2008)	Construction Waste Permit application	Prior to construction			Law in draft form, to be issued by end of 2008.

Figure 1.2-1, Land Use Rights Application Process

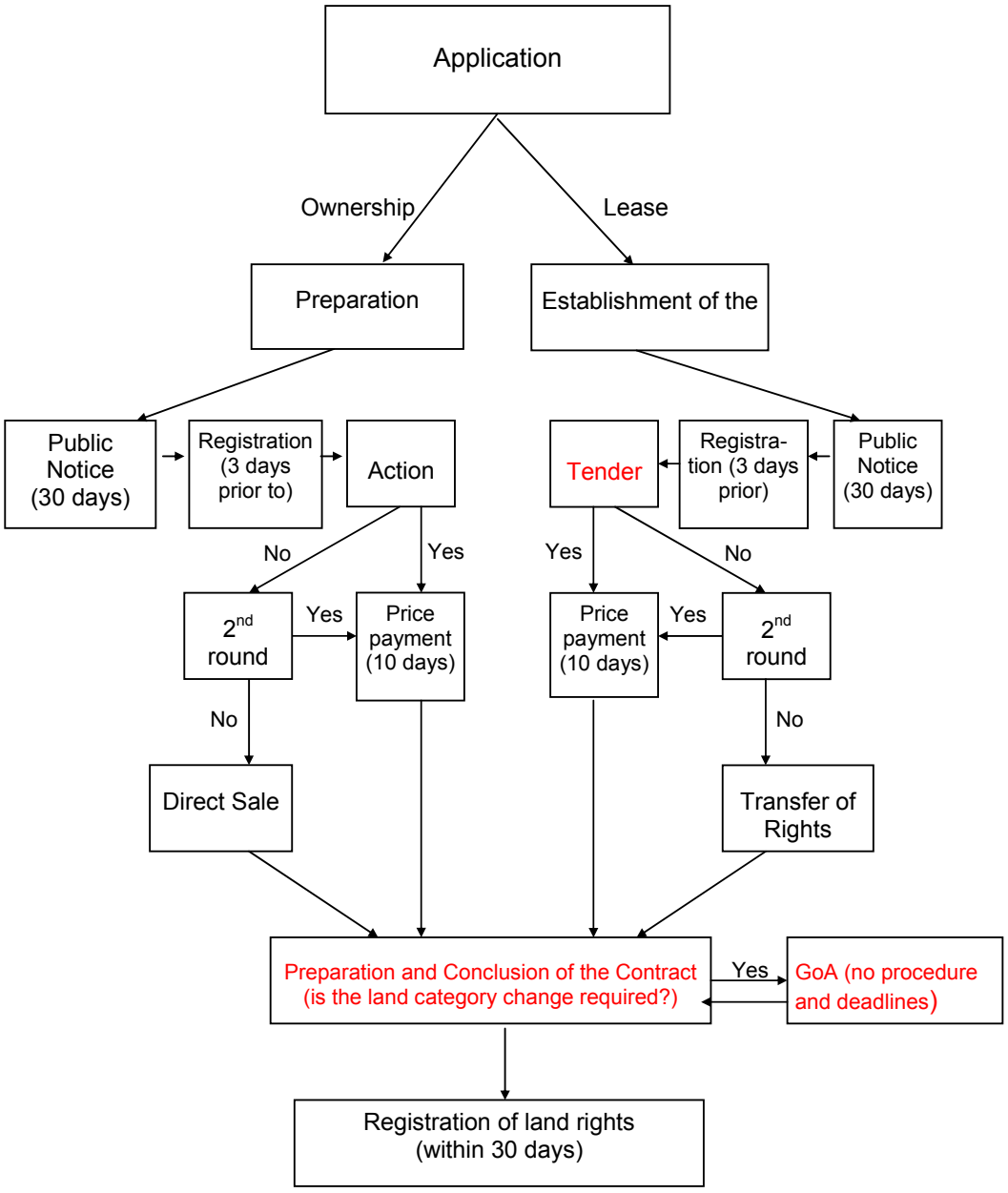
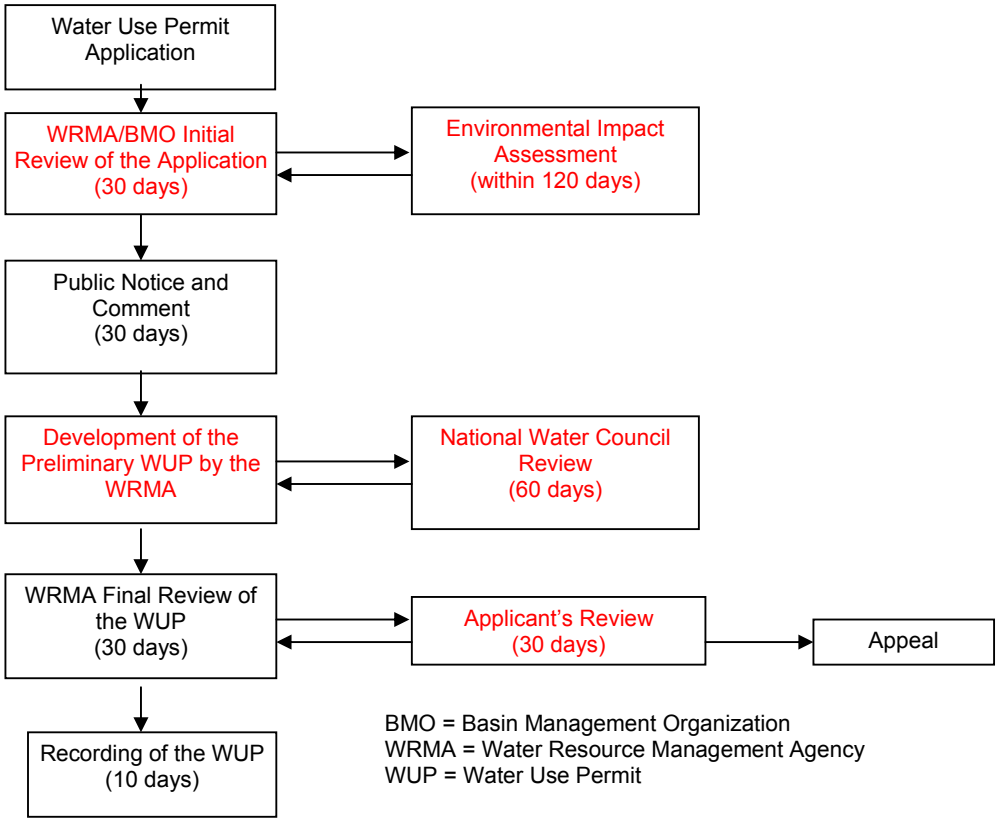


Figure 1.2-2, Water Use Permit (WUP) Application Process



1.3 APPLICABLE LAWS, REGULATIONS, STANDARDS, AND GUIDELINES

The objective of this section is to identify the laws, regulations, standards, and guidelines that are applicable to the environmental impact assessment process. This section also describes the environmental requirements of potential financiers of the project and identifies any international environmental agreements that may pertain to the project. [28]

This section summarizes source documents that contain requirements applicable to environmental impact assessment or provide requirements for the content of required documentation. Specific applicability to Armenia, where not obvious, is also discussed. {The final environmental assessment should consider any changes to the documents listed in the appendix to this section and any new laws or conventions related to environmental assessment in order to assure that the assessment complies with the latest requirements and guidelines. It is particularly important to consider any revisions to RoA laws and decrees.}

A more complete listing of documents reviewed during development of this report and the documents' relationship to the Environmental Background Information Document outline that is based on US NRC NUREG 1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants" (Ref. [1.3-120]) is identified in Appendix 1.3A-1. Specific applicability to environmental assessment documentation is identified in Table 1.3A-1.

Many of the documents are not specifically written to apply to a nuclear power plant, but rather address policies or actions of governments, funding organizations, and private entities that may influence the socio-economic and ecological environment of a region or locale. As such, some aspects of the summarized documents are not specifically discussed. Some of the source documents detail the process of environmental impact assessment and involvement of stakeholders in a transparent decision-making process. The discussion below concentrates on details that relate to the content of an environmental report, mentioning process only as it relates to the key steps in preparing such a report and in defining its content.

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[28] This section of the Environmental Background Information Document has no corresponding section in NUREG-1555, but is included to assure that the final environmental documentation provides comprehensive coverage of topics required to meet laws, standards and guidelines of the RoA, the international community, and potential international funding institutions.

1.3.1 RoA Laws, Regulations, and Standards applicable to the EIA

1.3.1.1 LAWS OF THE REPUBLIC OF ARMENIA[29]

1.3.1.1.1 Law on Environmental Impact Assessment [1.3-1][30]

This law of the Republic of Armenia (RoA) regulates the legal, economic, and institutional bases for the environmental impact assessment of intended activities. It is directly applicable to the environmental impact assessment process.

The environmental impact assessment process is a mandatory activity conducted by the state[31]; its main goal is to predict and prevent, or reduce to the minimum, hazardous impacts of an intended activity or procedure on human health, the environment, regular economic and social development. (Article 2, ¶ 1)

The objectives of environmental impact assessment include (Article 3):

- analysis of intended activities and the possibility of alternatives;
- appraisal of the possible effect and the degree of danger of the intended activity and alternatives;
- identification of possible ecological effect of intended activities; the integrity of consequence analysis and accuracy; the adequacy of measures for monitoring, prevention, elimination or minimization of consequences during operation and implementation processes, as well as in emergency situations;
- prohibition of any activity that can have an irreversible hazardous effect on the environment; and,
- to provide participation and involvement of the public in all phases of assessment.

Nuclear power plants and other facilities with nuclear reactors are subject to requirements for an environmental impact assessment. (Article 4, ¶ 1.a)

Article 5 of the Law specifies the scope of the assessment. Part of the scope is evaluation of alternative solutions, including zero option, and specification of measures for minimizing the potential impacts on the environment. This article defines part of the content for an environmental impact assessment report.

Article 6 of the Law specifies the procedure of notification about the intended activity, including information to be included in the notification. The required information defines some of the content for the environmental impact assessment report.

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[29] {As of December 2007, a study of existing laws applicable to nuclear facilities was underway, with a report due in September 2008 to identify new laws to be written and enacted, as well as existing laws that need to be revised. The final report on environmental impact assessment should reflect the results of that report and any resulting new/revised laws applicable to this topic.}

[30] Bracketed numbers [1.3-n] refer to numbered entries in the source document listing. See that listing for more complete citation of documents, including dates.

[31] Although the EIA process is conducted by the state, the project developer is responsible for collection of relevant data and initial assessment of impacts; the primary state activity is preparation of an environmental expertise conclusion regarding the project.

Articles 8 through 11 detail the requirements for publicizing the assessment, expert conclusions on the assessment, and conduct of public hearings. Paragraph 7 of Article 9 identifies items subject to assessment during the expert conclusion process that may also serve as indicators of environmental impact assessment report content.

If the environmental impact of the intended activity spreads beyond the state borders of the Republic of Armenia, the authorized body issues the assessment conclusion based on the requirements of international agreements ratified by the Republic of Armenia. In such cases the assessment conclusion is approved by the government of the Republic of Armenia. (Article 14) (See discussion of UN Conventions, below).

A "Law of the Republic of Armenia on State Environmental Review" has been drafted to provide additional detail on the State environmental review process, including treatment of actions that involve trans-boundary environmental impacts. In addition to the review processes, the draft law provides guidance on the content of documentation to be submitted and considered during the State environmental reviews. The draft law's definition of *Fundamental Document* includes the draft of a concept or program that has likely impacts and which is subject to adoption by legislative, institutional and local government legal acts. As such, this Environmental Background Information Document, or successor documents based on it, will be considered a *Fundamental Document* for the purposes of state environmental review. The proposed requirements and guidance of this draft law are reflected in the matrix provided in Appendix 1.3A.

1.3.1.1.2 Law on Protection and Use of Historical and Cultural Immovable Monuments and Historic Sites [1.3-7]

Construction designs and designs for transportation routes for making construction and other activities in the areas having historical monuments shall be coordinated with the authorized body (Ministry of Culture). If activities specified may damage monuments in those areas, arrangements (exploration, restoration, in exclusive cases replacements and other activities recommended by the authorized body) ensuring protection of monuments shall be implemented beforehand at the expense of the client of activities. (Article 22)

1.3.1.1.3 Energy Law [1.3-10]

This Law regulates the relationships between the government bodies, legal entities of the energy sector operating under this Law, and consumers of electricity, thermal energy and natural gas in the Republic of Armenia.

Nuclear energy, its effect on the environment, and related safety issues are regulated pursuant to international treaties and the legislation of the Republic of Armenia (Article 6, ¶ 2).

1.3.1.1.4 Law on Seismic Protection [1.3-15]

This law prescribes basic requirements for seismic protection in the Republic of Armenia and regulates the relations connected with them.

If under international agreement in the field of seismic protection, established standards differ from standards established under the legislation, the standards of international agreement are applied. (Article 1)

Although this Law will be most applicable to the project Safety Analysis Report (SAR), it defines the magnitude of a strong earthquake (Article 2, ¶1) and sets requirements on

seismic risk assessment (Article 14) that relate to the geological environment applicable to the proposed project.

1.3.1.1.5 Law on Licensing [1.3-12]

This Law specifies types of activities subject to licensing and regulates the relations connected to the licensing. Although the Law is primarily concerned with licensing of commercial activities, it addresses "… control over person who carry out activities threatening the life, health, property, state and public interests, nature protection and cultural heritage." (Article 5, ¶4)

Article 11 of the Law addresses environmental protection, hygienic and sanitary-epidemiological safety, compliance with firefighting standards and regulations. Paragraph 2 of Article 11 stipulates that:

> "The authorized state governmental bodies shall specify the lists of norms and rules on environmental protection, hygiene and sanitary epidemiological safety or fire safety, the requirements of which must be complied with for each type of activity subject to licensing. … The licensor shall provide the licensee with the list of norms and rules subject to mandatory observation appended with the license."

Article 8, ¶2 lists a number of institutions, including the Government of Armenia and ministries and agencies authorized by the Government that issue licenses. Article 43 lists the types of activities subject to licensing, including the types of activities in the Nuclear Power sector.

1.3.1.1.6 Law on Safe Utilization of Atomic Energy for Peaceful Purposes32 [1.3-9]

This Law specifies relations in state regulation of atomic energy utilization field, safety of nuclear facilities and other relations in atomic energy utilization with the purpose to protect personnel, public and environment as well as the safety related interests of the Republic of Armenia. As a law applying to NPPs, it is applicable to the environmental impact assessment process; however, it deals primarily with issues unrelated to environmental assessment. Key provisions that do relate to environmental impact assessment are indicated, as follows:

Article 2 of the Law directs that the GoA and state authorities are to ensure compliance with requirements of international treaties of the RoA and safety standards of the International Atomic Energy Agency (IAEA).

Article 6 of the Law, paragraph 1, stipulates that "Nuclear facilities and nuclear materials are the property of the RoA", but that after entering of the Law into force, nuclear materials and nuclear installations may be the property of legal (private) entities.

Article 7 of the Law, specifies the jurisdiction of the Government of Armenia, including to:

l) approve the list of activities and positions important in terms of safety submitted by the regulatory authority;

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[32] [As of December 2007, this Law was under review and revision by ANRA (now the State Committee for Regulation of Nuclear Safety). When enacted, the revised Law should be reviewed and this section of the Environmental Background Information Document updated accordingly.]

m) guarantee the fulfillment of international commitments made by the Republic of Armenia pursuant to international treaties in the field of atomic energy utilization which it has ratified;

n) co-ordinate the international activities performed by the Republic of Armenia in the field of atomic energy utilization.

Article 17 indicates that the regulatory authority shall implement environmental monitoring and control (item 1.w).

Article 18 of the Law, paragraph 1.a, states that the regulatory authority grants licenses for site selection, designing construction, commissioning, and operation and decommissioning of nuclear facilities.

1.3.1.1.7 The Water Code [1.3-14]

The Water Code, in Chapters 4 and 5, provides for water use permits and water system use permits, respectively. Article 20 requires notification of the public and public participation regarding pending water use permits.

1.3.1.1.8 The Land Code [1.3-11]

The Land Code indicates that the Government of Armenia (GoA) shall possess and dispose of State-owned land and shall exercise control over their use and preservation (Article 2). The territory of ANPP is state property. Among other things, Article 2 specifies that the GoA approves land use plans of local communities, and is in charge of the Land Cadastre. Article 3 outlines the powers of local community self government organizations to: develop land use plans, collect land payments, and support implementation of measures for environmental protection.

Article 24 states that *lands of special importance* include lands with defense, border, military importance and the land allocated for the use and services of constructions protected by law. Regulations on allocation and use of the land of special purposes and encumbrances to it, protection zones, provisions of special regulation, regulations on conducting urban development shall be prescribed by the Government of the Republic of Armenia. According to Ministry of Energy, ANPP territory is classified as land of special importance.

Articles 19 and 20 address specially preserved lands and ecological lands. Article 23 addresses land of historical and cultural designation. Article 26 addresses land of water management, including land occupied by hydro-technical and water management structures, such as the water pump intake structures for ANPP. Procedures for use of water lands are to be established by the Land Code and the Water Code. Article 37 specifies that negative effects on land shall be assessed on the bases of the complex of activities, as well as on the basis of environmental, sanitary hygiene and other assessments.

1.3.1.1.9 Law on Local Self Government [1.3-13]

This Law addresses local self government. Article 16, item 27, lists one of the powers of the Community Council to be approval of master plans for land use and zoning. Article 34 assigns the Chief of a Community to collect land taxes for land within the administrative boundaries of the community. Article 37 assigns the Chief of Community to develop the community lands zoning and use schemes and to obtain agreement from the Regional

Governor (Marzpet). This article also indicates that the Chief of Community issues permits for construction and demolition activities.

1.3.1.1.10 Law on Procurements [1.3-16]

This Law specifies the procedures for procurements by state governing and local self-governing bodies, state and community institutions, state and community non-commercial organizations and organizations having more than 50 percent of shares owned by the state or communities. If ANPP Unit 3 will be the property of the GoA, procurement of equipment and services, including consultation on environmental impact assessment preparation, would be subject to this Law.

1.3.1.1.11 Law on the National Water Program [1.3-18]

This law regulates the relations regarding the definition and implementation of the National Water Program of the Republic of Armenia. The National Water Program, based upon the preconditions of limited quantity of water, is one of the basic means for protecting human life and health, fauna and flora and its availability. Articles 11 through 15 define water systems of Special State Significance, applicable to the water systems supplying the ANPP site. Article 27 assigns the State authorized environmental body to define measures for preventing negative impacts on water ecosystems. Article 36 requires state authorized bodies to ensure public notification of the public on water related activities.

The Annex to this law defines a phased program of measures for implementation of the National Water Program. One of the short-term measures, to be completed before 2010, includes development of criteria and guidelines for environmental impact assessment, as part of water use permit application process.

1.3.1.1.12 Law on Air Protection [1.3-2a]

This Law provides for: development of norms for maximum permissible value of emissions to atmosphere and corresponding procedures for development of these norms; and adoption of procedures on protection of air and monitoring of air quality, as well as procedures on fees to be collected for air pollution. The Law stipulates that emissions to air from immovable objects are allowed only upon permission from the authorized body. It also states that the owner of the facility that may affect the atmosphere should develop and present economic, technical, organizational and other measures to mitigate adverse effects of the facility's operation and to meet requirements of the emission permit.

1.3.1.1.13 Law on Protection of Plant Life [1.3-9a]

This Law provides policy statements on protection, preservation, use and cultivation of plants in the RoA. Objectives of the Law include: to ensure diversity of plant life, as well as water and land protection; and, to guarantee implementation of special protection measures while using places of plants' habitat for economical purposes. The Law prohibits non-normalized utilization of chemical, mineral and other fertilizers.

1.3.1.1.14 Law on Protection of Fauna [1.3-9b]

This Law defines the state policy on protection, maintenance, reproduction and use of the wild species in the Republic of Armenia. Wild animal species (invertebrate or vertebrate) living in restricted or semi-restricted areas of the natural environment, their coexistence, location, migration ways and nesting areas are considered the objects of fauna protection within this Law.

1.3.1.2 RESOLUTIONS OF THE GOVERNMENT OF ARMENIA[33]

The Government of Armenia issues Resolutions (sometimes translated as "decision" or "decree") providing approval of processes and practices. A number of these have applicability to the environmental impact assessment process.

1.3.1.2.1 Resolution № 67 "On Approval of the Technical Regulations of Standards for Composition of Atmospheric Emissions and Control Methods" [1.3-20]

This Resolution defines the classification of atmospheric emissions by composition and maximum permitted emission of hazardous materials from the atmosphere-polluting sources, calculation and monitoring methods. It addresses releases of general compositions such as soot and dust, as well as specific compounds such as acids, alkali, mercury, and lead. (The resolution does not apply to emissions containing radioactive materials.)

1.3.1.2.2 Resolution № 98 "On Approval of the List of Animals of the RoA Red Book of Animals and the List of Plants of the RoA Red Book of Plants" [1.3-22]

This Resolution approves the list of animals of the RoA Red Book of Animals and the list of plants of the RoA Red Book of Plants as appendices 1 and 2 of the Resolution and requires the Ministry of Nature Protection to develop an action plan for study and protection of species in these Red Books. These species, if present in impacted areas, should be directly addressed by the environmental impact assessment.

1.3.1.2.3 Resolution № 160 "On Approval of Norms for Maximum Allowable Concentrations (MAC, mg/m3) of Emissions to the Atmosphere in Residential Areas" [1.3-23]

This Resolution establishes maximum allowable concentrations for non-radioactive pollutants released in residential areas.

1.3.1.2.4 Resolution № 192 "On Approving the Procedure on Issuance of a Permit for Allowed Quantity of Pollutants and Emissions into Atmosphere" [1.3-24]

This Resolution establishes the procedure for atmospheric release permits issued by the Ministry of Nature Protection. It also provides for coordination with the Ministry of Health in setting of standards for atmospheric emissions.

1.3.1.2.5 Resolution № 218 "On Approval of a Water Use Permit Standard Form and Water Use Permitting Standard Forms" [1.3-26]

This Resolution specifies the permit application forms for water use. Some data necessary for this form is common to that required for the environmental impact assessment. If such data are available for existing power units, they could be useful in determining appropriate values for a new facility.

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[33] {GoA Resolutions are constantly subject to revision or supersession and issuance of newly enacted Resolutions. This section should be updated to reflect those Resolutions in effect at the time the final environmental assessment report is prepared.}

1.3.1.2.6 Resolution № 313 "On Approving the Dimensions of Safety Zones and their Utilization Procedures for Energy Sector Facilities" [1.3-27]

This Resolution establishes safety zones that apply to transmission lines in excess of 1kV, such as those that connect the ANPP to the high voltage transmission system.

1.3.1.2.7 Resolution № 400 "On Approval of the Licensing Procedure and License Form for Operation of Nuclear Installations" [1.3-29]

This resolution establishes the licensing procedure and form for nuclear installations, including nuclear power plants. Operating licenses for nuclear installations are granted for a 10-year period. The application must be accompanied by documentation on: financing of specified items, including safety features, physical protection, storage of used nuclear fuel, and decommissioning; a safety analysis report in accordance with GoA Resolution № 2013; a report on probabilistic safety; a program for ensuring quality; and a physical protection plan (Attachment 1, Article 7).

1.3.1.2.8 Resolution № 592 "On Approval of the Procedure for Determination of Permitted Marginal Volumes of Unrecoverable Water Withdrawal for Each Water Resource in the Section of Ecological Discharges and Surface Flow" [1.3-34]

This resolution establishes the process of determination of permitted marginal volumes of unrecoverable water withdrawal for water use purposes per each water resource in the section of ecological discharges and surface flow. This will apply to plant withdrawal of water from the Sevjur River and any other sources used for the new unit.

1.3.1.2.9 Resolution № 609 "On Approval of the Procedure for Development, Expertise, Agreement, Approval and Modification of Master Plans for the RoA Urban and Rural Communities" [1.3-35]

This resolution establishes the procedures and requirements for changes in urban development plans, zoning plans, and construction approvals by city and village communities. Should construction of ANPP Unit 3 require changes to plans or construction subject to approval by local communities, then this Resolution will apply.

1.3.1.2.10 Resolution № 609-N "On Approval of the Licensing Procedure and License Form for Selection of the Site for Nuclear Installations" [1.3-35a]

This resolution establishes the procedures and content of applications for licensing a site selected for a nuclear installation. The application must be accompanied by information related to site suitability (e.g. geological, meteorological, and hydrological conditions, etc.) and environmental impacts of the proposed installation.

1.3.1.2.11 Resolution № 612 "On Approval of Procedures for Provision of Information on Trans-Boundary Water Resources" [1.3-36]

This Resolution specifies provision of information on water uses and quality to various commissions and ministries. The Resolution could be useful in identifying sources of information on the existing water resources to be described in the environmental impact assessment report.

1.3.1.2.12 Resolution № 640 "On Approval of Procedures for Organization and Implementation of Safety Examination in the Field of Nuclear Energy Use" [1.3-37]

Part I of the Resolution provides for safety examination in the field of nuclear energy use. It refers to an attached list of documents subject to mandatory examination by/on behalf of the nuclear regulatory authority (¶ 2). The examination is to be conducted by the nuclear regulator's Expert Organization, "Nuclear and Radiation Safety Center" SCJSC (¶ 5).

Part II of the Resolution outlines the procedure for conducting the examination, including preparation of a technical proposal by the licensee (¶ 6) and signing of a contract between the licensee and the Expert Organization (¶ 7).

The attachment to the Resolution specifies that documents verifying the safety of selection of sites for nuclear installations are subject to examination (item 4.a); although not explicitly listed, this probably includes the environmental report for a new NPP.

1.3.1.2.13 Resolution № 768 "On Approval of the List of Important Activities and Positions from Safety Point of View in Atomic Energy Use Sphere" [1.3-39]

This Resolution expands on the Law on Safe Utilization of Atomic Energy, Article 7-I by specifying a list of important activities from safety point of view.

Appendix 1 identifies safety important activities. Item 3 on this list is "Selection of site for nuclear and radioactive waste installations."

1.3.1.2.14 Resolution № 1060 "On Approval of the Procedure for Registration of Documents with State Water Cadastre and Provision of Information" [1.3-45]

This Resolution establishes a State Water Cadastre to develop a database of information and store of documents related to management and maintenance of hydro-technical constructions contributing to the use of water resources. {The State Water Cadastre, then, should be a major source of information related to current water uses.}

1.3.1.2.15 Resolution № 1064 "Procedure for the Establishment and Ensuring Operation of the System of Permanent Control Over the Radiation, Chemical and Bacteriological Environment" [1.3-46]

This resolution and its attachment define a procedure for control over (monitoring and supervision of) the state of radiation, chemical and bacteriological environment. As such, it relates to the impacts of radiation and chemical releases from the ANPP. It has provisions for qualitative indication of the pollution of the environment (soil, air, water, plant cover, food and fodder), for quantitative measurement of radioactive and chemical pollutants in the environment and for taking measures for protection of the population.

1.3.1.2.16 Resolution № 1182 "On Approval of Procedure for Control of Impacts on Water Resources in Watersheds and Wetlands" [1.3-48]

This Resolution and its attachment define a procedure for control of impacts on water resources in watersheds and wetlands, a key topic also for the environmental impact assessment report. Item 6 of the attachment specifies that the Ministry of Nature Protection is responsible for control of impacts and collection of data related to quality and quantity parameters of water resources (surface and ground waters), flow formation zone, flora and fauna and their natural habitats, and the assessment of natural and anthropogenic impacts on water resources of specially protected areas.

1.3.1.2.17 Resolution № 1219 "On Approval of Norms of Radioactive Safety" [1.3-49]

This Resolution and its appendix define Norms that ensure minimum risks of present and future human generations from harmful effect of ionizing radiation. Chapter III (Arts. 15 to 26) provides limits for radiation exposure of nuclear plant workers under normal (non-emergency) conditions. Chapter V (Arts. 31 to 43) provides exposure limits for the public under normal (non-emergency) conditions, including volumetric activity limits for drinking water (Art. 41).

1.3.1.2.18 Resolution № 1231 "On Approval of Conceptual Approach for Strengthening Physical Protection and Maintenance of Armenian Nuclear Power Plant and Nuclear Materials as Well as Rules of Physical Protection of Nuclear Installations and Nuclear Materials" [1.3-50]

This Resolution deals with physical protection of nuclear installations against acts of terrorism.

The Resolution includes a requirement for an assessment of the harm caused by possible acts of terrorism (Appendix 2, Rule 21.c), essentially establishing such as a design basis event for determining environmental impacts.

1.3.1.2.19 Resolution № 1263 "On Approval of Special Rules for Transportation of Nuclear and Radioactive Materials" [1.3-51]

This Resolution approves special rules for transportation of nuclear and radioactive materials. As such, it regulates one of the activities to be described in the environmental impact assessment report, specifically transportation of radioactive materials. {If nothing else, Section 3 of the Special Rules specifies limits of radioisotope activity and restrictions on radioactive materials that could be used as starting points for assessment of transportation event impacts.}

1.3.1.2.20 Resolution № 1489 "On Approval of Rules of Radioactive Safety" [1.3-52]

This resolution establishes limits on radiation exposures of personnel and rules for siting and conduct of operations at objects of nuclear energy use (e.g., NPPs, waste sites, etc.). This Resolution is fully applicable to the assessment of radiation impacts on workers, the public, and the environment.

1.3.1.2.21 Resolution № 2013 "On Approval of the Requirements to the Structure and Content of the Safety Justification Report of the Armenian Nuclear Power Plant (ANPP) and Power Unit 2" [1.3-55]

This Resolution and its attachment specify the structure and content of the safety justification for ANPP and power unit 2. One can assume that similar requirements will apply to safety justification (or safety analysis) of a new facility. In addition, the indicated content of the ANPP Safety Justification Report can serve as a roadmap to information that could be used for the environmental impact assessment of a new facility, especially if it is sited in the same location.

The Attachment to the Resolution, Section 6.1.4, specifies details that must be provided about the plant site. Section 6.5.11.6 requires an assessment of environmental impacts under conditions of power unit normal operation, failure and emergency. {The ANPP Safety Justification Report may be a useful source of information on potential environmental impacts of a new power plant.}

1.3.1.2.22 Resolution № 2183 "On Approval of Statute and Structure of the Regulatory Inspectorate for Nuclear and Radiation Safety (ANRA) Within the Administration of the Ministry for Nature Protection" [1.3-33]

By this resolution authorization of the regulatory body of the nuclear use sector shall be vested in the State Regulatory Inspectorate of Nuclear and Radiation Safety of the RoA Ministry of Natural Protection (ANRA). Item 8-b) of this Resolution defines one of the key functions of ANRA that is licensing of physical entities that implement activities or occupy positions that are crucial in terms of nuclear energy use sector or safety provision.

1.3.2 International Conventions and Protocols

1.3.2.1 CONVENTION ON ENVIRONMENTAL IMPACT ASSESSMENT IN A TRANSBOUNDARY CONTEXT (ESPOO, 1991) [1.3-60]

This United Nations Economic Commission for Europe (UNECE) Convention provides agreement on use of environmental impact assessments in order to prevent, reduce and control significant adverse transboundary environmental impact from proposed activities. It establishes an environmental impact assessment procedure that provides for notification of concerned parties and public participation (Article 3) and consultation of affected parties (Article 5) prior to taking a decision to authorize proposed activities that could have a significant impact preparation of the environmental impact assessment documentation.

The Espoo Convention entered into force on 10 September 1997. Armenia acceded to the Convention on 21 February 1997 and thus is bound to follow it. Of Armenia's neighboring countries, however, only Azerbaijan is a party to the Convention.[34]

In the spirit of the Espoo Convention, the Government of Armenia could extend the courtesies of notification and consultation to neighboring countries of Turkey, Iran and Georgia as if they were parties to the Convention. {If no impacts are predicted for Iran or Georgia, it could be concluded that they need not be consulted or notified; however, since Turkish territories lie within 30 km of the site, and Turkey shares rights to the Araks river that will be impacted by water use by and discharges from the new unit, Turkey should be notified and consulted as part of the environmental impact assessment process.} In any case, the content of the environmental impact assessment report should comport with the requirements of the Convention.

Appendix I to the Convention provides a list of activities that should be subject to environmental assessment, including: "Thermal power stations and other combustion installations with a heat output of 300 megawatts or more and nuclear power stations and other nuclear reactors" (¶ 2). (Note: Amendment 2 to the Convention, adopted in 2004, would expand this to include dismantling or decommissioning of such power stations and thus would also apply to D&D of current ANPP units.)

Appendix II to the Convention defines minimum set of information that should be included in the environmental impact assessment documentation. In addition, Article 5 includes consideration of alternatives to the proposed activity.

[34] Status confirmed on 3 September at: http://www.unece.org/env/eia/convratif.html.

1.3.2.2 CONVENTION ON NUCLEAR SAFETY [1.3-63]

Armenia has ratified the Convention on Nuclear Safety. Article 17 provides that each party to the convention take appropriate steps to ensure establishment and implementation of procedures for siting of nuclear facilities, including assessment of impacts on the facility safety and impacts of the facility on its territory.

1.3.2.3 PROTOCOL ON STRATEGIC ENVIRONMENTAL ASSESSMENT "SEA PROTOCOL" (KIEV, 2003) [1.3-61]

This Protocol, as an adjunct to the Espoo Convention, defines the framework for conducting strategic environmental assessments (SEA). Armenia was a participant in and signed the Protocol. Georgia was also a participant, but Turkey, Iran and Azerbaijan were not. (Note: the Protocol is not yet in force, with only 6 out of a minimum of 16 countries having ratified, accepted, approved, or acceded to it.)

Strategic environmental assessment is defined as the evaluation of the likely environmental, including health, effects that comprises the determination of the scope of an environmental report and its preparation, the carrying out of public participation and consultations, and the taking into account of the environmental report and the results of the public participation and consultations in a plan or program. Strategic environmental assessment is undertaken much earlier in the decision-making process than project environmental impact assessment, and it is therefore seen as a key tool for sustainable development. SEA is hierarchically at a higher level than environmental impact assessment, i.e., a country's overall energy development program would be subject to SEA, where individual energy projects would be subject to environmental impact assessment. Nevertheless, the Protocol provides some key elements that should be considered in defining the content of the environmental impact assessment report for a new project.

1.3.2.4 CONVENTION ON ACCESS TO INFORMATION, PUBLIC PARTICIPATION IN DECISION-MAKING AND ACCESS TO JUSTICE IN ENVIRONMENTAL MATTERS (AARHUS, 1998) [1.3-65]

This United Nations Economic Commission for Europe (UNECE) Convention sets principles to contribute to the protection of the right of every person of present and future generations to live in an environment adequate to his or her health and well-being, by guaranteeing the rights of access to information, public participation in decision-making, and access to justice in environmental matters. Armenia ratified this Convention in August 2001. Georgia and Azerbaijan are parties to the Convention, but Turkey and Iran are not.

Article 3 of the Aarhus Convention identifies principles to: promote environmental education and environmental awareness among the public; support associations, organizations or groups promoting environmental protection; and public access to information and the possibility to participate in decision-making in environmental matters. Article 5 sets principles for collection and dissemination of environmental information, including making the information easily accessible to the public, and publication of facts and analyses of facts relevant and important in framing major environmental policy proposals. Article 6 outlines the parameters of public participation.

1.3.2.5 CONVENTION ON THE PROTECTION AND USE OF TRANSBOUNDARY WATERCOURSES AND INTERNATIONAL LAKES (HELSINKI, 1992) [1.3-66]

This United Nations Economic Commission for Europe (UNECE) Convention deals with protection of water resources involving transboundary uses. Armenia is not a party to this

Convention; neither is Georgia, Turkey, or Iran. Azerbaijan has accepted it, however. A new ANPP unit could impact, through water use and discharges, the transboundary water resources of the Araks and downstream rivers.

1.3.2.6 CONVENTION ON THE TRANSBOUNDARY EFFECTS OF INDUSTRIAL ACCIDENTS (HELSINKI, 1992) [1.3-73]

This United Nations Economic Commission for Europe (UNECE) Convention deals with protection of human beings and the environment from industrial accidents. Article 4, ¶4 states that when a hazardous activity is subject to an environmental impact assessment, that assessment should include an evaluation of the transboundary effects of industrial accidents from the hazardous activity.

1.3.3 International Standards and Guidelines

1.3.3.1 INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)

Armenian laws and resolutions reflect intent to meet IAEA standards where possible. It can be assumed that IAEA guidelines are also acceptable to the Government of Armenia. International financing institutions (see following section) also refer to IAEA standards as setting requirements that must be met for nuclear facilities. It should be noted that IAEA guidance documents, though often providing guidelines for meeting IAEA requirements documents, are not in and of themselves “standards” and therefore may not be considered mandatory requirements under GoA laws and resolutions or financial institution guidelines.

Although most of the IAEA requirements and guidance deal with nuclear safety, they often provide insight or useful tools that can be incorporated into environmental assessment activities.

1.3.3.1.1 Safety Requirements NS-R-3, “Site Evaluation for Nuclear Installations” [1.3-100]

These Requirements are intended to ensure adequate protection of site personnel, the public and the environment from the effects of ionizing radiation arising from nuclear installations. As such they are useful in evaluation of the affects of radiation and radioactive materials, as opposed to water use, land use, socioeconomics, etc.

NS-R-3 follows the relationship between principles and objectives of safety, and establishes safety requirements and criteria. Section 2 provides the general safety criteria for site related evaluation of external natural and human induced hazards to the nuclear installation. It also establishes requirements relating to the effects of the installation on the region and matters relating to population and emergency planning. Section 3 establishes specific requirements for the characterization of hazards for natural and human induced events. Section 4 establishes specific requirements for site related evaluation of the effects of the installation on the regional environment, the atmosphere, the hydrosphere and biosphere, and the population. Applicable sections are identified, as appropriate, in the attached matrix.

Section 6 establishes requirements for a quality assurance (QA) program for site evaluation. QA is not addressed in the EBID outline, but to the extent that the environmental impact assessment process will be used as part of site selection, environmental impact assessment report development should address the following key requirements of NS-R-3:

- An adequate quality assurance program shall be established to control the effectiveness of the execution of the site investigations and assessments and engineering activities performed in the different stages of the site evaluation for the nuclear installation.
- The quality assurance program should be established at the earliest possible time consistent with its application in the conduct of site evaluation activities for the nuclear installation.
- The results of the activities for site investigation should be compiled in a report that documents the results of all in situ work, laboratory tests and geotechnical analyses and evaluations.
- The results of studies and investigations shall be documented in sufficient detail to permit an independent review. (This is particularly important since much of the information may be historical in nature and/or the results of academic research that has not been subject to a formal quality assurance program.)
- The process of establishing site related parameters and evaluations involves technical and engineering analyses and judgments that require extensive experience and knowledge. In many cases the parameters and analyses may not lend themselves to direct verification by inspections, tests or other techniques that can be precisely defined and controlled. These evaluations shall be reviewed and verified by individuals or groups (e.g. by peer review) who are separate from those who did the work.

(Current IAEA requirements for management systems for nuclear facilities and activities, including quality assurance, are embodied in Safety Requirements Document GS-R-3 [1.3-116].)

1.3.3.1.2 Safety Guide NS-G-3.1, "External Human Induced Events in Site Evaluation for Nuclear Power Plants" [1.3-101]

This Safety Guide recommends actions, conditions and procedures and provides guidance for fulfilling the requirements of the Safety Requirements for Site Evaluation of Nuclear Installations, NS-R-3, that concern human induced events external to the plant.

1.3.3.1.3 Safety Guide NS-G-3.2, "Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants" [1.3-102]

This Safety Guide makes recommendations on how to meet the requirements of the Safety Requirements for Site Evaluation of Nuclear Installations, NS-R-3, on the basis of knowledge of the mechanisms for the dispersion of effluents discharged into the atmosphere and into surface water and groundwater. Relevant site characteristics and safety considerations are discussed.

1.3.3.1.4 Safety Guide NS-G-3.3, "Evaluation of Seismic Hazards for Nuclear Power Plants" [1.3-103]

This Safety Guide provides guidelines and recommends procedures for the evaluation of seismic hazards for nuclear power plants. It supplements the Safety Requirements publication on Site Evaluation for Nuclear Facilities, NS-R-3.

The Guide takes into account the following: the need for hazard curves for the probabilistic safety assessment (PSA) of external events for new and existing nuclear facilities; feedback from IAEA reviews of seismic studies for nuclear facilities performed over the past decade; collective knowledge of the effects of significant recent earthquakes; and new approaches in methods of analysis.

1.3.3.1.5 Safety Guide NS-G-3.4, "Meteorological Events in Site Evaluation for Nuclear Power Plants" [1.3-104]

The purpose of this Safety Guide is to provide recommendations and guidance on conducting hazard assessments of extreme and rare meteorological phenomena. This Safety Guide provides interpretation of the Safety Requirements publication on Site Evaluation for Nuclear Facilities (NS-R-3) and guidance on how to fulfill these requirements.

1.3.3.1.6 Safety Guide NS-G-3.5, "Flood Hazard for Nuclear Power Plants on Coastal and River Sites" [1.3-105]

This Safety Guide provides recommendations on how to meet the requirements established in the Safety Requirements publication on Site Evaluation for Nuclear Installations (NS-R-3) in respect of the flood hazard to be used in site evaluation for nuclear power plants on coastal and river sites. Measures for the protection of nuclear power plant sites against floods and the strategy for monitoring sites are also discussed.

1.3.3.1.7 Safety Guide NS-G-3.6, "Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants" [1.3-106]

This Safety Guide supplements the Safety Requirements publication on Site Evaluation for Nuclear Installations (NS-R-3) and provides an interpretation of the Safety Requirements and guidance on how to implement them.

1.3.3.1.8 INSAG-12, "Basic Safety Principles for Nuclear Power Plants" [1.3-111]

This report of the International Safety Advisory Group (INSAG) provides a statement of the objectives and principles of safe design and operation for electricity generating nuclear power plants. Section 4.1 (¶¶ 134-143) provides principles and objectives related to siting of a nuclear plant, including: § 4.1.1, external factors affecting the plant; § 4.1.2, radiological impact on the public and the local environment; and § 4.1.4, Ultimate heat sink provisions.

1.3.3.1.9 Safety Series No. 111-F "The Principles of Radioactive Waste Management" [1.3-108]

This IAEA publication defines the objective of radioactive waste management and the associated set of internationally agreed principles. The objective of radioactive waste management is to deal with radioactive waste in a manner that protects human health and the environment now and in the future without imposing undue burdens on future generations.

Principle 1 (¶¶ 304-307) addresses protection of human health. Principle 2 (¶¶ 308-311) addresses protection of the environment. Principle 3 (¶¶ 312-314) addresses protection beyond national borders. Principle 4 (¶¶ 315-316) and Principle 5 (¶¶ 317-320) addresses protection of and burdens on future generations.

1.3.3.1.10 Safety Standards Series WS-R-2, "Predisposal Management of Radioactive Waste, Including Decommissioning" [1.3-110]

The objective of this Safety Requirements publication is to establish the basic requirements that must be satisfied in predisposal management of radioactive waste from operations, decommissioning and cleanup, and the requirements governing the decommissioning of nuclear facilities. Section 2 sets basic principles for protection of human health and the environment in radioactive waste management activities. Section 5 sets principles and requirements for radioactive waste management systems. Section 6 establishes requirements for decommissioning. Section 7 sets requirements for safety and environmental assessments of activities and facilities.

1.3.3.1.11 Safety Series SS 110, "The Safety of Nuclear Installations" [1.3-107]

The purpose of this Safety Series publication is to define those fundamental safety principles which, when effectively applied, contribute to the reduction to very low levels of any detrimental effects from the use of nuclear technology. Section 5 deals with technical aspects of safety, including siting (¶ 501).

1.3.3.1.12 Safety Series SS 115, "International Basic Safety Standards for Protection against Ionizing Radiations and for the Safety of Radiation Sources" [1.3-109]

The purpose of the Basic Safety Standards is to establish basic requirements for protection against the risks associated with exposure to ionizing radiation and for the safety of radiation sources that may deliver such exposure. The Standard contains schedules that set limits and dose constraints for exposure to radiation that must be met in activities associated with nuclear power production and waste management.

1.3.3.1.13 Safety Report SR 19, "Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment" [1.3-114]

This safety reports series publication provides a practical generic methodology for assessing the impact of radionuclide discharges in terms of the resulting individual and collective radiation doses. The approaches given in this report are appropriate for estimating impacts of radioactive releases on humans and the environment.

1.3.3.1.14 INSAG-20, "Stakeholder Involvement in Nuclear Issues" [1.3-112]

This report of the International Nuclear Safety Advisory Group (INSAG) makes general recommendations about involvement of stakeholders in decision making regarding new nuclear facilities and shutdown and dismantling of existing facilities. It recommends early and comprehensive notification and involvement of stakeholders, both internal to the decision making organizations and external (e.g. the public).

1.3.3.2 U.S. NUCLEAR REGULATORY COMMISSION (US NRC)

U.S. Nuclear Regulatory Commission documents are often used as guidelines or models for nuclear regulation in other countries. The following documents are of use in environmental assessment.

1.3.3.2.1 NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants" [1.3-120]

This document provides guidance to the NRC staff in implementing provisions of U.S. law 10 CFR 51, "Environmental Protection Regulations for Domestic Licensing and Related

Regulatory Functions," related to new site/plant applications. The NUREG consists of a set of Environmental Standard Review Plans, or ESRPs. {This section of the EBID and the attached Appendix 1.3A use the organization of the NUREG as a format and the "areas of review" identified in each of the corresponding ESRPs were used as guideline for content of this EBID.}.

1.3.3.2.2 Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations" [1.3-121]

This Regulatory Guide (available at: http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/active/04-007) is intended to assist in the initial stage of selecting potential sites for a nuclear power station. This guide provides a general set of safety and environmental criteria that the NRC staff has found to be valuable in assessing candidate site identification in specific licensing cases. It covers key topics such as: geology and seismology; atmospheric extremes and dispersion; exclusion area and low population zone; population considerations; emergency planning; hydrology; industrial, military and transportation facilities; ecological systems and biota; land use; and socioeconomics. These topics are also addressed by NUREG-1555, discussed above.

1.3.4 Environmental Assessment Policies and Guidelines of International Financing Institutions

It can be assumed that if Armenia is to develop a new nuclear unit project, international funding will be used to accomplish the project, in whole or in part. Decisions on funding of major projects influence governmental decisions that can impact the environment, therefore international organizations that provide or manage funding for such projects have requirements to assess impacts prior to granting loans or other means of funding. These requirements can be used to also define appropriate content for an environmental impact assessment report in order that the report can support funding decisions as well as governmental decisions. In addition, a number of the key financial institutions have published guidelines for environmental assessment. This guide was applied in completion of EBID Chapter 8.

1.3.4.1 EXPORT IMPORT BANK OF THE UNITED STATES (EX-IM BANK)

Information requirements for transactions on nuclear power projects by the Ex-Im Bank are contained in a separate document, Ex-Im Bank Nuclear Procedures and Guidelines. If the Ex-Im Bank is or may be involved in the funding of the project, their Nuclear Procedures and Guidelines must be followed. For projects where the European Bank for Reconstruction and Development (EBRD) is involved, the Ex-Im Bank may apply EBRD guidelines. Where the EBRD guidelines are insufficient to adequately consider the potential environmental effects of the project, applicable elements of the IAEA guidelines and the World Bank guidelines will be used to supplement the EBRD guidelines. (See discussion of World Bank and EBRD guidelines, below.) Nuclear projects should, in all cases, comply with the relevant environmental standards of the host country, and when the applicable international nuclear and environmental guidelines against which the project has been evaluated are more stringent, these guidelines will apply.

Annex C of the Ex-Im Bank Nuclear Procedures and Guidelines [1.3-80] describes the type of information about the environmental effects of a project that should be contained within an acceptable environmental impact assessment report, based on the World Bank Operational Manual, OP 4.01 (see next).

1.3.4.2 WORLD BANK

The World Bank is a source of financial and technical assistance to developing countries around the world. The World Bank currently does not finance nuclear projects; however their procedures for environmental assessment, such as OP 4.01, discussed below, are often relied upon by other financial institutions. The World Bank is made up of two development institutions owned by 185 member countries—the International Bank for Reconstruction and Development (IBRD) and the International Development Association (IDA). If involved in financing of a new unit at ANPP, IBRD is the entity that would be involved.

1.3.4.2.1 World Bank Operational Manual, OP 4.01, Environmental Assessment [1.3-82]

The World Bank Operational Manual, OP 4.01, Environmental Assessment, sets the Bank's policy requirements for environmental assessment of projects.

Annex B to OP 4.01 describes the content of an environmental assessment for projects such as a new NPP, including (following is brief summary, see full Annex for more detail on content):

- An Executive Summary that concisely discusses significant findings and recommended actions;
- Discussion of policy, legal and administrative framework within which the environmental impact assessment is carried out;
- A description of the proposed project and its geographic, ecological, social, and temporal context;
- Baseline data relevant to decisions about project location, design, operation, or mitigatory measures;
- Prediction and assessment of environmental impacts, mitigation measures and any residual negative impacts that cannot be mitigated;
- Systematic comparison of alternatives to the proposed project site, technology, design and operation – including the "without project" situation – in terms of their potential environmental impacts, the feasibility of mitigating these impacts, and their capital and recurrent costs;
- An Environmental Management Plan that describes mitigation, monitoring and institutional measures to be taken during construction and operation; and,
- A record of consultation meetings, including consultations for obtaining the informed views of the affected people, local non-governmental organizations and regulatory agencies.

Annex C to OP 4.01 identifies the content of an Environmental Management Plan.

1.3.4.2.2 Environmental Assessment Sourcebook [1.3-83]

The sourcebook (marked 1999 but originally promulgated in 1993, with updates on specific topics issued though 2002) provides additional detail beyond that given in OP 4.01. Much of the detail in this sourcebook provides guidance for activities internal to the World Bank organization, but it also includes guidance suitable for consideration in the environmental impact assessment process.

Chapter 1, Annexes B and C duplicate the same annexes in OP 4.01, as discussed above. Annex 1-3 provides a sample terms of reference for environmental assessment that includes specific tasks detailing the content of an environmental impact assessment report.

Chapter 2 includes substantial discussion of global impacts, including global warming, that may prove useful in discussion of alternatives to a new NPP.

Chapter 3 covers social and cultural issues in environmental assessment, including a section on "Cultural Property" that includes sites, structures, and remains of archaeological, historical, religious, cultural, or aesthetic value.

Chapter 4 provides guidance on economic analysis with consideration of environmental costs and benefits, dealing with the dilemma of assigning economic costs of environmental impacts for use in cost-benefit analyses.

Chapter 5 indicates that the Bank is committed to using the environmental impact assessment process as a means for strengthening environmental institutions and local capability to deal with environmental concerns and to integrate them into the identification, design and implementation of economic development activities. The chapter provides guidance and examples of successes in strengthening capabilities of local environmental laws, regulatory agencies, and support institutes.

1.3.4.3 INTERNATIONAL FINANCE CORPORATION

The International Finance Corporation (IFC) is a member of the World Bank Group. IFC provides loans, equity, structured finance and risk management products, and advisory services to build the private sector in developing countries. Since a new unit at ANPP would be a governmental project, it could not be a direct recipient of IFC funding; however, private sector companies participating in construction, operation, or maintenance of the new unit, could possibly receive IFC support.

1.3.4.3.1 IFC Environment and Social (E&S) Review Procedures [1.3-84]

These procedures are intended for application by IFC specialists in review of social and environmental impacts of projects proposed for financing or advisory assistance by the IFC and as such do not provide any information useful to the environmental impact assessment process.

1.3.4.4 EUROPEAN BANK FOR RECONSTRUCTION AND DEVELOPMENT (EBRD)

EBRD Environmental Procedures [1.3-85] describes EBRD's process and requirements for environmental assessment.

Section 2.2 of the Procedures identifies information needed by EBRD staff for conduct of a pre-concept review prior to accepting a project for consideration. This information ought to be assembled during preparation of the environmental impact assessment report, as well.

Section 2.5.2 describes the content of an Environmental Action Plan, also referred to as the Environmental Management Plan.

Section 2.6 describes the EBRD preparations for their internal final review before committing to a project. This includes some elements that, if included in the

environmental impact assessment report, might facilitate EBRD consideration of a new project.

Annex 2 is a sample table of contents for an environmental impact assessment report. The Annex states that in tailoring this generic table of contents for a given project, the Bank will take into account good practice guidance documents issued by other international institutions, such the European Union, the IAIA, and the MFI Environment Working Group.

1.3.4.5 EUROPEAN COMMISSION (EC)

1.3.4.5.1 Guidance on EIA Scoping [1.3-86]

This Guidance, referenced in EBRD Environmental Procedures, applies to EC Accession Countries (those which are seeking to become members of the European Union). Although Armenia is not an Accession Country, the guidance may be helpful in defining the content of the environmental impact assessment report for a new power plant.

This document is the second of three by the EC related to environmental assessment; the first defines a process for *screening*, by which a decision is taken on whether or not environmental impact assessment is required; this, the second, is the process of *scoping*, or identifying the content and extent of the information to be submitted to authorities; and the third defines the *review* process for establishing if the impact assessment/statement is adequate.

Scoping defines the scope of the environmental information to be submitted to the competent authority and the terms of reference for the environmental studies to be undertaken to compile that information. The EBID Planning task was essentially a scoping being conducted by the EBID team on behalf of the GoA. Part B of the Guidance outlines processes for consultation during the scoping stage. At the end of Part B is a Checklist of Information Needed for Scoping that could be of use in the environmental impact assessment process. Also provided are checklists that can be used during environmental impact assessment report preparation for: evaluating potential alternatives and mitigation measures; and evaluating the significance of impacts.

1.3.4.6 ASIAN DEVELOPMENT BANK ENVIRONMENTAL ASSESSMENT GUIDELINES [1.3-94]

The Asian Development Bank (ADB) currently does not finance nuclear projects, but that policy could be subject to change.

The Guidelines of the ADB are generally consistent with other financial institution guidelines. The guidelines are extensive and provide guidance in greater detail than many other guidelines, and, therefore, might be useful for development of specific studies to be incorporated into an environmental assessment report. Appendix 2 provides the ADB guidelines for format and content of an environmental impact assessment report. This is similar to other guides for environmental impact report format and content as reflected in the requirements matrix, but quite different from the NUREG-1555 format being used for this EBID. Paragraph 13 of the Appendix states: “ADB requests that the Borrower follow ADB-prescribed format for EIA”. Should the ADB be involved as a lender for the new NPP, agreement on environmental impact assessment report format should be reached, or at least a roadmap to illustrate where the ADP expected content resides in the final environmental impact assessment report for a new unit at ANPP.

1.3.4.7 EXPORT DEVELOPMENT CANADA (EDC) [1.3-95] AND [1.3-96]

Export Development Canada (EDC), Project Finance provides structuring expertise and direct financing of complex, large-scale global projects. This type of financing support is typically required when the project sponsor needs to build, expand or acquire a project.

A project sponsor with a project that demonstrates economic benefits to Canada can inquire about EDC's project financing solutions. The following documentation is required:

- a financial model clearly detailing the sources of revenue;
- market and feasibility studies;
- an insurance review;
- an independent engineer's report;
- an environmental assessment; and
- details of Canadian content and/or ownership (as applicable).

EDC's Environmental Policy [1.3-95] states that prior to agreeing to finance a project, evaluating the environmental impacts of projects that they may support, to ensure that these meet World Bank Group or other internationally accepted standards, or host country environmental standards, whichever is the more stringent.

EDC's Environmental Review Directive [1.3-96] sets out a systematic process EDC follows when assessing the environmental impacts of certain projects it is asked to support, requiring a determination of whether EDC is justified in supporting the project. In conducting environmental reviews, EDC will benchmark projects against one or more relevant environmental standards and guidelines published by the World Bank Group, the European Bank for Reconstruction and Development, the Asian Development Bank, any applicable safeguard policies published by the World Bank Group, or any higher international recognized environmental standards such as European Community standards. Annex 3 to the Environmental Review Directive outlines the content of an environmental impact assessment report, which is fully consistent with Annex B to OP 4.01 (Ref. [1.3-82]).

The EDC Environmental Review Directive is based on the OECD "Common Approaches on Environment and Officially Supported Export Credits" (Ref. [1.3-97]), which in turn is based in large part on World Bank Group guidelines. The Directive is also committed to implementation of the "Equator Principles" (Ref. [1.3-98]), which set out nine principles that projects must conform to for financing by Equator Principles Financial Institutions. The principles include:

- Categorization of the project based on the magnitude of potential impacts and risks;
- Conduct of a social and environmental assessment;
- Preparation of an action plan and management system to address the impacts and risks;
- Consultation with interested parties and disclosure of assessment results; and
- Independent review of the assessment by experts not directly associated with the borrower (project sponsor).

1.3.4.8 MULTILATERAL FINANCIAL INSTITUTION WORKING GROUP ON ENVIRONMENT (MFI-WGE)

1.3.4.8.1 "A Common Framework: Converging Requirements of Multilateral Financial Institutions" [1.3-92]

The Working Group on Environment of the Multilateral Financial Institutions (MFI-WGE) began development of a Common Framework for environmental assessment processes, with an initial focus on environmental impact assessment. The Framework describes common attributes of the environmental impact assessment process and identifies the expected content of an environmental impact assessment report. .

1.3.4.8.2 "A Common Framework for Environmental Assessment: A Good Practice Note" [1.3-93]

This Good Practice, Part II.A, describes the environmental impact assessment process in the same manner as the Common Framework document, stating that financial institutions should provide guidance to borrowers to understand the requirements regarding the environmental impact assessment process and review assessment documents and systems to ascertain if they will achieve the intended results.

Part II.B covers preparation of Environmental and Social Management Plans, or Environmental Action Plans, as an integral part of the environmental impact assessment process. The objective of the Plan is to describe mitigation and enhancement measures and monitoring requirements that are to be carried out in later stages of the project.

Part II.C covers terms of reference for preparation of the environmental impact assessment report.

Part II.D describes environmental audits of existing projects. This process could be used to assess the environmental impact of the existing ANPP as an indicator of the potential impacts of a new facility.

Part III of the Good Practice provides guidelines for addressing impacts during environmental assessment, covering:

a) pollution control and management;
b) toxic and hazardous substances control and management;
c) natural habitats and biodiversity conservation;
d) physical cultural property;
e) directly affected communities;
f) vulnerable groups;
g) land acquisition and resettlement; and
h) worker health and safety.

SOURCE DOCUMENT LISTING

Source documents considered during preparation of this EBID (those with bolded document numbers, e.g., **[1.3-1]**, are reflected in the matrix of Table 1.3-1 to identify specific locations where requirements applicable to the environmental impact assessment process are located):

Laws of the Republic of Armenia:

[1.3-1] Law of the Republic of Armenia on Environmental Impact Assessment, November 20, 1995.

[1.3-2] Law of the Republic of Armenia on State Environmental Review (**Draft** as of 21 January 2008).

[1.3-2a] Law of the Republic of Armenia on Air Protection, January 11, 1994.[35]

[1.3-3] Law on Administrative and Territorial Division of the Republic of Armenia, November 7, 1995)

[1.3-4] Law of the Republic of Armenia on Road Fees, March 3, 1998.

[1.3-5] Law on Urban Development, May 5, 1998.

[1.3-6] Law of the Republic of Armenia on Population Protection in Emergency Situations, December 02, 1998.

[1.3-7] Law of the Republic of Armenia on Protection and Use of Historical and Cultural Immovable Monuments and Historic Sites, 11.11.1998.

[1.3-8] Law of the Republic of Armenia on Environmental Fees and Natural Resources Use Charges, 28 December 1998.

[1.3-9] Law of the Republic of Armenia for the Safe Utilization of Atomic Energy for Peaceful Purposes, 01 February 1998.[36]

[1.3-9a] Law of the Republic of Armenia on Protection of Plant Life, 22 November 1999. [37]

[1.3-9b] Law of the Republic of Armenia on Protection of Fauna, 3 April 2000. [38]

[1.3-10] Law of the Republic of Armenia on Energy, 11 April 2001.

[1.3-11] Land Code of the Republic of Armenia, May 2, 2001.

[1.3-12] Law of the Republic of Armenia on Licensing, May 30, 2001.

[1.3-13] Law on Local Self Government Bodies, May 7, 2002.

[1.3-14] Water Code of the Republic of Armenia, June 4, 2002.

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[35] This document was identified late in the EBID drafting process and impacts on the content of the EBID are not reflected in Table 1.3A-1.

[36] [As of December 2007, this Law was under review and revision by ANRA (now the State Committee for Regulation of Nuclear Safety). When enacted, the revised Law should be reviewed and this appendix to the Environmental Background Information Document updated accordingly.]

[37] This document was identified late in the EBID drafting process and impacts on the content of the EBID are not reflected in Table 1.3A-1.

[38] This document was identified late in the EBID drafting process and impacts on the content of the EBID are not reflected in Table 1.3A-1.

[1.3-15] Law of the Republic of Armenia on Seismic Protection, June 12, 2002.

[1.3-16] Law of the Republic of Armenia on Procurements, December 6, 2004.

[1.3-17] Law of the Republic of Armenia on Automobile Roads, December 5, 2006.

[1.3-18] Law of the Republic of Armenia on the National Water Program of the Republic of Armenia, November 27, 2006.

Decrees/Resolutions of the Government of Armenia

[1.3-20][39] № 67, "On Approval of Technical Regulations of Standards for Composition of Atmospheric Emissions and Control Methods", January 11, 2007.

[1.3-21] № 96, "On Approving of the Procedure for the Examination of Civil Construction Documents" 2 February 2002.

[1.3-22] № 98, "On Approval of the List of Animals of the RoA Red Book of Animals and the List of Plants of the RoA Red Book of Plants", February 2, 2006.

[1.3-23] № 160, "On Approval of Norms for Maximum Allowable Concentrations (MAC, mg/m^3) of Emissions to the Atmosphere in Residential Areas", February 2, 2006.

[1.3-24] № 192, "On Approving the Procedure on Issuance of a Permit for Allowed Quantity of Pollutants and Emissions into Atmosphere", March 30, 1999.

[1.3-25] № 194, "On Making Amendments in the ROA Government Decree № 2328, dated December 22, 2005", January 17, 2008. (№ 2328 dated December 22, 2005 approved the National Plan for the Protection of the Population in the Event of a Nuclear and (or) Radiation Accident at the Armenian Nuclear Power Plant (External Emergency Plan for the Armenian Nuclear Power Plant)).

[1.3-26] № 218, "On Approval of a Water Use Permit Standard Form and Water Use Permitting Standard Forms", March 7, 2003.

[1.3-26a] № 249, "On Approval of Rules for Maintenance of 1000V and Higher High Voltage Power Network and Main Pipelines," May 18, 2000.

[1.3-27] № 313, "On Determination of Safety Zones of the Electric Sector Objects and their Use", May 26, 1998.

[1.3-28] № 354, "On Approval of the Procedure for Determination of Rates and Regime of Water Withdrawal from Water Resources Allocated to Water Users" March 13, 2003.

[1.3-29] № 400 "On Approval of the Licensing Procedure and License Form for Operation of Nuclear Installations" March 24, 2005.

[1.3-30] № 415, on Making Additions to the GoA Decree No. 96, 2002, 17 April 2003.

[1.3-31] № 465, "On Approval of the List of Important Objects from Safety Point of View in Atomic Energy Use Sphere", July 19, 1999.

[1.3-32] № 475, "Approval of the List of Roads of Intergovernmental and State Importance", April 14, 2005.

[39] There is an intentional gap in numbers to allow for future additions.

[1.3-33] № 2183, “On Approval of Statute and Structure of the Regulatory Inspectorate for Nuclear and Radiation Safety (ANRA) Within the Administration of the Ministry for Nature Protection”, 26 December, 2002.

[1.3-34] № 592, “On Approval of the Procedure for Determination of Permitted Marginal Volumes of Unrecoverable Water Withdrawal for Each Water Resource in the Section of Ecological Discharges and Surface Flow”, May 22, 2003.

[1.3-35] № 609, “On Approval of the Procedure for Development, Expertise, Agreement, Approval and Modification of Master Plans for the RoA Urban and Rural Communities”, June 4, 2003.

[1.3-35a] № 609-N, “On Approval of the Licensing Procedure and License Form for Selection of the Site for Nuclear Installations”, May 12, 2005.

[1.3-36] № 612, “On Approval of Procedures for Provision of Information on Trans-Boundary Water Resources” 4 June 2003.

[1.3-37] № 640, “On Approval of Procedures for Organization and Implementation of Safety Examination in the Field of Nuclear Energy Use” 12 July 2001.

[1.3-38] № 660, “On Approval of the Procedure for the Public Awareness on Planned Modifications of the Biological Environment and for Participation of Public Representatives in the Discussion and Decision-Making of Publicizsed Civil Construction Programs and Projects”, October 29, 1998.

[1.3-39] № 768, “On Approval of the List of Important Activities and Positions from Safety Point of View in Atomic Energy Use Sphere”, December 22, 1999.

[1.3-40] № 812, “On Approval of the Procedure for the Development, Examination, Coordination, Approval and Amendment of the Designs for Residential, Public and Industrial Buildings”, December 21, 1998.

[1.3-41] № 882, “On Amendment of the RoA Government Resolution № 812”, 19 September 2001.

[1.3-42] № 931, “On Approval of Procedure for Safe Transportation of Nuclear and Radioactive Materials”, June 27, 2002.

[1.3-42a] № 961, “On Approval of Technical Procedure Related to Power Transmission and Distribution,” July 12, 2007.

[1.3-43] № 982, on Making Amendments and Additions to the GoA Decree No. 96, 2002, June 20, 2005.

[1.3-44] № 1001, on Making Amendments and Additions to the GoA Decree No. 660, 1998, August 8, 2003.

[1.3-45] № 1060, “On Approval of the Procedure for Registration of Documents with State Water Cadastre and Provision of Information”, 23 July, 2003.

[1.3-46] № 1064, “On the establishment and operation of the system for continuous monitoring of the radiological, chemical and bacteriological situation, July 29, 2004.

[1.3-47] № 1106, “On Approval of Traffic Rules for Vehicles Used for Transportation of Heavy Loads or Having Sizes Exceeding the Sizes Set by Traffic Rules or Operating as a Part of a Road-Train Along with Two and More Trailers”, July 20, 2006.

[1.3-48] № 1182, “On Approval of Procedure for Control of Impacts on Water Resources in Watersheds and Wetlands” August 14, 2003.

[1.3-49] № 1219, “On Approval of Norms of Radioactive Safety” August 18, 2006.

[1.3-50] № 1231, "On Approval of Conceptual Approach for Strengthening Physical Protection and Maintenance of Armenian Nuclear Power Plant and Nuclear Materials as Well as Rules of Physical Protection of Nuclear Installations and Nuclear Materials", September 11, 2003.

[1.3-51] № 1263, "On Approval of Special Rules for Transportation of Nuclear and Radioactive Materials", December 24, 2001.

[1.3-52] № 1489, "On Approval of Rules of Radioactive Safety", August 18, 2006.

[1.3-53] № 1530, "On Making Additions to the GoA decree No.96, 2002, September 4, 2003.

[1.3-53a] № 1597, "On Fulfillment of Obligations Undertaken under the Protocol Additional to the Agreement between the Republic Armenia and the International Atomic Energy Agency for 'The Application of Safeguards in connection with Treaty on the Non-Proliferation of Nuclear Weapons'", 21 October 2004.

[1.3-54] № 1637, "On Opening a Special Account for Financial Resources for the ANPP Decommissioning" 12 October, 2006.

[1.3-55] № 2013, "On Approval of the Requirements to the Structure and Content of the Safety Justification Report of the Armenian Nuclear Power Plant (ANPP) and Power Unit 2" November 21, 2002.

[1.3-56] № 2328 , Superceded – see [1.3-25].

[1.3-57] № 2404, "On Regulation of Territories Adjacent to the Intergovernmental and State Importance Roads", December 29, 2005.

[1.3-58] № 2412, "Annual Work Plan for 2006-2008 Three-Year Development and for 2006 Renovation and Maintenance of the RoA State Roads for General Use", December 29, 2005.

United Nations Conventions, etc.

[1.3-60][40] UNECE Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991). {http://www.unece.org/env/eia/eia.htm}

[1.3-61] Protocol on Strategic Environmental Assessment "SEA Protocol" (Kiev, 2003) {http://www.unece.org/env/eia/sea_protocol.htm}

[1.3-62] Applying Strategic Environmental Assessment, Good Practice Guidance for Development Co-Operation, Organization for Economic Cooperation and Development (OECD), 2006.

[1.3-63] Convention on Nuclear Safety, (Vienna, 1994).

[1.3-64] Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (IAEA, Vienna, 1997). [Armenia has not ratified this Convention.]

[1.3-65] UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus, 1998) {http://www.unece.org/env/pp/documents/cep43e.pdf}.

[1.3-66] UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992).

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[40] Intentional gap in numbering.

[1.3-67] United Nations Framework Convention on Climate Change (New York, 1992) (UNFCCC) {http://unfccc.int/resource/docs/convkp/conveng.pdf}

[1.3-68] Kyoto Protocol to the United Nations Framework Convention on Climate Change (Kyoto, 1998) {http://unfccc.int/resource/docs/convkp/kpeng.pdf}

[1.3-69] Convention on Biological Diversity (Rio de Janiero, 1992) {http://www.cbd.int/doc/legal/cbd-un-en.pdf}

[1.3-70] United Nations Educational, Scientific, and Cultural Organization (UNESCO) Convention on the Conservation of the World Cultural and Natural Habitats (Paris, 1972) {http://www.gdrc.org/heritage/whc.html}

[1.3-71] UNESCO Convention on Wetlands of International Importance especially as Waterfowl Habitat, (Ramsar, 1971, as amended in 1982 and 1987) {http://www.ramsar.org/key_conv_e.htm}

[1.3-72] Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, (Basel, 1998) {http://www.basel.int/text/con-e-rev.pdf}

[1.3-73] Convention on The Transboundary Effects of Industrial Accidents, (Helsinki, 1992) {http://www.unece.org/env/documents/2006/teia/Convention%20E.pdf}

[1.3-74] Stockholm Convention on Persistent Organic Pollutants {http://www.pops.int/documents/convtext/convtext_en.pdf}

Banking/Funding Institutions

[1.3-80][41] Export Import Bank of the United States, Nuclear Procedures and Guidelines {http://www.exim.gov/products/policies/nuclear/envnucp.cfm} (Last updated: June 27, 2005)

[1.3-81] **World Bank**

[1.3-82] Operational Manual, OP 4.01, Environmental Assessment, January 1999 (revised in August 2004 and March 2007) {http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/8d1a4edd930ec366852567fa00106d34/9367a2a9d9daeed38525672c007d0972?OpenDocument}

[1.3-83] Environmental Assessment Sourcebook {http://go.worldbank.org/LLF3CMS1I0}

[1.3-84] International Finance Corporation Environmental and Social Review Procedures {http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/pol_ESRP2007/$FILE/ESRP2007.pdf}

[1.3-85] **EBRD** Environmental Procedures, 28 July 2003 {http://www.ebrd.com/about/policies/enviro/procedur/procedur.pdf}

[1.3-86] **European Commission**, Guidance on EIA Scoping, KH-12-01-002-EN-N, June 2001 [referenced by EBRD Environmental Procedures] {http://ec.europa.eu/environment/eia/eia-guidelines/g-scoping-full-text.pdf}.

[41] Intentional gap in numbering.

[1.3-87] Appendix A, Environmental Information Requirements set out in Annex IV of Directive 97/11/EC.

[1.3-88] Scoping Checklist (part of the document, Part B).

[1.3-89] Checklist of Potential Alternatives and Mitigation Measures (part of the document, Part B).

[1.3-90] Checklist of Criteria for Evaluating the Significance of Impacts (part of the document, Part B, for use in conjunction with Scoping Checklist).

[1.3-91] **Multilateral Financial Institutions Working Group on Environment (MFI-WGE)** {http://www.aidharmonization.org/ah-ga/secondary-pages/editable?key=307}

[1.3-92] A Common Framework: Converging Requirements of Multilateral Financial Institutions, 1. Environmental Impact Assessment (EIA) – January 2003. (Matrix does not incorporate this document, as it duplicates listings for Annexes B and C of [1.3-82].)

[1.3-93] A Common Framework for Environmental Assessment: A Good Practice Note - (February 2005).

[1.3-94] Asian Development Bank, Environmental Assessment Guidelines, 2003 {http://www.adb.org/documents/guidelines/environmental_assessment/Environmental_Assessment_Guidelines.pdf}

[1.3-95][42] Export Development Canada, 2007, *Environmental Policy*, available at: http://www.edc.ca/english/docs/environmental_policy_e.pdf.

[1.3-96] Export Development Canada, date not specified, *Environmental Review Directive*, available at: http://www.edc.ca/english/docs/Environmental_Review_Directive_e.pdf.

[1.3-97] Organisation for Economic Co-operation and Development (OECD), 2001, *Common Approaches on Environment and Officially Supported Export Credits*, available at: http://www.oecd.org/dataoecd/26/33/21684464.pdf.

[1.3-98] Secretariat for Equator Principles, 2006, *The "Equator Principles" A financial industry benchmark for determining, assessing and managing social & environmental risk in project financing.* Available at: http://www.equator-principles.com/documents/Equator_Principles.pdf.

International Atomic Energy Agency (IAEA) Documents[43]

[1.3-100][44] Safety Requirements NS-R-3, “Site Evaluation for Nuclear Installations” IAEA, 2003.

[1.3-101] Safety Guide NS-G-3.1, “External Human Induced Events in Site Evaluation for Nuclear Power Plants”, 2002

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[42] Documents [1.3-95] through [1.3-98] were identified late in the EBID drafting process and are not reflected in Table 1.3A-1.
[43] IAEA Safety Guides typically deal with issues more typically covered in Safety Analysis Reports, but some include guidance recommended for use in environmental assessments as well.
[44] Intentional gap in numbering.

[1.3-102] Safety Guide NS-G-3.2, "Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants", 2002.

[1.3-103] Safety Guide NS-G-3.3, "Evaluation of Seismic Hazards for Nuclear Power Plants", 2002.

[1.3-104] Safety Guide NS-G-3.4, "Meteorological Events in Site Evaluation for Nuclear Power Plants", 2003.

[1.3-105] Safety Guide NS-G-3.5, "Flood Hazard for Nuclear Power Plants on Coastal and River Sites", 2003.

[1.3-106] Safety Guide NS-G-3.6, "Geotechnical Aspects of Site Evaluation and Foundations for Nuclear Power Plants", 2004.

[1.3-107] Safety Series SS 110, "The Safety of Nuclear Installations", 1993.

[1.3-108] IAEA Safety Series No. 111-F, "The Principles of Radioactive Waste Management", 1995.

[1.3-109] IAEA Safety Series No. 115, "International Basic Safety Standards for Protection against Ionizing Radiations and for the Safety of Radiation Sources", 1996 (also 2003 CD version).

[1.3-110] IAEA Safety Standards Series WS-R-2, "Predisposal Management of Radioactive Waste, Including Decommissioning", 2000.

[1.3-111] INSAG-12, "Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev. 1", IAEA, 1999.

[1.3-112] INSAG-20, "Stakeholder Involvement in Nuclear Issues", 2006.

[1.3-113] Safety Guide SG 111-G-41, "Siting of Geological Disposal Facilities"

[1.3-114] Safety Reports Series SR 19, "Generic Models for Use in Assessing the Impact of Discharges of Radioactive Substances to the Environment" 2001.

[1.3-115] Technical Report 394, "Health and environmental impacts of electricity generation systems: procedures for comparative assessment"

[1.3-116] Safety Requirements GS-R-3, "The Management System for Facilities and Activities", 2006.

U.S. Nuclear Regulatory Commission (USNRC)

[1.3-120][45] NUREG-1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", 1999.

[1.3-121] Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations", 1998 {http://www.nrc.gov/reading-rm/doc-collections/reg-guides/environmental-siting/active/04-007/}

[45] Intentional gap in numbering.

Table 1.3A-1, Matrix of EBID Sections vs. Source Document Requirements/Guidance

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
1.0 [46, 47]	Introduction	[1.3-2], Art. 15, 1.a & k, 2.j.		[1.3-87] 6	
1.1	Project Description	[1.3-1] Art. 6: 2(a), (b), (c), (d) [1.3-2], Art. 15, 1.a & c. [1.3-35a], 5.c	[1.3-60] Art. 4, 1 (App. II: (a)) [1.3-61] Art. 7, 2 (Annex IV: 1) [1.3-61] Art. 10, 2(a)	[1.3-80] Annex C [1.3-82] Annex B, 2(c) [1.3-83] Annex 1-3, 7 [1.3-85] 2.2, Annex 2 [1.3-87] 1	
1.2	Status of Reviews, Approvals, and Consultations	[1.3-1] Art. 6: 2(e), (f), (g) [1.3-2], Art. 15, 3. [1.3-40] [1.3-35a] 5.f	[1.3-61] Art. 10, 2(b) [1.3-65] Arts. 3, 5 & 6	[1.3-80] Annex C [1.3-82] Annex B, 2(h)(iii) [1.3-85] Annex 2	[1.3-112] §§ 3 & 4
1.3	Applicable Laws, Regulations, Standards, and Guidelines	[1.3-2], Art. 15, 1.b. [1.3-10] Art. 6		[1.3-80] Annex C [1.3-82] Annex B, 2(b)	

[46] Organization follows that of NUREG-1555 (Ref. [1.3-120]).

[47] Indication of a source document at *n*.0 level indicates that it applies to the entire section *n* and its subsections, *n*.1, *n*.2, etc.

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
		[1.3-12] Art. 11 [1.3-14], Ch 4, Ch 5 [1.3-37] Att., item 4.a [1.3-39] App.1, item 3		[1.3-83] Annex 1-3, 9	
2.0	Environmental Description	[1.3-1] Art. 5: 1(a) [1.3-2], Art. 7; Art. 13, 3.c; Art. 15, 1.d & e, 2.c & d. [1.3-55] Att. 6.1.4	[1.3-60] Art. 4, 1 (App. II: (c)) [1.3-61] Art. 7, 2 (Annex IV: 2, 3)	[1.3-80] Annex C [1.3-82] Annex B, 2(d)	[1.3-107] ¶ 501 [1.3-111] ¶¶136-137
2.1	Station Location	[1.3-1] Art. 6: 2(b)		[1.3-83] Annex 1-3, 8(a) [1.3-85] 2.2, Annex 2	[1.3-100] 2.6, 2.12 [1.3-121] C.3, C.4, C.8, C.10, App. A
2.2	Land	[1.3-1] Art. 6: 2(b) [1.3-2] Art. 7: a, b, c. [1.3-27] [1.3-35a] 5.d		[1.3-83] Annex 1-3, 8(a) [1.3-85] 2.2, Annex 2	[1.3-101] 1.1,1.5, 3.1-3, 3.6-9, 3.11-13 [1.3-102] 4.1-8 [1.3-114] 3.44-3.51, 4.14-4.15 [1.3-100] 2.26, 4.14

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
2.3	Water	[1.3-2] Art. 7: d. [1.3-45] [1.3-36] [1.3-14] [1.3-11], Art. 26. [1.3-27] [1.3-35a], 5.d [1.3-18]		[1.3-83] Annex 1-3, 8(a) [1.3-85] Annex 2	[1.3-101] 3.9 [1.3-102] 3.1-3, 3.7-15, § 4 [1.3-105] 1.8-15, 3.1-6, 4.1-2, 4.16-17, 4.20-26 [1.3-100] 2.26, 3.18-23, 3.29-32, 4.4-9, 4.14, 4.15 [1.3-111] ¶¶ 142-143 [1.3-121] C.7.1-7.2, App. A
2.4	Ecology	[1.3-2], Art. 7: e, f, g. [1.3-22]		[1.3-83] Annex 1-3, 8(b) [1.3-85] Annex 2	[1.3-102] 4.2 [1.3-121] C.9, App. B
2.5	Socioeconomics	[1.3-2], Art. 7: k. [1.3-7], Art. 22 [1.3-11], Arts. 19-20.		[1.3-83] Annex 1-3, 8(c) [1.3-85] Annex 2	[1.3-100] 2.26-27, 4.10-14 [1.3-102] 5.1-8 [1.3-121] C.3, C.4, C.11, App. A

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
2.6	Geology	[1.3-2], Art. 7: b. [1.3-15] Art. 14 [1.3-35a] 5.d		[1.3-83] Annex 1-3, 8(a) [1.3-85] Annex 2	[1.3-103] 2.25-29, 4.10-14 [1.3-105] 4.19-26 [1.3-106] 2, 3 [1.3-100] 2.14-2.21, 3.1-7, 3.33-3.43 [1.3-121] C.1, App. A
2.7	Meteorology and Air Quality	[1.3-2], Art. 7: g. [1.3-35a] 5.d		[1.3-83] Annex 1-3, 8(a) [1.3-85] Annex 2	[1.3-102] 2.10-37 [1.3-100] 3.8-14, 3.18-3.23, 3.52-55
	Regional climate				[1.3-102] 2.1-7 [1.3-121] C.2, App. A
	Characteristics of site and vicinity				[1.3-102] 2.1-7, 2.9-37 [1.3-104] 2.1-3, 3.1-14

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
	Atmospheric transport and diffusion				[1.3-102] 2 [1.3-100] 4.1-4.3, 4.15 [1.3-121] C.2, App. A
	Specific impacts (e.g. fogging)				[1.3-121] C.2
2.8	Related Project Activities				
3.0	Plant Description	[1.3-2] Art. 13, 3.d, Art. 15, 1.c, 2.a & b.	[1.3-60] Art. 3, 2(a); Art. 4, 1 (App. II: (a))	[1.3-80] Annex C [1.3-82] Annex B, 2(c) [1.3-85] 2.2, Annex 2 [1.3-87] 1	
3.1	External Appearance and Plant Layout	[1.3-1] Art. 6: 2(a)			
3.2	Reactor Power Conversion System	[1.3-1] Art. 6: 2(c)			
3.3	Plant Water Use	[1.3-1] Art. 6: 2(b) [1.3-14], Ch 4 [1.3-11], Art. 26. [1.3-26], items 5,6			[1.3-102] § 4 [1.3-121] C.7.2

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
		[1.3-34]			
3.4	Cooling System	[1.3-1] Art. 6: 2(b), (c) [1.3-11], Art. 26. [1.3-26], items 5,6			[1.3-102] § 4
3.5	Radioactive Waste Management System	[1.3-1] Art. 6: 2(c) [1.3-49] [1.3-52]			[1.3-102] 2.8, 3.5-6 [1.3-109] Appendix III, III.9; Schedule II, II.8 [1.3-110] 5.9-5.20
3.6	Nonradioactive Waste Systems	[1.3-1] Art. 6: 2(c)			
3.7	Power Transmission System	[1.3-1] Art. 6: 2(b)			
3.8	Transportation of Radioactive Material	[1.3-1] Art. 6: 2(c) [1.3-51]			

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
4.0	Environmental Impacts of Construction	[1.3-1] Art. 5: 1(a), 2; Art. 6: 2(d); Art. 9: 7(c), (d) [1.3-2] Art. 13, 3.f; Art. 14, 2.a & e; Art. 15, 1.d & e, 2.d.	[1.3-60] Art. 4, 1 (App. II: (d)); Art. 3, 2(a) [1.3-61] Art. 7, 2 (Annex IV: 6); Art. 11, 1(a)	[1.3-80] Annex C [1.3-82] Annex B, 2(e); Annex C [1.3-83] Annex 1-3, 10 [1.3-85] 2.2, 2.5.2, 2.6, Annex 2 [1.3-87] 3, 4 [1.3-93] II.B	
4.1	Land-Use Impacts	[1.3-11], Art. 2.		[1.3-88] 1.1-1.20, 2.1	[1.3-102] § 4, 1.8
4.2	Water-Related Impacts	[1.3-11], Art. 26. [1.3-34] [1.3-18]		[1.3-88] 1.11, 1.22-1.25, 2.2 [1.3-93] III.A,	[1.3-102] § 4 [1.3-100] 4.5-4.6, 4.9
4.3	Ecological Impacts	[1.3-11], Art. 37. [1.3-20] [1.3-22]		[1.3-88] 1.2, 1.28, 1.31, 5.4, 6.3, 6.5 [1.3-93] III.A,	[1.3-121] C.9, App. B
4.4	Socioeconomic Impacts	[1.3-11], Art. 37. [1.3-18]		[1.3-83] Ch 3 [1.3-88] 1.17-1.21, 1.26, 1.29, 6.5, 9.1-9.5	[1.3-100] 4.6, 4.9 [1.3-102] § 5

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
				[1.3-93] III.D, III.E	[1.3-121] C.11
4.5	Radiation Exposure to Construction Workers	[1.3-52] [1.3-49], Ch. III, V.		[1.3-93] III.H	[1.3-102] 5.13-5.15 [1.3-109] 2.4, 2.5(b), 2.6, 2.24, 2.26
4.6	Measures and Controls to Limit Adverse Impacts during Construction	[1.3-1] Art. 5: 1(c), 2; Art. 9: 7(e), (g) [1.3-2] Art. 13, 3.g; Art. 15, 1.g, 2.f. [1.3-11], Art. 37.	[1.3-60] Art. 4, 1 (App. II: (e)) [1.3-61] Art. 7, 2 (Annex IV: 7); Art. 11, 1(b)	[1.3-82] Annex C, 2 [1.3-83] Annex 1-3, 12 [1.3-87] 5 [1.3-89] [1.3-93] II.B, III.A	
5.0	Environmental Impacts of Station Operation	[1.3-1] Art. 5: 1(a), 2; Art. 6: 2(d); Art. 9: 7(c), (d) [1.3-2], Art. 13, 3.f; Art.14, 2.a & e; Art. 15, 1.d & e, 2.d. [1.3-35a], 5.d [1.3-55], Att., 6.5.11.6	[1.3-60] Art. 4, 1 (App. II: (d)); Art. 3, 2(a) [1.3-61] Art. 7, 2 (Annex IV: 6); Art. 11, 1(a)	[1.3-80] Annex C [1.3-82] Annex B, 2(d); Annex C [1.3-83] Annex 1-3, 10 [1.3-85] 2.2, 2.5.2, 2.6, Annex 2 [1.3-87] 1, 3, 4 [1.3-93] II.B	[1.3-110] 7.2-7.5
5.1	Land-Use Impacts	[1.3-11], Art. 37.		[1.3-88] 1.1-1.20, 2.1	[1.3-102] § 4, 1.8

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
					[1.3-100] 2.10-2.11 [1.3-121] C.9, C.10, App. B
5.2	Water-Related Impacts	[1.3-26], 5, 6, 8, 9, 10 [1.3-48] Att. item 6 [1.3-11], Art. 26; Art 37. [1.3-14] Ch 4 [1.3-49], Art. 41. [1.3-18]		[1.3-88] 1.11, 1.22-1.25, 2.2, 7.1-7.3 [1.3-93] III.A,	[1.3-102] § 4 [1.3-100] 2.10-2.11, 4.9 [1.3-121] C.7.3, C.9, App. B
5.3	Cooling System Impacts	[1.3-14] Ch 4 [1.3-11], Art. 26; Art 37. [1.3-26] 5, 6, 8, 9, 10		[1.3-88] 6.6 [1.3-93] III.A,	[1.3-102] § 4 [1.3-121] C.7.3, C.9, App. B

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
5.4	Radiological Impacts of Normal Operation	[1.3-11], Art. 37. [1.3-35a], 5.d [1.3-52], Art. 20 [1.3-49]		[1.3-93] III.A, III.H	[1.3-102] 1.5-6, 2.8, 2.38-42, 3.5, 3.20-39, 5.13-5.15 [1.3-100] 2.12, 2.22-2.24, 2.27, 4.1-9, 4.13, 4.15 [1.3-114] §§ 2 - 8 [1.3-111] ¶¶ 138-139 [1.3-109] 2.4-2.6, 2.24, 2.26 [1.3-121] C.7.4, C.9, App. B
	Dose estimates				[1.3-102] 3.5, 3.20-39
	Analysis of impacts on individuals	[1.3-49]			[1.3-102] 3.5, 3.20-39
5.5	Environmental Impacts of Waste	[1.3-11], Art 37. [1.3-26], 10 [1.3-52]	[1.3-64] Art. 11, 27	[1.3-88] 1.16, 4.3, 7.1-7.5 [1.3-93] III.A,	[1.3-100] 2.9 [1.3-110] 2.1-2.3, 2.5-2.7
5.6	Transmission System Impacts	[1.3-27]		[1.3-88] 1.21	[1.3-121] C.9, C.11, App. B
5.7	Uranium Fuel Cycle Impacts		[1.3-64] Art. 4, 27	[1.3-88] 2.3	[1.3-100] 2.9

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
					[1.3-115] reference [1.3-110] 3.3, 7.2-7.5
5.8	Socioeconomic Impacts	[1.3-11], Art. 37. [1.3-18]		[1.3-83] Ch 3 [1.3-88] 3.3-3.4, 9.1-9.5, 10.1-10.5 [1.3-93] III.D, III.E	[1.3-102] § 5 [1.3-100] 4.9 [1.3-121] C.4, C.11, App. B
5.9	Decommissioning				[1.3-110] 6.5-6.13

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
5.10	Measures and Controls to Limit Adverse Impacts during Operation	[1.3-1] Art. 5: 1(c), 2; Art. 9: 7(e), (g). [1.3-2], Art. 15, 1.g, 2.f. [1.3-11], Art. 37. [1.3-26] 12	[1.3-60] Art. 4, 1 (App. II: (e)) [1.3-61] Art. 7, 2 (Annex IV: 7) [1.3-61] Art. 11, 1(b)	[1.3-80] Annex C [1.3-82] Annex C, 2 [1.3-83] Annex 1-3, 12 [1.3-85] 2.2, 2.5.2, 2.6, Annex 2 [1.3-87] 5 [1.3-89] [1.3-93] II.B, III.A	[1.3-105] 13
6.0	Environmental Measurements and Monitoring Programs	[1.3-2], Art. 14, 2.d; Art. 15, 1.h, 2.g. [1.3-9] Art. 17, 1(w) [1.3-42] [1.3-48], Att. Item 6	[1.3-60] Art. 4, 1 (App. II: (h)) [1.3-61] Art. 7, 2 (Annex IV: 9) [1.3-61] Art. 12	[1.3-80] Annex C [1.3-82] Annex B, 2(g); Annex C, 3 [1.3-83] Annex 1-3, 12 [1.3-85] Annex 2 [1.3-93] II.B	[1.3-106] 7 [1.3-100] 5, 6
	Thermal				

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
	Radiological	[1.3-46] [1.3-52]			[1.3-102] [1.3-100] 5.1
	Hydrological				[1.3-102] 3.7-11 [1.3-105] 15.12-15 [1.3-100] 5.1
	Metrological	[1.3-20]			[1.3-102] 2.10 [1.3-104] 2.5-6 [1.3-100] 5.1

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
7.0	Environmental Impacts of Postulated Accidents Involving Radioactive Materials	[1.3-1] Art. 5: 1(a); Art. 6: 2(d); Art. 9: 7(c), (d). [1.3-2] Art. 14, 2.e; Art. 15, 1.d & e, 2.d. [1.3-50], App 2, Rule 21.c. [1.3-55], Att., 6.5.11.6 [1.3-52]	[1.3-60] Art. 3, 2(a); Art. 4, 1 (App. II: (d)) [1.3-61] Art. 7, 2 (Annex IV: 6) [1.3-61] Art. 11, 1(a) [1.3-73] Art. 4, ¶4	[1.3-80] Annex C [1.3-82] Annex B, 2(d); Annex C [1.3-85] Annex 2 [1.3-88] 3.1, 8.1-8.4	[1.3-101] 1.3, §§ 4-9 [1.3-102] §§ 4, 5, 2.8 [1.3-103] §§ 4, 5 and 6 [1.3-104] § 2, 4.4-35 5.1-5 [1.3-105] 5.4-6, 5.12, §§ 8,9,10,14 [1.3-106] §§ 4, 5, 6 [1.3-100] 2.1, 22.22-2.24, §§ 3 & 4 [1.3-111] ¶¶ 138-139 [1.3-121] C.3-C.5
8.0	Need for Power[48] (Evaluation of the NPP Site)[49]			[1.3-100]	[1.3-121]

[48] {Recent decisions by US NRC have not considered need for power based on competitive environment for new electrical generation resources. Nevertheless, the need for power is addressed by the Least Cost Generation Plan and is discussed in EBID Section 1.}

[49] Since need for power is not treated in Chapter 8 of the EBID, this chapter was used to document an evaluation of the site, consistent with US NRC Regulatory Guide 4.7.

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
9.0	Alternatives to the Proposed Action	[1.3-1] Art. 5: 1(b); Art. 9: 7(f) [1.3-2] Art. 5: c; Art. 13, 3.e; Art. 14, 2.b & c; Art. 15, 1.f, 2.e.	[1.3-60] Art. 4, 1 (App. II: (b)) [1.3-60] Art. 5, (a) [1.3-61] Art. 7, 2 (Annex IV: 8)	[1.3-80] Annex C [1.3-82] Annex B, 2(f) [1.3-83] Annex 1-3, 11 [1.3-85] Annex 2 [1.3-87] 2 [1.3-89]	[1.3-115] (for reference) [1.3-121] C.4
10.0	Environmental Assumptions, Commitments, Assessment Open Items, And Conclusions[50]				
10.1	Summary of Key Assumptions				
10.2	Commitments to Mitigate Environmental Impacts				
10.3	Open Items for a Complete Environmental Assessment				

[50] Chapter 10 content has been revised from that in NUREG-1555 in order to better respond to the needs of MoENR.

EBID Section	Title	Laws and Resolutions of RoA	UN Conventions / OECD Guides	Ex-Im Bank, World Bank, EBRD / EC	IAEA / USNRC
10.4	Conclusions				

Environmental Background Information Document

Chapter 2: Environmental Description

October 2008

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2. ENVIRONMENTAL DESCRIPTION

This Chapter describes the existing environment in which ANPP Unit 3 will be built.

Section 2.1 describes the station location, including information on the site, the station vicinity, and the station region.

Section 2.2 describes the nature and extent of present and planned land use within the site, its vicinity, and the region that might be impacted or modified as a result of station construction and operation.

Section 2.3 describes the surface-water bodies and groundwater aquifers that could affect the unit water supply and effluent disposal or that could be affected by unit construction or operation, surface and ground water that could affect or be affected by the construction or operation of the project, including offsite facilities.

Section 2.4 describes the terrestrial and aquatic environment, plants, and animals of the site, and offsite areas likely to be impacted by the construction, maintenance, or operation of the project.

Section 2.5 describes the current and predicted population distribution within a 50-km radius of the site in sufficient detail to provide input to analyses of radiological impacts and accident impacts and to provide support for socioeconomic analysis. It also describes community characteristics in the region likely to be affected by the construction, maintenance, or operation of the unit and related facilities.

Section 2.6 describes the geological features of the site and vicinity as they relate to siting of a nuclear plant at this location.

Section 2.7 provides data on meteorology and climatology of the area around the site.

2.1 STATION LOCATION

The objective of this section is to establish a geographical point of reference for other descriptive material of the EIA (e.g., land and water use, local ecology, or demography).

Definitions:

Station – For the purposes of this report, *the station* means all facilities (reactors, auxiliary structures, etc.) that are located or are proposed to be located on the applicant's site. The station includes everything located on the applicant's property that surrounds the proposed or existing reactors. In the case of the proposed new unit of ANPP, intakes and discharges are beyond this property line, but are considered part of *the station*. Existing or proposed facilities not associated with the production of electricity (e.g., training center), but necessary to support operation of the new unit are considered part of *the station*. *The station* does not include existing facilities on the ANPP site that are solely to support operation, maintenance, and decommissioning of the existing Units 1 and 2 (e.g., the dry spent fuel storage facility). Transmission lines and their associated facilities are not considered part of *the station*.

ANPP Site – for the purposes of this report, *the site* is that area of land owned or controlled by ANPP for the principal purpose of constructing and operating a nuclear power station; i.e., the owner-controlled property immediately surrounding the Armenia Nuclear Power Plant (ANPP).[1] (Distances given in this section are measured from the reactor location identified in Section 2.1.4.)

Station Vicinity – for the purposes of this report, the *station vicinity* is taken as the area within 10 km of the plant site (centerline of new reactor).[2] This is generally that area that could be affected by construction impacts, such as excavations, noise, dust, etc. (Section 2.5 provides detailed population data out to a distance of 16 km which coincides with the distance to the Araks River and the Turkish border.)

Station Region – for the purpose of this report, the *station region* is defined as the area within a 50-km radius of the station.[3] Pending completion of accident analyses and dose projections, the area within 50 km of the site is considered to bound those areas: 1) likely to be effected by releases from the plant; 2) likely to house construction workers and operating staff, within an hour commuting time; 3) high density population centers and

---

[1] NUREG-1555, ESRP 2.2.1 defines site as that area of land owned or controlled by the applicant for the principal purpose of constructing and operating a nuclear power station. As a general rule, the applicant's "site boundary" should be accepted as defining the site.

[2] 10 km is defined in NUREG-1555, ESRP 2.2.1 as the station vicinity; the intent is to investigate land use in an area in which the site makes up no more than 10% of the area.

[3] NUREG-1555 generally uses 80 km as definition of the region for evaluation of environmental impacts; however, IAEA Safety Requirements NS-R-3 avoids specification of a specific distance. NS-R-3 directs investigation of regions that differ, depending on the topic of interest. For example, evaluation of natural events should consider a sufficiently large region that features likely to generate natural hazards are considered, yet impacts on population focus on the plant vicinity. In any case, the central issue in NS-R-3 focuses on that region where potential radiological impacts could occur to the population.

industrial areas near the site; and 4) the higher density agricultural areas of the Ararat valley.

2.1.1 Republic of Armenia

The Republic of Armenia is situated in the Transcaucasus, with Georgia Republic to the north, Azerbaijan to the east, Iran to the south, and Turkey to the west (see Figure 2.1-1). The territory covers 29,800 km^2.

2.1.2 Station Region

The station region encompasses the marz (province) of Armavir and city of Yerevan, plus portions of Aragatsotn marz (almost all), Kotayk marz (southwestern third, highly populated area near Yerevan), Shirak marz (southeastern quarter), and Ararat marz (northwest quarter), as shown in Figure 2.1-2.

The site is in the north-central part of Armavir marz, 32 km due west of the center of Armenia's major, capital, city of Yerevan (population 1.1 million). It is 13 km west of Vagharshapat town (often shown on maps as Echmiadzin or Ejmiadsin, population 56.7 thousand), 4.6 km northeast of Metsamor Town (satellite city for the plant, population 10.2 thousand), and 9.2 km east-northeast of Armavir Town (population 32.3 thousand). Other large towns in the *region* include:

- Ashtarak Town, Aragatsotn marz, 22.6 km to the northeast, population 21.5 thousand;
- Abovian Town, Kotayk marz, 42.1 km to the east-northeast, population 45 thousand;
- Masis Town, Ararat marz, 28.1 km to the east-southeast, population 21.8 thousand;
- Artashat Town, Ararat marz, 41.4 km to the southeast, population 25.1 thousand; and
- Charentsavan Town, Kotayk marz, 49.7 km to the east-northeast, population 24.6 thousand.

(More detail on population centers is presented in Section 2.5.)

The closest border with Turkey, demarcated by the Araks River, is approximately 16 km to the south. The Turkish city of Igdir, population 60 thousand, is approximately 30 km to the south of the site.

2.1.3 Station "Vicinity"

The station vicinity is illustrated in Figure 2.1-3. This is in the western part of the Ararat Valley, Armavir (Hoktemberyan) basin, on the southern flanks of Mount Aragats.

In addition to the towns of Armavir and Metsamor mentioned in the previous section, the following villages are in the station vicinity (see section 2.5 for population data):

- Aknalich, Armavir marz, 4 km to the south;
- Zhdanov, Armavir marz, 5 km to the west-southwest;
- Arshaluys, Armavir marz, 6.3 km to the east-southeast;
- Ferik, 5.7 km to the east;
- Haytagh, Armavir marz, 7.6 km to the east;

- Samaghar, Armavir marz, 8.8 km to the east;
- Tsaghkalanj, Armavir marz, 7.6 km to the east-northeast;
- Aragats, Armavir marz, 8.8 km to the east-northeast;
- Taronik, Armavir marz, 7 km to the southeast;
- Artashar, Armavir marz, 8.5 km to the south-southeast;
- Zartonk, Armavir marz, 8 km to the south;
- Maisyan (Armavir Village), Armavir marz, 7 km to the west-southwest;
- Mrgashat, Armavir marz, 9 km to the southwest;
- Noravan, Armavir marz, 9.4 km to the west;
- Nor Yedesia, Aragatsotn marz, 5 km to the north;
- Nor Amanos, Aragatsotn marz, 8.8 km to the northwest; and
- Aragatsotn, Aragatsotn marz, 9.3 to the north-northeast.

The Yerevan-Armavir Highway (Republican Highway M-5) passes within 4 km to the south of the site. The main Yerevan-Tbilisi railway runs within 7 km of the site, with rail spurs that serve the existing ANPP Units. (See Section 2.5 for more detail on transportation routes.)

The Sevjur River, which transects the southern portion of the 10 km vicinity, is a tributary of the Araks River, 16.1 km from the site. The Sevjur joins the Kasakh River, which passes through the southeastern edge of the 10 km zone, within approximately 9 km of the site before flowing into the Araks. (See Section 2.3 for more discussion of water sources.)

2.1.4 Station Site

The site for the new unit is encompassed by land owned and controlled by the CJSC Armenian Nuclear Power Plant (ANPP) operating organization for the principal purpose of operating nuclear power stations. The site currently has two power-generating units with Soviet-designed VVER-440 (V-270) reactors. The first power unit at the ANPP was placed in the first grid connection on December 22, 1976, and the second on January 5, 1980. The installed power capacity of the units is 407.5 MW_e each. Both units were shutdown in early 1989 as a safety measure following the 1988 Spitak earthquake. Unit 1 remains in a shutdown condition, primarily due to corrosion damage discovered on the reactor vessel. Unit 2 was restarted in 1995 following extensive inspections, safety upgrades, and refurbishment of equipment. Ref. [2.1-1]

The ANPP site was originally planned to include four total units of VVER-440 reactors, with Units 3 and 4 to be situated to the west of Units 1 and 2. Preliminary site clearance for Units 3 and 4 was conducted in the early 1980's, but construction of further units at ANPP was never begun. It is proposed that the new unit would occupy the area previously planned for Units 3 and 4. Figure 2.1-4 illustrates the ANPP site, identifying the location of the proposed new unit, structures of the existing Units 1 and 2, and existing support buildings. Table 2.1-1 provides a legend for the buildings identified in Figure 2.1-4.

Preliminarily, the new reactor will be located at Latitude 40 degrees 10.8 minutes N, Longitude 44 degrees 08.6 minutes E. This is located in the Armavir marz, approximately 1.2 km from the border with Aragatsotn marz. Taxes paid to local authorities by ANPP are payable at the City Hall of Metsamor Town. The ANPP site vicinity falls within the administrative boundaries of Metsamor Town for the purposes of permitting and land use

administration. ANPP territories are designated "lands of special importance" and as such, the GoA has jurisdiction on changes in land use. See Section 2.2 for discussion of neighboring land uses and designations.

The ANPP site encompasses a total of 360 hectares (ha)[4]. The distances to the site boundary from the preliminary reactor centerline coordinates are:

- 1,450 m to the west;
- 750 m to the south;
- 1,850 m to the east; and
- 1,300 m to the north.

The site is bounded in the north and northwest by mountains and in the east and south by the Great Lower Zanga Canal. The ANPP site has moderately rugged terrain with absolute marks of 927 to 949 m above sea level. Ref. [2.1-2]

{The final environmental assessment should include Figure 2.1-5 showing a high oblique aerial view of the site or perspective drawing}.

2.1.5 Off-site Station Facilities

Facilities necessary to support station operation, but not within the confines of the ANPP site, but meeting the definition of *the station* at the beginning of this section, include (see Figures 2.1-3 and 2.1-6):

- The ANPP technical water intake from the Sevjur River and pumping station, Latitude 40 degrees 07.5 minutes N, Longitude 44 degrees 11.2 minutes E, near the village of Taronik (marked MWI1 in Figure 2.1-3);
- The backup technical water intake, groundwater collection pond and pumping station, Latitude 40 degrees 08.3 minutes N, Longitude 44 degrees 10.8 minutes E, between the villages of Taronik and Aknalich (marked MWI2 in Figure 2.1-3);
- Cooling water blowdown discharge to Kosh-Ujan storm water drainage canal (which empties into the Sevjur River – see Section 2.3), Latitude 40 degrees 08.0 minutes N, Longitude 44 degrees 11.5 minutes E, near the village of Taronik (Section 3.4 proposes to extend the cooling water blowdown discharge to the Sevjur river);
- Waste water treatment plant (designed to receive sanitary sewage from Armavir Town[5], Metsamor Town, Norapat village, and ANPP, but not in service), Latitude 40 degrees 07.4 minutes N, Longitude 44 degrees 08.8 minutes E.

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[4] GoA Decision 1848-N, dated 9 December 2004, "on Changing the Target Importance of Lands and Lands Allotment" transferred 289 hectares of land to ANPP. This additional land was not reflected in the maps provided for preparation of the EBID and are not reflected in Figure 2.1-4 nor the distances given for the distances from the reactor to site boundaries.

Table 2.1-1, Legend for Plant Layout Drawing (Figure 2.1-4)			
Existing Structures and Features			
1.	Main building	28.	Cooler N1
2.	Special building	29.	Cooler N2
3.	Water pumping building for 2nd pumping	30.	Cooler N3
4.	Pumping station of fire-fighting foam	31.	Cooler N4
5.	Complex building of pumping station	32.	Water supply
6.	Building of diesel pumping station	33.	Water discharge
7.	Relay protection building	34.	Technical water intake part for unit 1
8.	Building for mazut and oil	35.	Technical water intake part for unit 2
9.	Dry storage of worked radioactive materials	36.	Radioactive wastes disposal area
10.	Building for the water chemical treatment	37.	Slag disposal and neutralization reservoirs
11.	Alkali and acid storage	38-1.	Pumping station N1
12.	Lime storage	38-2.	Pumping station N2
13.	Central workshop	38-3.	Water reserve
14.	Building of diesel generator	38-4.	Operator's room
15.	Building of acetylene oxygen	38-5.	Guard's house
16.	Passage for sanitation laboratory	39.	Crane mobile storage
17.	Central storage	40.	Car parking, cover
18.	Fire station	41.	Fence/wall
19.	Nitrogen oxygen storage	42.	Water discharge
20.	Filtering unit for industrial flows of water treatment plant	43.	Area, car parking
21.	Reserve boiler house	44.	Equipment complex storage
22.	Administrative building with cafeteria	45.	Green house
23.	Special protection building	46.	Residential building
24-1.	Automobile administrative building	47.	Administrative building
24-2.	Parking area for 25 automobile	48.	Vegetable storage
24-3.	Storage with cover	49.	Mechanical manufactory for electrical mounting works
24-4.	Fuel storage	50.	Workshop for manufacturing armature
24-5.	Garage for 3 cars	51.	Electrical mounting materials storage
24-6.	Parking area for trailers	52.	Crane mobile repair division
24-7.	Fence/wall	53.	Wood processing workshop
25.	Repair construction and administrative	54.	Concrete factory compressor station

[5] Note: In Soviet-era maps such as Figure 2.1-6, Armavir Town is shown as Hoktemberyan. This name is often used in ANPP documents originated in the Russian language.

	division		
26.	Ventilation stack	55.	Materials central storage
27.	Area for connection of main building and ventilation stack	56.	Concrete center
57.	Steam engine wagon workshop	72.	Engineering residential building
58.	Building with medical unit	73.	Complex works workshop
59.	Wood work workshop of construction department	74.	Radioactive waste storage
60.	Equipments and materials complex storage	75.	Ventilation fittings manufactory
61.	Equipments and heat-insulating materials complex storage	76.	Mechanical manufactory for metal treatment works
62.	Equipments and materials storage	77.	Garage
63.	storage	78.	Workshop-non complete building for anti corrosion works
64.	Oxygen station	79.	Non complete treatment plant
65.	Acetylene station	80.	High-voltage power substation
66.	Repair mechanical workshop and small mechanical storage	81.	Non complete cafeteria
67.	Storage for sanitary technical works	82.	Railway station
68.	Workshop for electrical equipments testing and repair	83.	“Auto service”
69.	Sanitary technical fabrications storage	84.	Construction administration base
70	Workshop for manufacturing heat-insulating materials	85.	Radioactive materials storage of “Yerkaghsovet”
71.	Workshop for pre-mounting works	86.	Seismic station building

Figure 2.1-1, Map of Republic of Armenia

Figure 2.1-2, Map of NPP Region

Figure 2.1-3, Map of NPP Vicinity

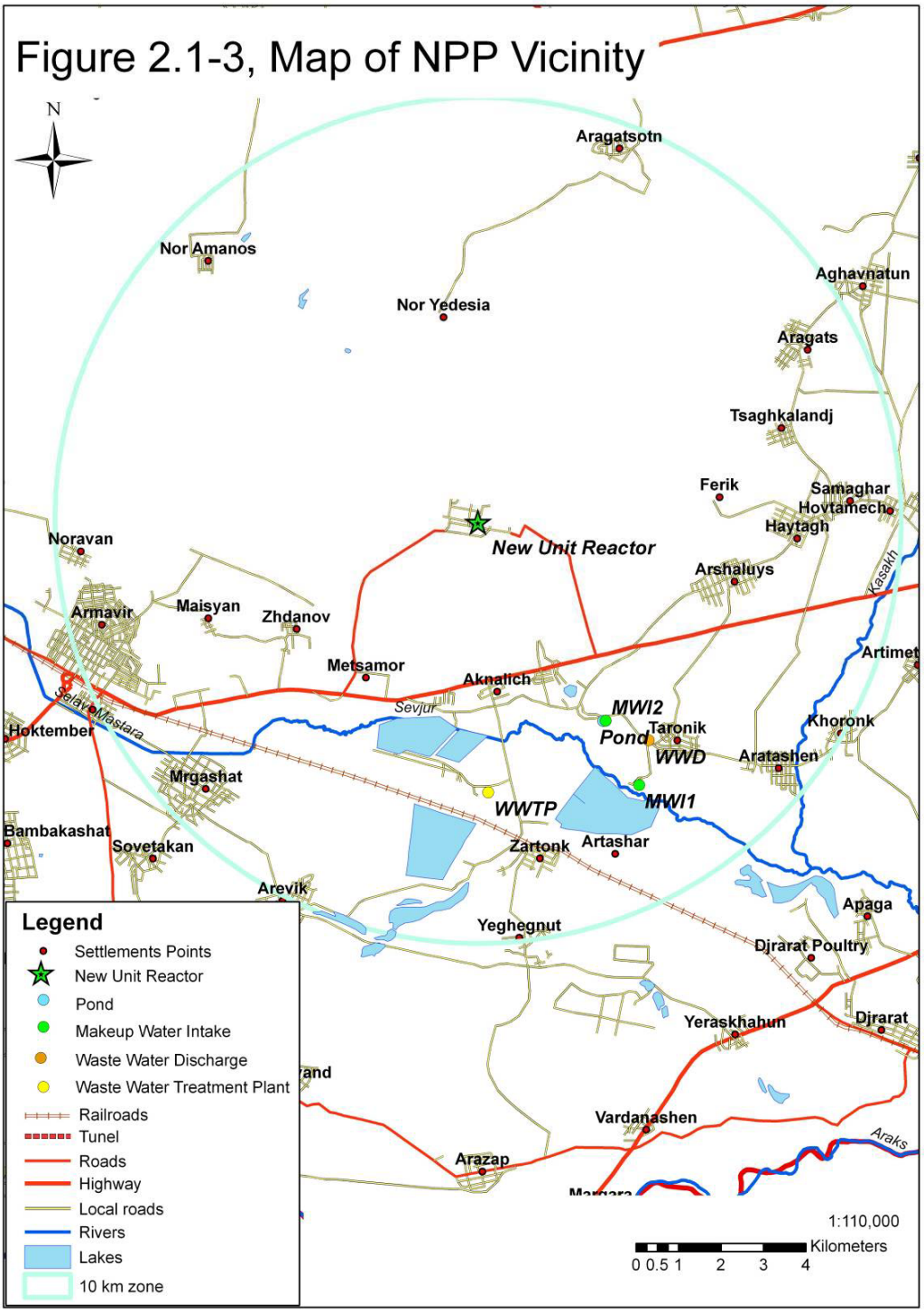


Figure 2.1-4, Map of NPP Site and Construction Area

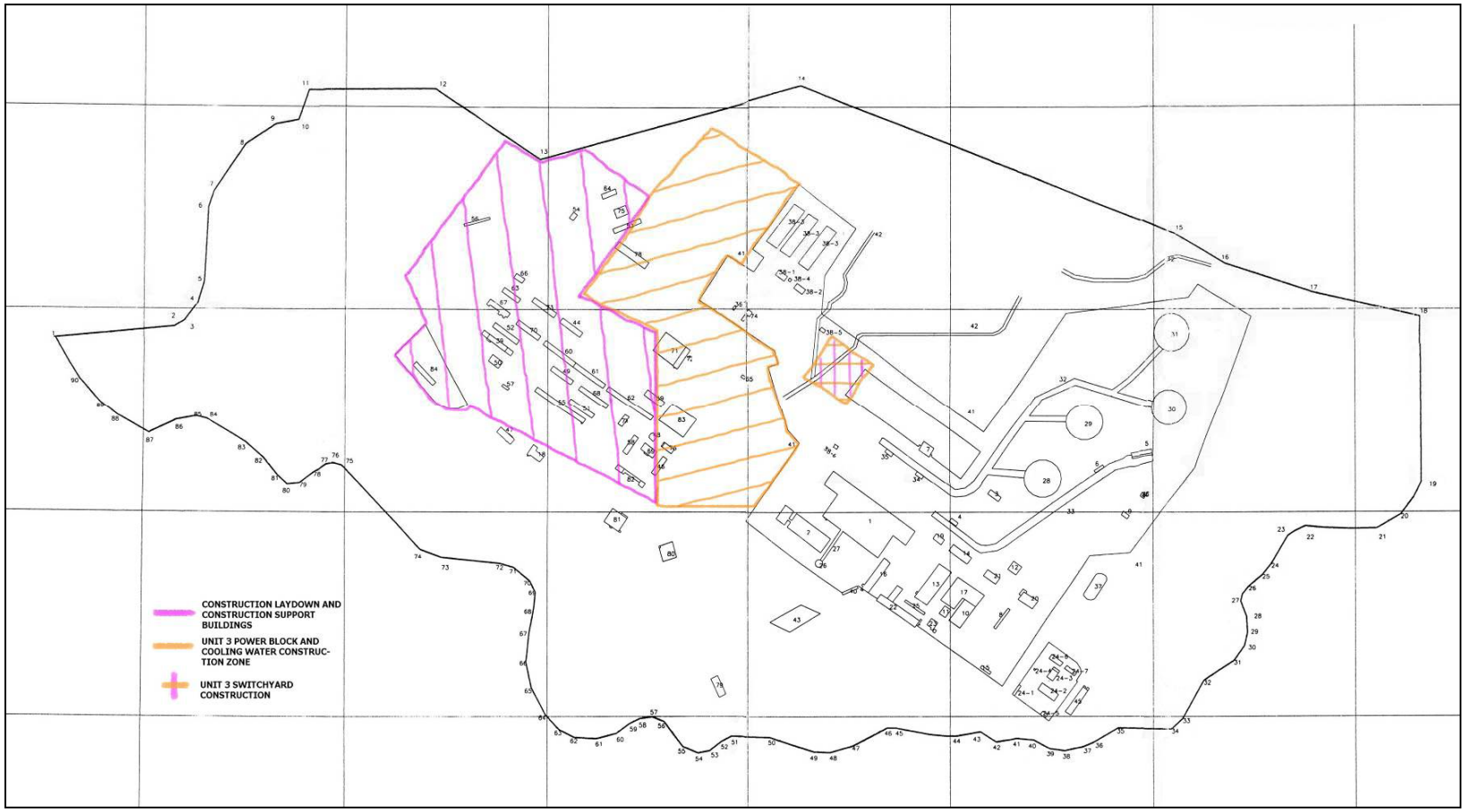
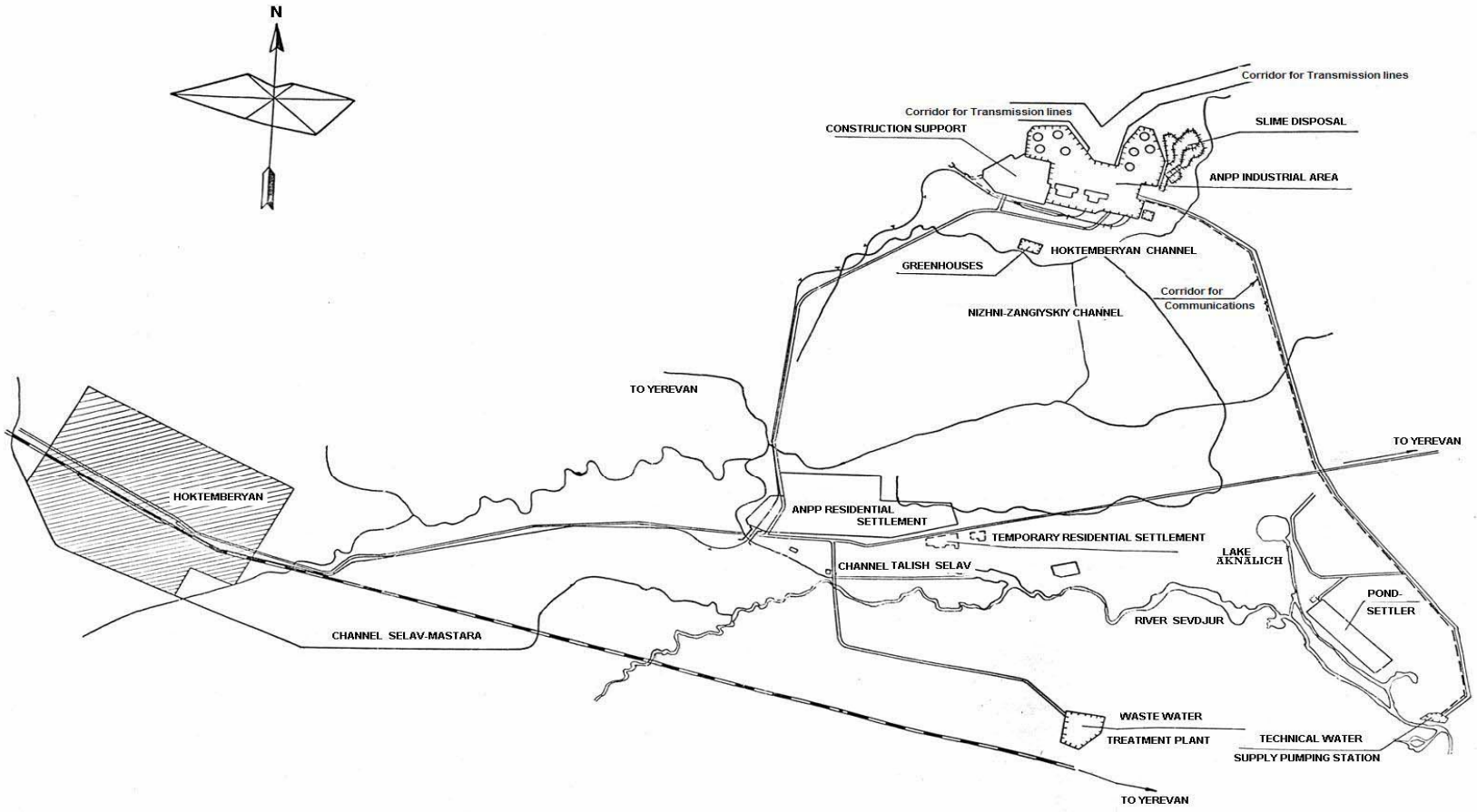


Figure 2.1-5, High Oblique View of Site, {The final Environmental Report should include a high-oblique aerial view or perspective drawing of the site with an indication of the plant boundary }

Figure 2.1-6, Original Units 3 and 4 Master Plan



REFERENCES:

[2.1-1] CJSC "Armenia Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Revision 1, Section 1.1.

[2.1-2] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Revision 1, Section 1.4.1.

2.2 LAND

The new nuclear power unit will be located on a parcel of land owned by the Government of Armenia, with rights of use granted to the Closed Joint Stock Company "Armenian Nuclear Power Plant" and occupied in part by the existing Armenian Nuclear Plant units. The land is in the semi-desert landscape of the Trans-Caucasus region in western Armenia.

2.2.1 The Caucasus

The geography of the Caucasus is often discussed in terms of the North Caucasus Region, which includes the Main Caucasus Mountain Range, and the Trans-Caucasus Region to the south of that range. Since the breakup of the Soviet Union, the term South Caucasus has come into usage as a political term to refer to the countries of Armenia, Azerbaijan and Georgia.

Figure 2.2-1 shows the Caucasus region (Ref [2.2-1]). The Caucasus is situated at the transition between Europe and Asia. The boundaries of the Caucasus are defined by a combination of geographical and political features. The Caucasus region is traditionally located between the Kuma-Manich depression to the north and the Turkey-Iran border to the south. On the west, the Caucasus is bounded by the Black and Azov Seas and on the east by the Caspian Sea. As so defined, the Caucasus area comprises 440,000 km sq. (Ref [2.2-1], GRID CEO report) and includes the Countries of Armenia, Azerbaijan, Georgia, and a portion of The Russian Federation.

The Caucasus Range is in the central part of the Alpine Himalayan fold belt. Elevations in the Caucasus go from 5,642 meters atop Mount Elbrus, to slightly below sea level at the edge of the Caspian Sea. The main Caucasus Range, with limited passes in the central portions, forms an effective barrier to transportation.

Armenia is in the Trans Caucasus between the Main Caucasus Ridge to the north and the Agridag Ridge and Ararat to the south. The Republic of Armenia is landlocked. To the west, Georgia lies between Armenia and the Black Sea about 145 km away. To the east, Azerbaijan lies between Armenia and the Caspian Sea about 175 km away. Georgia and Azerbaijan form the northern border. To the south Armenia shares a border with Turkey and the Islamic Republic of Iran (Figure 2.2-2).

Armenia measures about 400km at its longest point (north-west to south-east), and about 200km east-west. There is a narrow projection (Zangezour) in the south-east. The total area of the country is 29,740 km (2,974,259 ha). Refs [2.2-2] and [2.2-3]

The four neighboring countries (Georgia, Azerbaijan, Iran and Turkey), form the 1479 km border (see Figure 2.1-1). The location of the nuclear power plant site is indicated on the figure.

It is the mountainous terrain that gives identity to the Caucasus and to Armenia. The lowest point in the country is 400 m above sea level and is found on the Debed River at the border with Georgia. The highest elevation is 4,090 m at Aragats Lerrnagagat.

This wide range of elevations results in a variety of significantly different landscapes, with variations in geological substrate, terrain, climate, soils, and water resources. The landscape zones support different agricultural and industrial activities. These landscapes support a great variety of habitats, which support distinctive flora and fauna.

The landscape zoning structure in Armenia is defined in Table 2.2-1. The distribution of the landscape zones is shown in Figure 2.2-3. (Ref [2.2-5]) The figure illustrates the relative abundance of the desert landscape. The figure also shows the distribution of agriculture areas in Armenia.

The natural environment of Armenia is described in reports on the state of the environment issued periodically by the RoA Ministry of Nature Protection (Refs [2-3-1], [2.3-5], [2.3-17], [2.3-28])

2.2.2 The Site Region

Subsequent to the dissolution of the Soviet Union land ownership of neighboring land changed substantially. The state farms and agricultural cooperatives of the Soviet Union have been dismantled and rural land has been almost entirely transferred to small land-holding farmers. Land reform was started in 1991 and completed in 1993. The privatization program led to the emergence of 324,000 family farms as of that time. The current number of farms may be even higher due to subdivisions resulting from inheritance. In 2001 the average farm-holding size in Armenia stood at 1.21 hectares (Ref [2.2-10]). This is essentially the pattern of land ownership near the NPP.

Armavir Marz, which contains the site, is 2753 square kilometers (Ref [2.2-11]); of this, 136,667 hectares, or 50 per cent of the land in the Marz is agricultural land. The land to the south and east is irrigated for cultivated crops. Grazing of livestock is also evident on the irrigated land. The land to the north and west is at higher elevation and irrigation systems have not extended in this direction. Some of this un-irrigated land is used for grazing of livestock.

The RoA Statistical Service reported that geographical position and climatic conditions of the Marz are favorable for growing grain, potatoes, perennial grass, and forage crops, and for cattle breeding. Section 2.5 provides information on specific crops and livestock raised in Armavir and neighboring Marzes.

2.2.2.1 SETTLEMENTS AND TOWNS IN THE SITE VICINITY

The settlements and towns near the site are discussed in Section 2.1. The locations are shown on Figure 2.1-3.

There is a major highway passing near the site and there are numerous smaller roads serving the agricultural areas. There is also a railroad south of the site. The railroad includes a spur up to the site. Figure 2.1-2 shows major transportation routes, railroads, and rivers in the site vicinity.

2.2.2.2 INDUSTRY

In the Republic of Armenia there are substantial resources of such natural fossils and minerals as tuff, marble, pumice, perlite, limestone, basalt, and salt. Coal, iron, bauxites, molybdenum, gold, silver, lead, and zinc are also extracted. There is a great diversity of precious and semi-precious stones. On the territory of Armenia there are 565 deposits containing 60 types of minerals. Non-metallic minerals – in particular building stone – account for more than 60% of total potential mineral reserves; geological explorations have investigated 475 deposits. (Ref [2.2-12])

Prior to 1991, one-third of the Soviet Union's mine output of molybdenum came from the Republic of Armenia. Since then Armenia is estimated to produce an even greater share of the molybdenum output among the commonwealth of independent states. The major

producer of molybdenum was the Zangezur copper and molybdenum mining complex, located near the town of Kadzharan in the southeastern area of Armenia.

It is estimated that Armenia has 7.6% of the molybdenum reserves of the world, 90% of which belong to Zangezur. (Ref [2.2-13])

There are three distinct regions of Armenia, which differ in geological history and consequently in exploitable mineral resources Figure 2.2-7 (Ref [2.2-13])**:**

• Alaverdi-Kapan zone – copper, lead, zinc, iron

• Pambak-Zangezur zone – copper, molybdenum, rarely lead, zinc, antimony, gold, silver

• Sevan-Amasia zone – chromium, gold, rarely mercury, silver, antimony

The metallic mineral deposits are generally at a great distance from the NPP site Figure 2.2-8. Because the mineral deposits are remote from the Unit 3 site, there will not be any interaction between the Unit 3 cooling tower plume and atmospheric emissions from mineral processing. The exploitable non-metallic mineral deposits are known closer to the site Figure 2.2-9. Quarrying of the non-metallic minerals does not pose a concern with Unit 3 operation.
There are no known oil reserves in Armenia. According to the Energy Overview of Armenia (Ref [2.2-14]), in the mid 1990s there was some oil exploration by Greek and U.S. companies, but this activity ended in 1999 without success.

Armenia has coal reserves estimated at 200 to 250 million tons (Ref. [2.2-14]). There are six known coal fields, at Antaramut (in the north), Ijevan (northeast), Jajur (northwest), Jermanis (west central), Nor Arevik (south), and Shamut (north). In addition, there are also oil shale deposits at Jajur, Nor Arevik, Aramus (central), and Dilijan (north central).

Currently, there is no coal production in Armenia. There are exploitable coal deposits at Ijevan, in the northeast part of the country, and Jermanis, in the west central part of the country, and there are plans to open at least one state-owned mine. (Ref [2.2-14] and [2.2-15]).

The Ministerial Report on the State of the Environment 2002-2005 indicates that mineral reserves are increasing as additional exploration is taking place. (Ref [2.2-7])

Industry constitutes the largest sector of the economy of the Armavir Marz. However, the Armavir Marz constitutes 7.2 percent of the agricultural productivity for the nation as a whole. Armavir Marz provides 1.2 percent of the Armenian industrial economic base (Ref [2.2-11])**.**

Table 2.2-3 shows the annual production of mineral commodities and Table 2.2-4 shows the components of the mineral industry in Armenia in 2004. (Ref [2.2-13]).

Armenia also has extensive chemical industry, although no chemical plants have been identified within 16 km of the plant site. The nearest town with industrial facilities is Armavir. A recent report on the chemical industry in Armenia (Ref [2.2-16]) listed six enterprises in Armavir in 2004. Four are manufacturers of construction materials, one is a glass plant, and one is light manufacturing.

2.2.2.3 MAJOR PIPELINES

Armenia is not currently served by pipelines carrying crude oil or oil products. Oil products are imported by trucks or railroad (Ref [2.2-14]).

Armenia has a substantial natural gas infrastructure dating from the Soviet era. Much of it is not being used because of the trade blockade from Azerbaijan (Ref [2.2-14]). Presently, all of Armenia's natural gas comes from the north, from Russia, mainly via the Kazakh-Berd-Sevan pipeline through Georgia. The pipelines could gain importance if the blockade ended. The pipelines could become part of a broader pipeline network that could supply gas to Turkey. There is also a pipeline into Armenia from Azerbaijan; however, it has been inactive since the beginning of the conflict over Nagorno-Karabakh. It is expected that if there were a settlement Azerbaijan could again become a major natural gas supplier using this pipeline.

Construction of gas pipeline from Iran into Armenia which would act to diversify Armenia's gas supply currently is in progress (Ref [2.2-14]). This Iran-Armenia pipeline would include a 41-kilometer section in Armenia and another 100 kilometers. The capacity would be about 1 billion cubic meters per year. Addition of a compressor station, at extra cost, would raise the capacity up to about 3 billion cubic meters per year.

Armenia presently has about 240 million cubic meters of underground natural gas storage capacity that can be used for seasonal adjustment of natural gas flows. The largest reservoir is the Abovian gas depot, in Kotayk marz not far from Yerevan, which during the Soviet era could store up to about 180 million cubic meters of natural gas; now, however, the facility can hold no more than about 80 million cubic meters without leaking. Refurbishment of this facility is of great strategic importance from a gas supply management consideration.

There are about 2,000 kilometers of main natural gas pipelines and 11,000 kilometers of gas distribution pipelines in Armenia. A map of Armenia's major natural gas transmission pipeline system is shown in Figure 2.2-10 (Ref [2.2-14]).

2.2.2.4 PROTECTED AREAS

The Republic of Armenia has identified special areas for protection of ecosystems, habitats and rare, endemic and threatened species. These protected areas include five State Reserves, 22 State Reservations and one National Park. Together these cover around 311,000 ha, or 10% of the surface of the country. (Ref. [2.2-17])

The reserves are of highest importance. The Erubini Reserve about 36 km ESE of the Unit 3 site and the Khosrov Forest Reserve, about 70 km ESE of the site are of special ecological value. The purpose of the Erubini Reserve is to protect the gene stock of cereals unique to Armenia [2.2-17, page 14]. The fauna of the Erubini Reserve have not been well studied. The Reserve is located at the transition between semi-desert and mountain steppe landscape zones. The species reported to occur are typical of the species found in both zones [2.2-17, page 14].

The purpose of the Khosrov Forest Reserve is the protection of the Azat River water resources, juniper and oak, arid mountain vegetation, rare animals and plants. It is reported that the flora of the reserve includes about 1800 species of vascular plants. This

is over half of all plant species known in Armenia [2.2-17, page 18]. The Khosrov reserve covers about 29,000 ha and extends from the semi-desert to the upper limit of the forest landscape zone. The fauna population is also highly diverse and includes 50 species of mammals. The mammals include well-known predecessors of domesticated

goat and sheep, namely wild goat, Caucasian bearded goat, and Armenian

moufflon or Transcaucasian wild sheep [2.2-17, page 21].

The Vordan Karmir Reservation is another important specially protected area in the site vicinity. In the Vordan Karmir Reservation endemic cochineal (Porphyrophora hamelii) occurs in saline soils of the Ararat plain. (Refs [2.2-17]). Figure 2.2-11 shows the specially protected areas of Armenia.

Some wetlands are also subject to protection. Figure 2.2-12 shows major wetlands. The existence of wetlands in Armenia has been threatened by a number of man's activities. The importance of wetlands is recognized and a number of steps are being taken to protect remaining productive wetland areas (Ref. [2.2-18]). The RoA is a Contracting Party to the Ramsar Convention on Wetlands. Two sites in Armenia (Lake Sevan and Lake Arpi) are recognized by the Ramsar Convention as being Sites of International Importance.

Three other sites are under consideration for recognition through the Ramsar Convention (Ref. [2.2-18]). This group includes Pond Ardenis, Relict wetlands of Lori, and 351 hectares of the Khor Virap Marsh in Ararat Marz, approximately 50 kilometers from the ANPP. The Khor Virap wetland is recognized by the RoA as a special area.

2.2.3 The Site

The ANPP site, at an elevation of approximately 930 m, is within the semi-desert landscape in the western part of the Ararat Valley, 10 km northeast of the town of Armavir and 32 km west of Yerevan. (Figure 2.5-2). The ANPP is approximately 16 km from the Turkish border, which runs along the Araks River. The site is bounded in the north and northwest by mountains and in the east and south by the Great Lower Zanga Canal. (Ref. [2.2-6])

Topographically, the ANPP site is located on the Shamiram outer plateau of the Aragats shield-shaped volcanic massif, between the volcanic edifice of Mount Aragats and the Ararat Depression. The Shamiram plateau has moderately rugged terrain, which gently descends southward toward the Ararat Plain at a grade between 1.5 and 5%. (Figure 2.2-4)

The ANPP site has moderately sloping terrain ranging in elevation between 927 and 949 m above sea level Figure 2.3-4.

When the existing NPP was planned, the land was owned by the Soviet Armenia government. Following the dissolution of the Soviet Union, the NPP and the land on which it sits was transferred to Government of Armenia, with rights of use granted to CJSC "Armenian Nuclear Power Plant".

The site was approved for use for 4 identical nuclear generating units. Units 1 and 2 were constructed. Unit 1 was taken out of service following the Spitak Earthquake and will not

be returned to service. Unit 2 is currently operating. Construction of Units 3 and 4 was started and then abandoned after the Spitak earthquake. At that time substantial foundation work had been completed on the two new units. Construction had been completed on several new buildings necessary to support construction activities. Upon the decision to abandon construction, foundation work was demolished and much of the construction debris was removed from the area.

The new nuclear plant will be built on the land where Units 3 and 4 were to be built. This land has remained under the control of the existing nuclear power facility. At the current time scattered evidence of the abandoned units remains in the form of rubble from demolition. No remnants of the preconstruction environment remain. However nature has crept back in and re-established itself with flora and fauna typical of the desert landscape.

2.2.3.1 HYDROLOGY, GEO-HYDROLOGY, AND SOIL

The hydrology and the geohydrology of the land underlying the site were studied extensively at the time of the engineering design of ANPP Units 1 and 2. The findings of the historic studies have been relied on in more recent engineering reports. The recent reports provide information from the earlier studies and identify the engineering reports where the earlier studies appear.

A 1975 Preliminary Design Study for Phase 2 of the ANPP [2.2-19] described the geohydrology of the site and the region using engineering-geological surveys that had been carried out since 1968. The geological structure of the described region is formed by rocks of upper Pliocene and Quaternary age conditioned by volcanic activity of that time.

More specifically, the geological structure of the region is characterized by a composite of cracked lava and scoria, volcanic emissions, as well as tuffs of upper Pliocene and Quaternary [2.2-21].

The ANPP site mainly consists of two types of deposits: large-fragmental crushed stone and block lava with layers of scoria, semi-scoria basalts with volcanic ashes and sand [2.2-19].

The upper part to a depth of 3-5 m consists of large-fragmental macadam with layers and lenses of loam lying on crumbling basalts with thickness up to 10 m. Below the basalts there is large-fragmental crushed stone with layers and lenses of loam and tuff.

The foundation of structures of the ANPP is large-fragmental crushed stone and basalts.

The geological formations that constitute the industrial site of the ANPP have a high degree of permeability [2.2-19] [2.2-20]. There is no stable upper layer of ground water [2.2-19].

Water infiltrating into the lava on the mountainside of Aragats, within the lava plateau, reaches a confining layer (clay and loamy soil of the upper Miocene). It flows beneath this layer, accumulating in cavities, and establishing huge subsoil flows from the north to the south, toward the direction of the Ararat Valley. Near the site the surface of the water flow lies at a depth from 64 to 94 m below the surface [2.2-19]. On the site of the ANPP the level of subsoil waters of the underground flow is at a depth of 86-95 m [2.2-21].

It has been reported that the speed of motion of the subsoil flow amounted to 0.35m/s, based on an experiment in 1970 by Armenian Institute “Hydroproject.” [2.2-21]

In the vicinity of the site, water emerges to form the Sevjur River and as springs near the villages of Kulibeklu, Zeiva and lake Aknalich. This water was the source of the household and drinking water supply for the industrial facilities of the ANPP and adjacent residential areas [2.2-19].

Based on measurements of the chemical composition of the subsurface water, it is described as sweet and of the hydrocarbonate-calcium-magnesium type [2.2-21]. The amount total dissolved solids (on average) is 676.29 mg/l; chlorides average 3.88 mg/equiv; sulphates average 3.83mg/equiv; total hardness averages 7.16mg/equiv; average pH is7.02, free carbon dioxide averages 5.87mg/l, and aggressive CO_2 is absent. The ground water meets the requirements of GOST 2761-84 “Sources for Water Supply” [2.2-20] [2.2-21].

The mountainous terrain and the geological history of the region results in a range of soil types in Armenia. Figure 2.2-5. The semi-desert zone, include semi-desert gray, irrigated meadow gray, alkalized and hydromorph saline-alkali lands. (Ref [2.2-7])

The ANPP Unit 2 Safety Analysis Report (Ref. [2.2-6]) describes the soil at the site as follows:

> “Below a soil and vegetation stratum of insignificant thickness, which consists of dry, yellow-brown loams with sparse impurities of basalt fragments, there is a nearly ubiquitous stratum of light, macroporous, carbonatized loams and sandy loams of light-gray color with up to 40 percent in impurities of basalt boulders, stones and gruss. The thickness of this stratum is variable and reaches a maximum of 5.0÷6.0 m. Below it, but by no means everywhere, is a stratum of scorified, fine-grain, weather-beaten basalt, consisting of a grussy mass of rock and detritus with silty sand. The thickness of this stratum is highly variable in spatial terms and varies from 1.0 and less to 10.0 m. Below the scorified basalt is the first stratum from the surface of gray and dark-gray, porous, vuggy-fractured (sometimes with a large cleavage, up to 1.5÷2.0 cm) basalt. Below the basalt stratum, almost everywhere in the central part of the survey area, is a stratum of volcanic scoria consisting of detritus, gruss and more sparsely of rocks of burned dark-gray, porous, highly spongy and honeycombed basalt with volcanic sand of varied grain size that constitutes up to 40 percent of the volume.
>
> “The thickness of this stratum also undergoes major fluctuations along its course. Sometimes there are lenses of burned loam and sandy loam with fragments of minor thickness in the interfaces between the last strata.
>
> “These lenses sometimes consist of coarsely fragmental, altered material (consisting of fragments of dark-gray and gray basalt and andesitic basalt and more sparsely of brick-red basalt and pumice, with brown fillers). In places this volcanic scoria lies in the upper part of the section and has a significant thickness of 23.0 m.
>
> “According to available regional data for the area, below this member of strata there is a stratum of basalt that is underlain by a stratum of volcanic sedimentary deposits re-altered in the interface, followed again by basalt, etc.”

The saline nature of the desert soils present special problems to agriculture. In the cultivated farm areas in the site vicinity, further desertification is a possible consequence of current irrigation practices and is of serious concern. (Ref [2.2-8])

2.2.3.2 LAND USE OF SITE

Figure 2.2-6 shows land allocated by the Armenian Soviet Socialist Republic for the construction of the ANPP. Table 2.2-2 describes the land parcels and identifies recent ownership of some nearby properties. More complete information about land ownership in the site vicinity could not be obtained. Confirmation of the boundaries of the ANPP site, as illustrated in Figure 2.2-6, Area designated with (circle) 1 is an open item. The boundary of the land owned or legally controlled by the ANPP CSJC defines the area in which the ANPP Unit 3 operator will have control over activities, including exclusion or removal of personnel and property, and thus is the "owner controlled area."

Land controlled by the CJSC ANPP includes 360 ha designated for ANPP construction and operation. The ANPP also owns a narrow communication corridor between the site and the Sevjur River bank pumping station. The area within the communication corridor is 36 ha. The ANPP is accessed by a road within this corridor running about 2 kilometers to the Metsamor-Yerevan highway, Highway M-5.

The land bordering the site is used for agriculture. There are no industrial land uses neighboring the site.

In 2004 a process was initiated to transfer adjoining land from the RoA to the ANPP. This transfer included 289 ha of the parcel identified on the map as "reforestation." The intended transfer of the land was to provide a sanitary zone; that is a buffer between the power plant and neighboring land users [2.2-9]. When this transfer is complete, the land will become part of the site. Figures and tables should be revised to reflect these changes.

There is a western access road leading to the site. This road shares the right of way with the Railway from Armavir to the site. This was the main access for construction of Units 1 and 2.

Transmission lines serving Unit 2 will remain in service for the operating unit. The new nuclear unit will use these transmission corridors. An additional 400 kV line will be required between Unit 3 and Hrazdan. Routing is not determined yet but it is expected that it will utilize existing corridors. New interconnections to neighboring utilities are planned to provide greater reliability of the electrical transmission grid. These activities are progressing independently of new unit construction.

2.2.3.3 LAND USE PLANNING

The procedure for obtaining a land use permit Land Use planning is described in Section 1.2.2. The continued use of the site for power production would be consistent with existing land use.

Section 4.4 discusses the impact of the project on local communities and notes that approval of construction and development plans for construction of Unit 3 will involve the leaders of local communities, the provincial governor (Marzepet) of Armavir marz, and the mayor of Yerevan.

Table 2.2-1 Landscape Zoning Structure in Armenia (Refs [2.2-2], [2.2-4])

Landscape zone	Upper elevation of Zone, m Above Sea Level	Percent of Land within each landscape zone
Desert	800	10 including semi-desert
Semi-desert	1250	
Dry Steppe	1600	37 including Steppe
Steppe	2400	
Forest	1800 to 2300	20
Alpine Meadows	3700	28 Including Alpine
Alpine	Above 3700	

Table 2.2-2 Land allocation to build Armenian NPP, documented according to the ARM SSR Ministers' Board Decision

#	Object name	Land allocation, in hectares including					ARM SSR Ministers' Board Decisions	#	Recent owners
		Total	Hoktembe-ryan district	Echmiadzin district	Ashta-rak district	Fish farms			
1	ANPP construction	360.0	Free used 360.0	-	-	-	# 501C 17.08.71	1	ANPP
2	Residential Settlement of ANPP	250.0	State farm "Maisyan" 98.0 ha, State used 2.0 ha	State farm "Aknalich" 100 ha	-	50.0	# 449C 07.09.67	2	Metsa-mor
3	Communicatio n Corridor from ANPP to river-bank pumping station	36.0		Collective farm "Arshaluys" 17.5 ha, State farm "Verin Zeyva" 7.5 ha, State farm "Aknalich" 6.5 ha, museum "Metsamor" 3.0 ha, free used 1.5 ha	-	-	# 485 15.11.68	3	ANPP
4	Treatment facilities	20.8	Armenian research-and-production experimental station of essential oil plant	-	-	-	# 459 12.10.76	4	7 ha-ANPP, 13.8 ha-Metsa-mor
5	ANPP water pond with water intake structures	15.0		State farm "Taronik", 15.0 ha	-	-	# 238 17.04.79	5	ANPP
6	Railway and automobile road to ANPP	21.5	Collective farm "Mrgashat" 14.1 ha State farm "Maisyan" 7.4 ha	-	-	-	# 123 18.03.	6	Road reaper and constru ction agency (DRSU) Railway agency
7	Diary farm complex	80.0	State farm "Maisyan" 30.0 ha, free used 50.0 ha	-	-	-	# 738 07.10.81	7	50 ha-ANPP, 30 ha-Metsa-

									mor
8	Collective gardening society	34.8	State farm "Maisyan" 34.8 ha	-	-	-	# 587 01.10.79	**8**	Metsa-mor
9	Protective forestation around ANPP	368.0	State farm "Maisyan" 26.0 ha	State farm "Ayghrlich" 33.0 ha	State farm #3 278 ha	-	# 674 20.08.69	**9**	According to the GoA decree #1848 dated 09.12.04, 289 ha out of 368 ha transferred to ANPP, although it isn't transferred from the Armavir marz municipality
10	Cemetery	2.0	State farm "Maisyan"	-	-	-	# 224 13.04.82	**10**	Metsa-mor
11	Dump	4.0	-	-	State farm #3	-	# 303 11.05.82	**11**	Metsa-mor
Total		**1192.1**							

Table 2.2-3 Production of Mineral Commodities

(Metric tons unless otherwise specified)

Commodity	1996	1997	1998	1999	2000 p/
ARMENIA					
Metals:					
Copper:					
Concentrate, Cu content e/	9100 r/	9000 r/	9200 r/	9600 r/	14000
Blister	-	5000	3000	5000 e/	7231 3/
Gold e/ kilograms	244 3/	500	350 r/	400 r/	400
Molybdenum concentrate, Mo content	1800	1800 e/	2500 e/	5403 r/	6044
Silver kilograms	626	1000	1000	1200 e/	1300
Zinc, concentrate, Zn content	820 e/	830 e/	825 e/	879 r/	528 3/
Industrial minerals:					
Cement	282	297	300 r/	287	219 3/
Clays, bentonite (powder)	2750	2750 e/	3000 e/	3493 r/	2807 3/
Limestone	1800	1700	1700	1700 e/	1700
Perlite e/	6000	6000	35000	35000	35000
Salt	26400	26000 e/	24911	26955	30000 3/

e/ Estimated. p/ Preliminary. r/ Revised. – Zero.
3/ Reported figure.
Estimated data are rounded to no more than three significant digits; may not add to totals shown.
Table includes data available through November 2001

Table 2.2-4 Structure of Mineral Industry

(Metric tons unless otherwise specified)

Country and commodity	Major operating companies	Location	Annual capacity e/
ARMENIA			
Aluminum, rolled and foil	Kanaker aluminum plant	Kanaker	25000
Copper:			
Mine output, Cu content	Facilities: Kapan mining directorate Shamlugh mining directorate (NIO) Akhtala mining directorate (NIO) Zangezur copper-molybdenum complex mining Kadzharan deposit Agarak copper-molybdenum mining and processing complex	 Kapan Shamlugh Akhtala Kadzharan Agarak	30000 4/
Blister	Manes and Vallex joint stock company	Alaverdi	15000
Diamonds, cut stones	Aghavni diamond cutting works	Nor Geghi	NA
Do.	Amma group diamond cutting works	Artashat	NA
Do.	Andranik diamond cutting works	Nor Hachyn	NA
Do.	Diamond Company of Armenia (DCA)	Yerevan	NA
Do.	Lori diamond cutting works	Nor Hachyn	NA
Do.	Lusampor	Melik gyugh	NA
Do.	Punji diamond cutting works	Yerevan	NA
Do.	Sapphire diamond cutting works	Nor Hachyn	NA
Do. thousand carats	Shoghakan gem cutting plant		120
Gold kilograms	Companies: Zod mining complex (mining ceased in 1997) Megradzor deposit (mining ceased in 1997)	 Zod Megradzor	2000 4/
Do. do.	Ararat gold processing and tailings recovery plant	Ararat	1000
Molybdenum, mine output, Mo content	Complexes: Zangezur copper-molybdenum complex mining Kadzharan deposit Agarak copper-molybdenum mining and processing complex	 Kadzharan Agarak	8000 4/
Perlite thousand tons	Aragats-Perlite mining and beneficiation complex	Aragats Lerrnagagat	200
Zinc, mine output, Zn content	Kapan mining directorate	Kapan	NA

e/ Estimated. NA Not available
4/ Capacity estimates are totals for all enterprises that produce that commodity.
Estimated data are rounded to no more than three significant digits. Table includes data and information available through October 2001
Many location names have changed since the break up of the Soviet Union. Many Enterprises, however, are still named or commonly referred to, based on the former location name, which accounts for discrepancies in the names of enterprises and that of locations.

Figure 2.2-1 The location of Armenia within the Caucasus

From Caucasus Environmental Outlook

http://www.grid.unep.ch/product/publication/CEO-for-Internet/CEO/full.htm

Figure 2.2 – 2 Political Map of the Transcaucasus

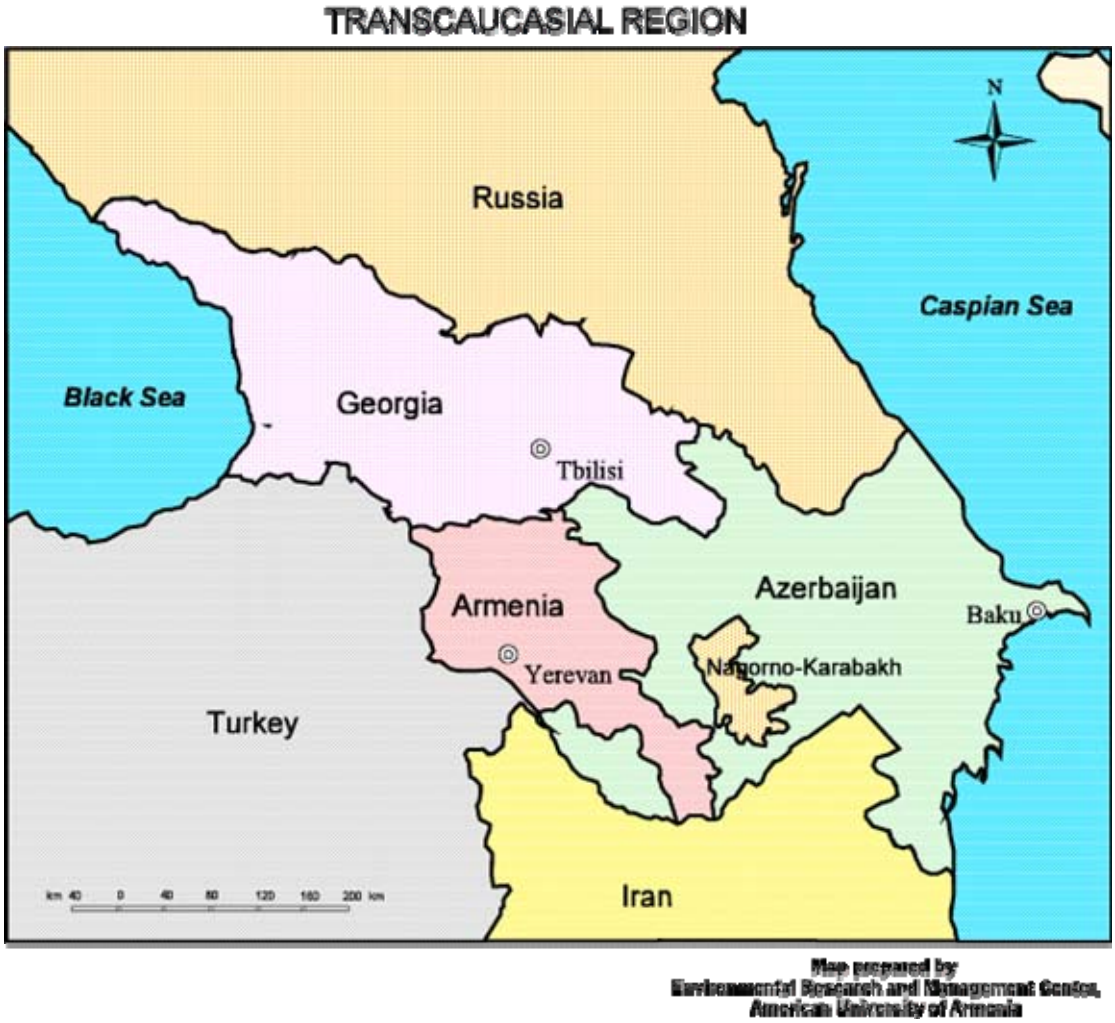


Figure 2.2-3 Landscapes

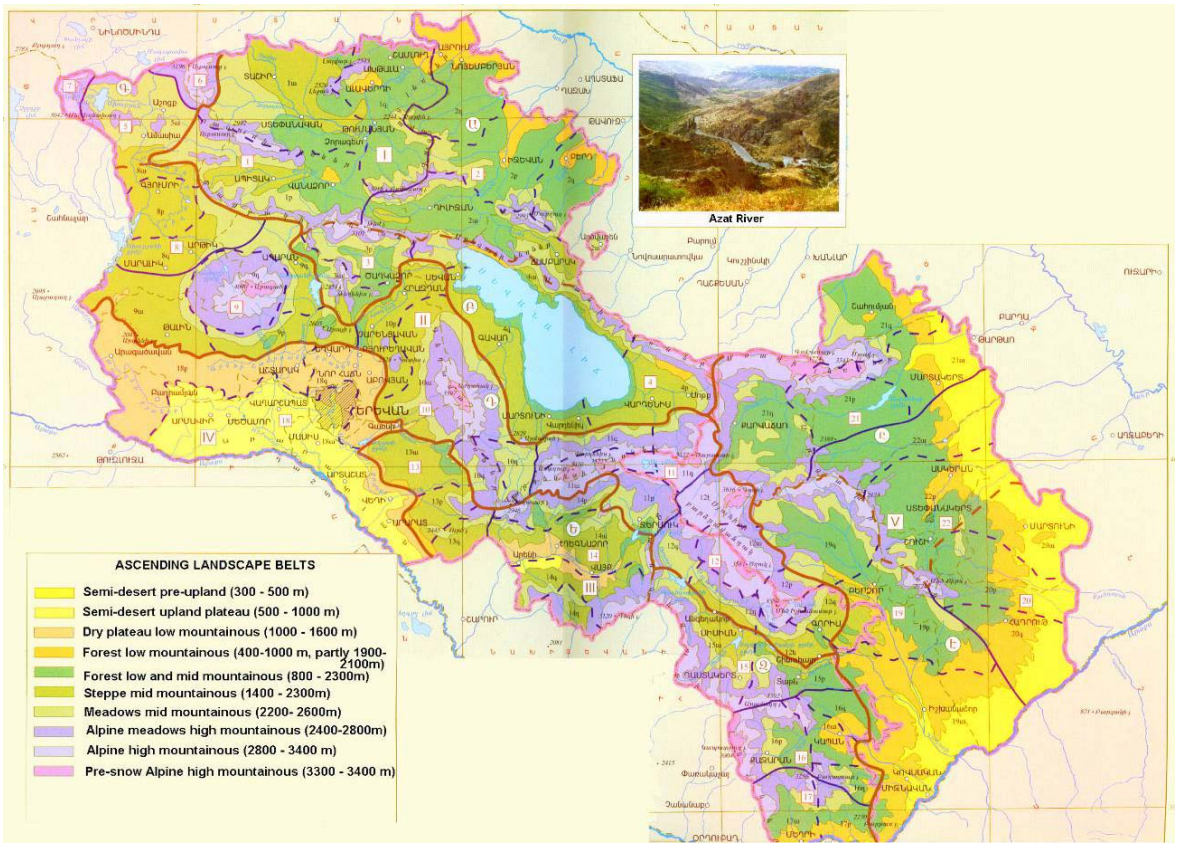


Figure 2.2-4 Topographic Map

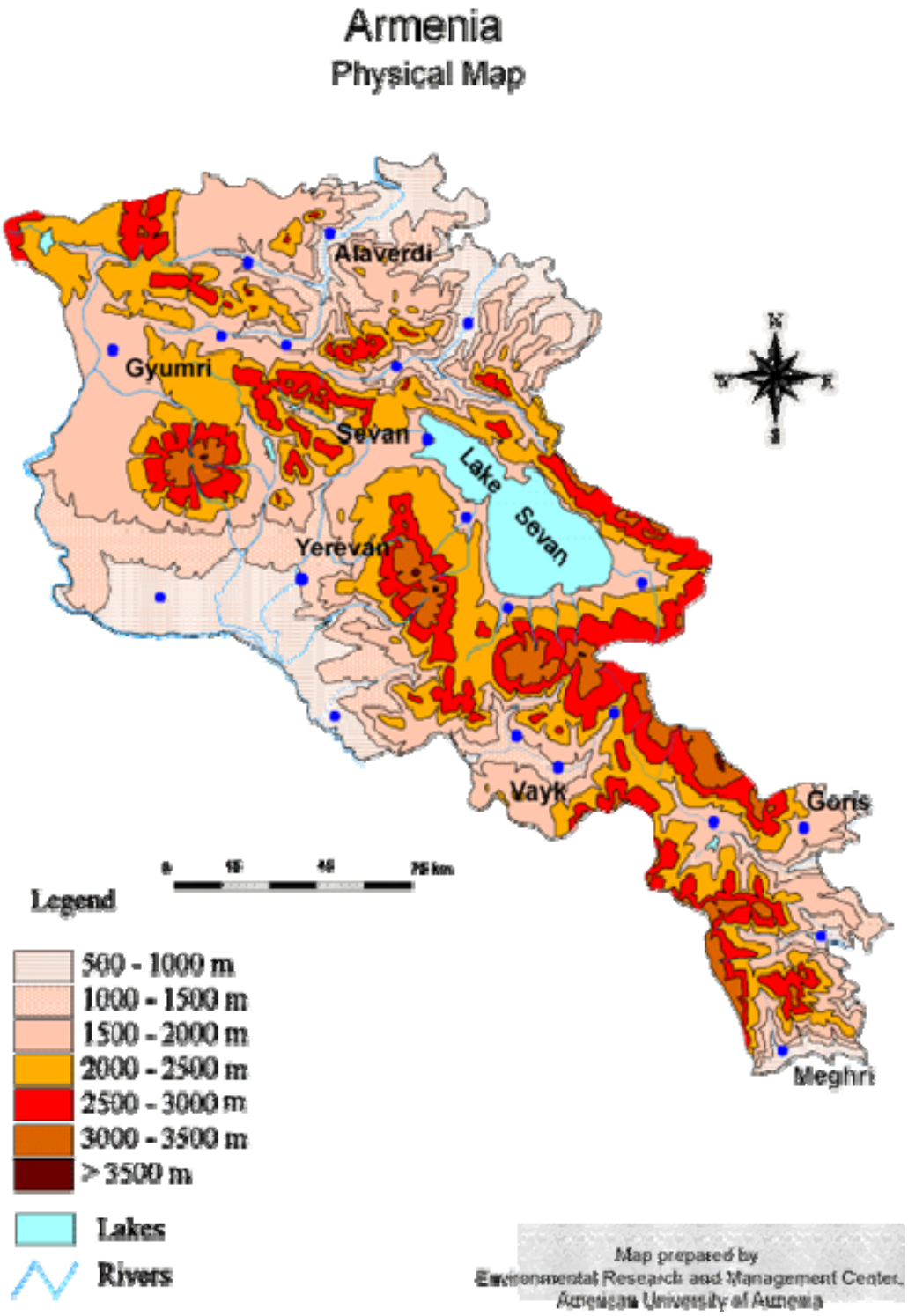


Figure 2.2-5 Soil Types

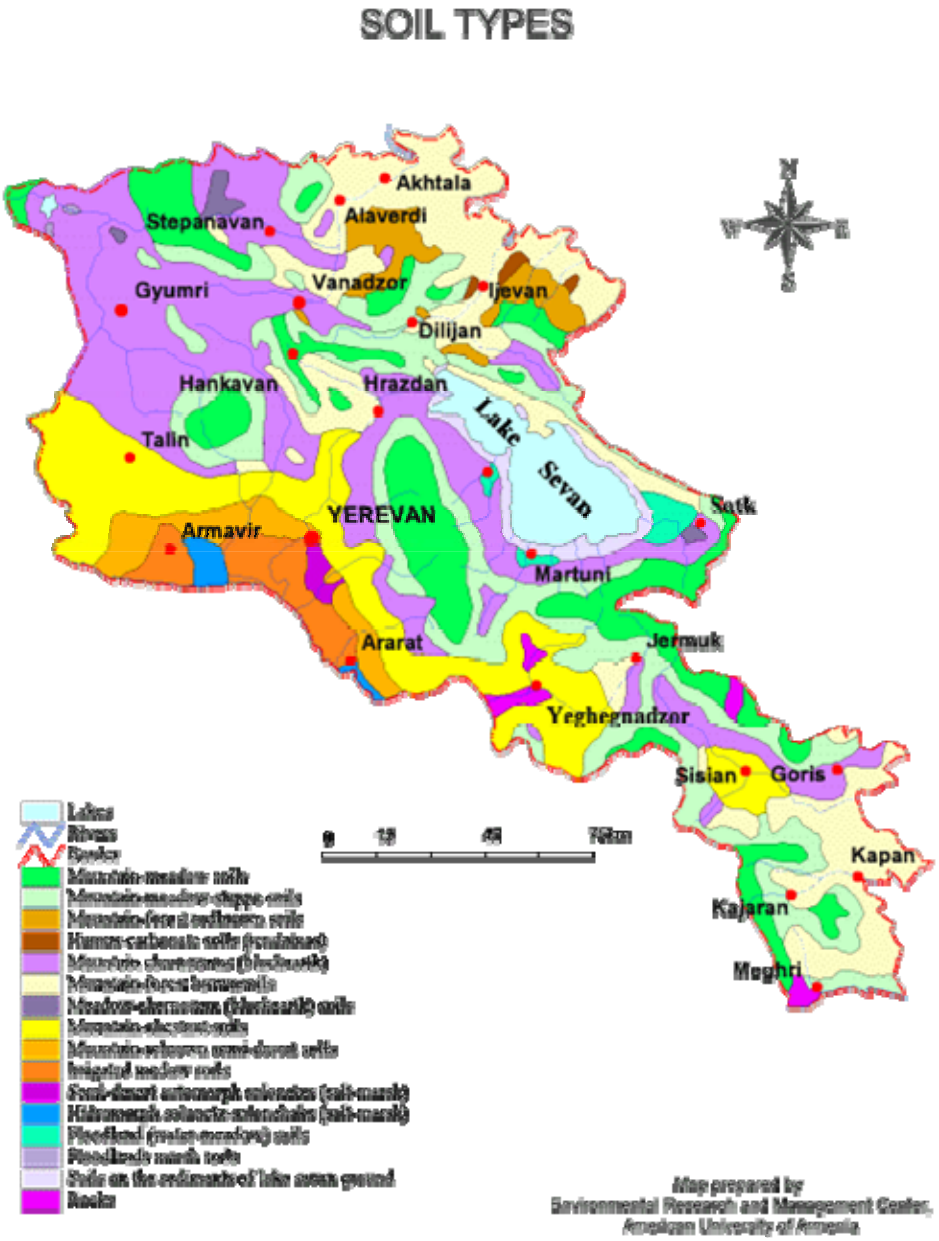


Figure 2.2-6 Land granted to the ANPP

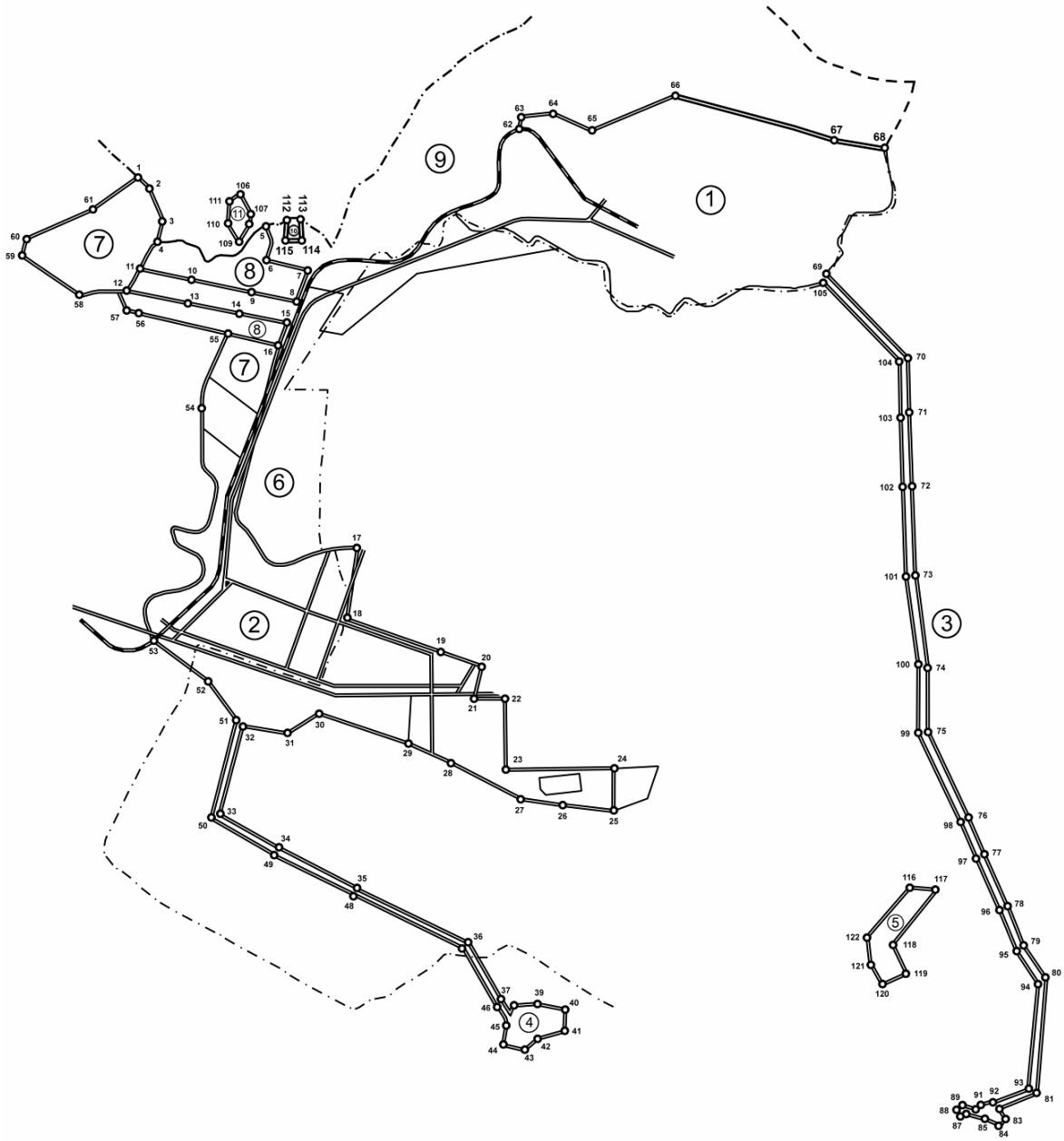


Figure 2.2-7 Armenia Mineral Resources

Figure 2.2-8 Metallic Mineral Deposits

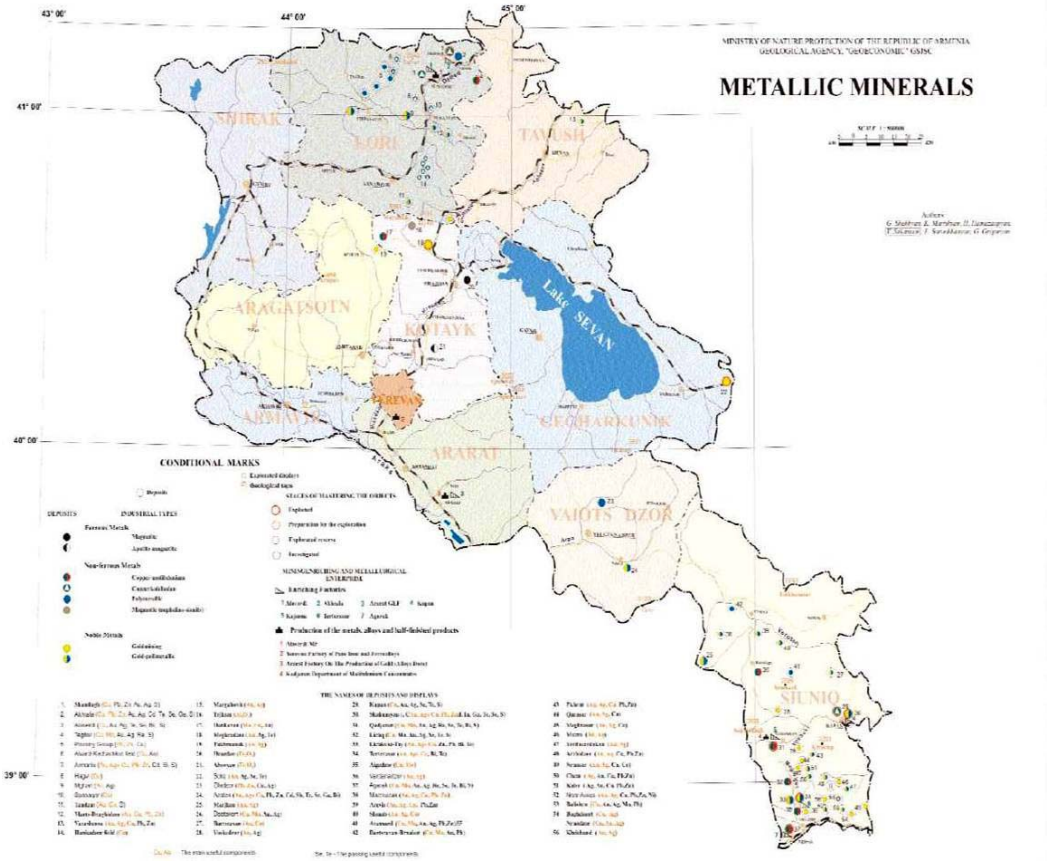


Figure 2.2-9 Non Metallic deposits

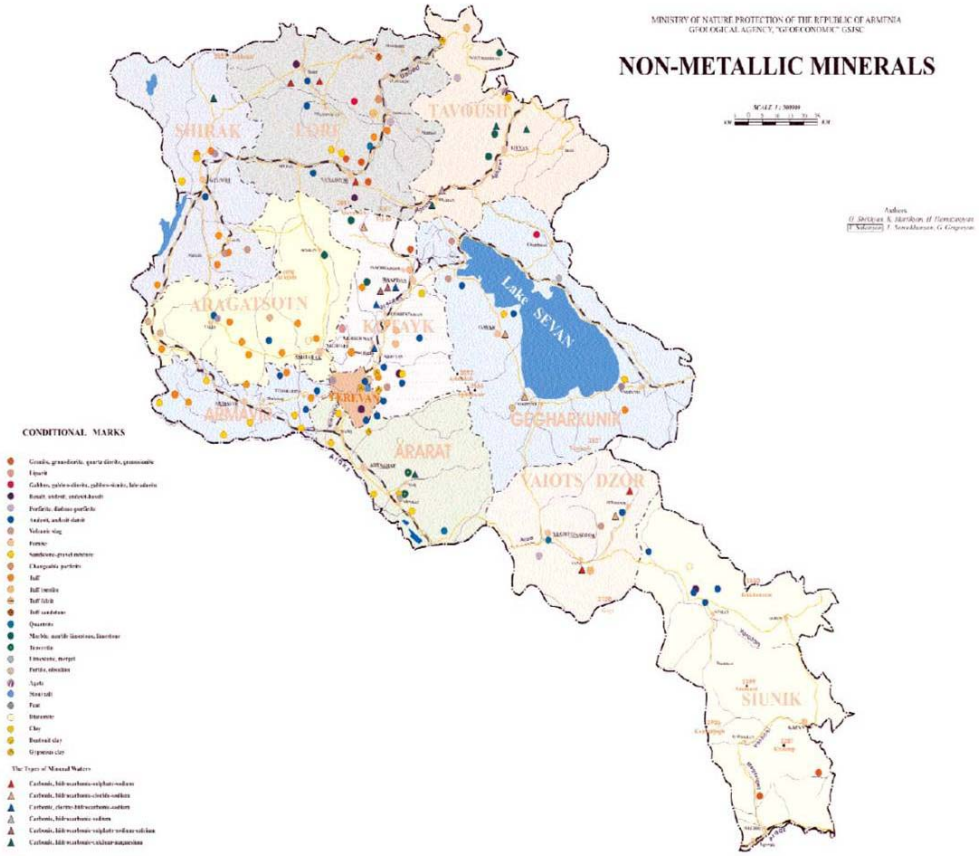


Figure 2.2 -10. Main Gas Transmission Pipelines Routes

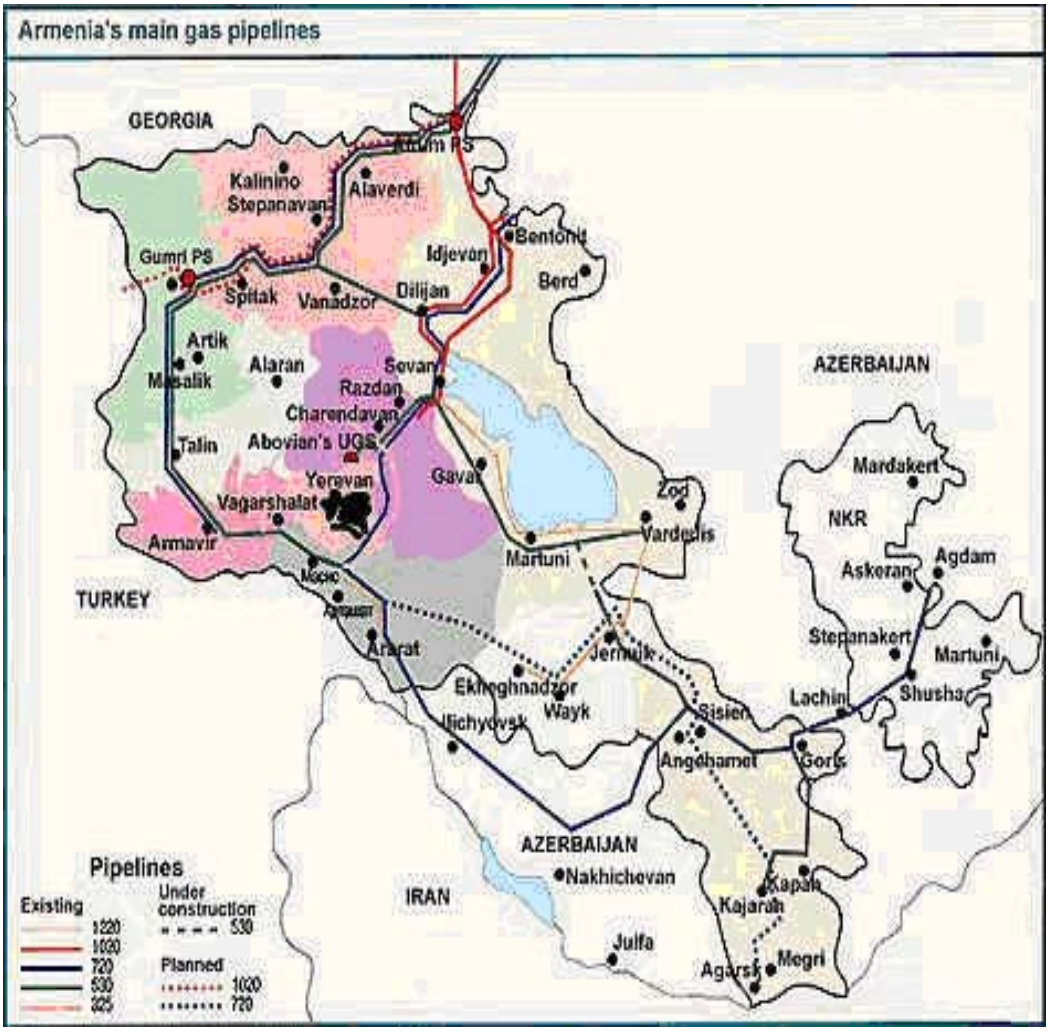


Figure 2.2 -11 Protected Areas of Armenia

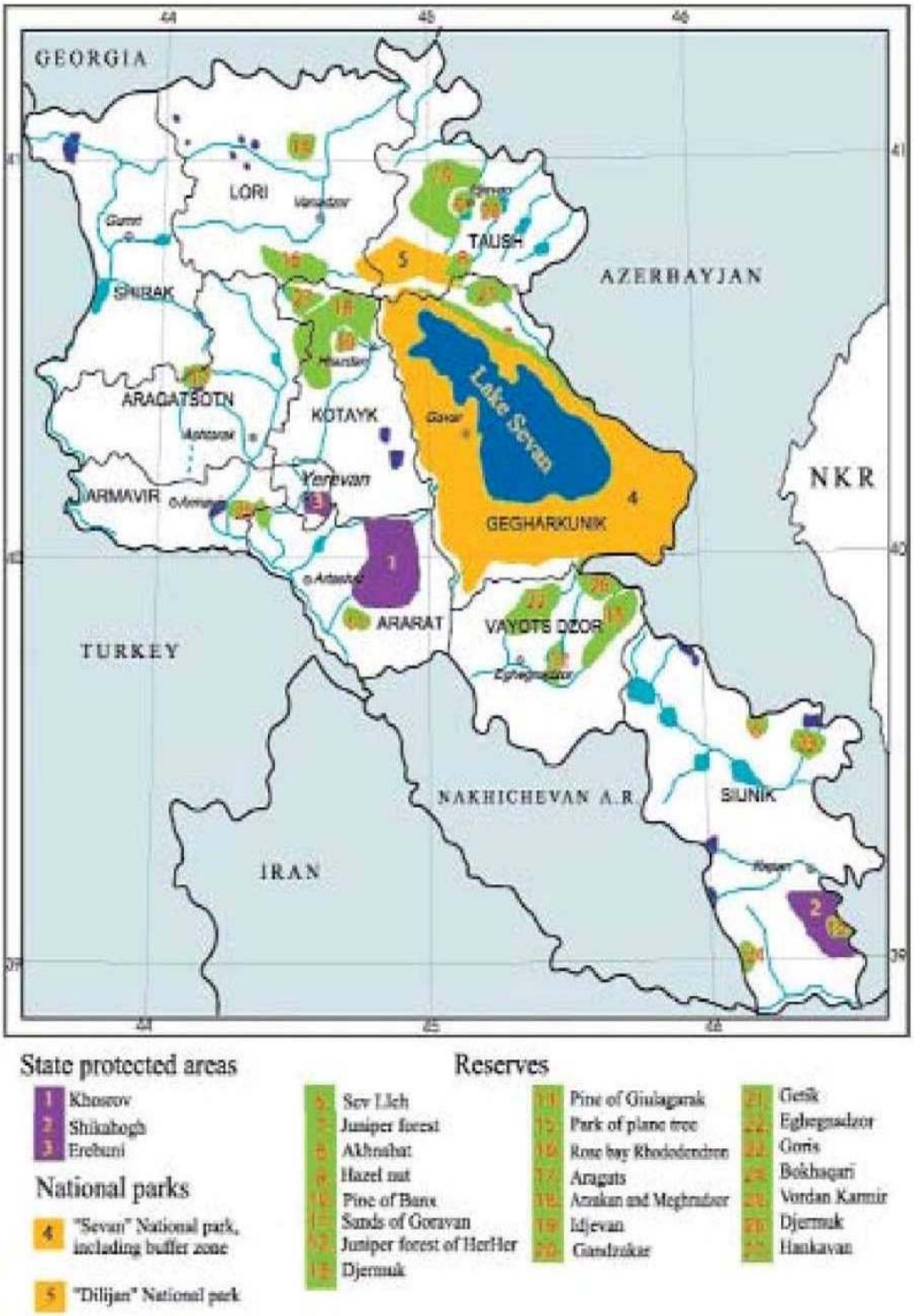


Figure 2.2-12 Wetlands of Armenia

REFERENCES:

[2.2-1] United Nations Environment Program, Global Resource Information Database (GRID), 2002, *Caucasus Environmental Outlook (CEO) 2002*, found at http://www.grid.unep.ch/product/publication/CEO-for-Internet/CEO/intro.htm

[2.2-2] RoA, Ministry of Nature Protection, March, 1999, *Republic of Armenia First National Report to The Convention on Biological Diversity incorporating "A Country Study on the Biodiversity of Armenia"*,

[2.2-3] Ministry of Nature Protection, Yerevan, July, 1999, *Biodiversity Strategy and Action Plan for the Republic of Armenia*.

[2.2-4] Ministry of Nature Protection of the Republic of Armenia, Yerevan 2002, *National Action Programme To Combat Desertification In Armenia*.

[2.2-5] Republic of Armenia State Cadastre, October 2007, *Atlas of Armenia*.

[2.2-6] CJSC Armenian Nuclear Power Plant, 2007, *Safety Analysis Report On Power Unit № 2 At The ANPP*, (UB.ATD.45.OYAB-004).

[2.2-7] "Republic Of Armenia, Ministry Of Nature Protection, Yerevan 2006, *Ministerial Report 2003-2005*. .

[2.2-8] Ministry of Nature Protection of the Republic of Armenia, Yerevan, 2002, *National Action Programme To Combat Desertification In Armenia*.

[2.2-9] Government of Armenia Decree 1848 dated December 12, 2004, *On Transferring Certain Lands*.

[2.2-10] Food and Agriculture Organisation of the United Nations, Subregional Office for Central and Eastern Europe, Budapest, December 2001, *Strategy for Land Consolidation and Improved Land Management in Armenia*, Pre-Feasibility Study, Study team: Dipl.-Ing. Karin Chluba (State Department for Land Consolidation, Baden-Württemberg) and Prof. Dr. Einhard Schmidt-Kallert (AHT International, Essen),.

[2.2-11] National Statistical Service, Republic of Armenia, Yerevan, 2006, *Marzes (Regions) of the Republic of Armenia in Figures, 2001 – 2005, Statistical Handbook*.

[2.2-12] Republic of Armenia State Cadastre, October 2007, *Atlas of Armenia*, p. 39

[2.2-13] Levine, Richard M., and Wallace, Glenn, *The Mineral Industries Of The Commonwealth Of Independent States: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Ukraine, And Uzbekistan*, Commonwealth of Independent States, USGS Minerals Yearbook 2004.

[2.2-14] Global energy Network Institute (GENI), December 10, 2002, *An Energy Overview of the Republic of Armenia*, San Diego California.

[2.2-15] Brownfield, Michael E., Matirosyan, Artur, Pierce, Brenda S., and, Johnson, Edward A., *Geologic Map Of The Jermanis Coal Field, Central Armenia*, Pamphlet to accompany Miscellaneous Field Studies Map MF–2350,. US Geological Survey, Reston, VA 20192.

[2.2-16] Republic of Armenia, 2005, *National Profile of Chemicals and Waste Management*, Yerevan.

[2.2-17] Khaniyan, Nazik, 2004, *Specially Protected Nature Areas Of Armenia*, Ministry of Nature Protection of The Republic of Armenia, Yerevan.

[2.2-18] "Europe's Environment, The Fourth Assessment," European Environment Agency, published 10 October 2007.
URL: http://reports.eea.europa.eu/state_of_environment_report_2007_1/en

[2.2-19] Ministry of Energy and Electrification of USSR, 1975, *Armenian Nuclear Power Plant, II Phase, Preliminary Design*, *Part 1*, "Thermopowerproject" Design Institute, Gorki Division, Gorki.

[2.2-20] State Unitarian Enterprise Scientific-Research Design and Construction Institute of the Ministry of Atomic Energy of the Russian Federation, 2001, *Armenian Nuclear Power Plant Unit 2, Essential Service Water Cooling System, Substantiation of Safety of the Essential Service Water System, including Issues of Environmental and Radiological Safety*, Section 8.2.3.1.

[2.2-21] Energy Institute SCJSC, 1998, *Feasibility Report Presented to the Government of the Republic of Armenia*,

2.3 WATER

A reliable source of water is essential to the operation of the power plant. Water is used for the production of steam, for the cooling of condensers to capture the energy in the steam, and to keep critical plant equipment cool. Discharges from the power plant will be returned to surface waters. The characteristics of the water source and the discharge sink, and the competing demands for water are important considerations in the assessment of environmental impacts.

Armenia is a landlocked country sharing rivers with their neighbors. There is no access to the sea. Armenia lies wholly within the Kura River basin although Kura remains outside of Armenia (Figure 2.3-1). The basins of the tributaries flowing directly to the Kura River cover less than 25 percent of the country, in the northeast. The major direct tributaries to the Kura are the Debet, Pambak, Agstev, and Tavoush Rivers. The remaining 22,790 km^2 of the country drain into the Araks River. The Araks flows into the Kura in Azerbaijan about 150 km upstream of where the Kura flows into the Caspian Sea. The river system is often referred to as the Kura Araks river Basin.

Water in Armenia is limited to the precipitation that falls on the country and to Armenia's fair share of the water that flows across or along borders into the country. Armenia must pass on a fair share of water as their rivers flow out of the country. They must also ensure that flows are allowed to remain high enough to support aquatic life in the rivers. Some of the water is lost to the atmosphere as evaporation or transpiration. The balance of the water is available to support the diverse needs of the Armenian people.

2.3.1 Water Balance of Armenia

On average 18.4 billion m^3 of precipitation falls on Armenia as rain or snow annually. It is estimated that 12.2 billion m^3 of water are lost back to the atmosphere as evaporation and 6.2 billion m^3 run off as river water within the country. Ref [2.3-1]

About 3.80 billion m^3 of the annual precipitation percolates into the ground. Of the water that percolates into the ground about 0.7 billion m^3 are extracted by wells and used for irrigation, domestic and industrial purposes. About 1.30 billion m^3 flows out of the ground in springs and makes its way into the rivers. The balance of 1.8 billion m^3 ultimately infiltrates directly into the rivers. The estimated 6.2 billion m^3 of river flow includes this 3.1 billion m^3 that flows first through the ground before becoming river flow (Ref [2.3-1]). Thus groundwater contributes 50% of the flow in the rivers. Also see Ref [2.3-39].

By agreement with Turkey, Armenia also has rights to half of the water flowing down the border rivers. The border flow of the Araks River between Turkey and Armenia is estimated at 1.929 billion m^3/year; that of the Akhuryan River, also between Turkey and Armenia, at 0.986 billion m^3/year. Half of these two flows, or 1.458 billion m^3/year, is accounted for in Armenia's water balance. The total actual renewable water resources (ARWR) are thus estimated at 7.458 billion m^3/year. References [2.3-1] and [2.3-2]

Some of the water originating inside Armenia flows downstream into other neighboring countries. These flows also are subject to decrees and agreements. Ref. [2.3-3]. The outflow to the Kura River in Georgia through the Debet River is estimated at about 0.890 billion m^3/year. The outflow to the Kura through Azerbaijan is estimated at about 0.555

billion m^3/year. The total outflow to Azerbaijan through the tributaries of the Araks River (Arpa, Vorotan, Vokhchi) is estimated at about 1.791 billion m^3/year. References [2.3-2] and [2.3-4]). The available water balance is reduced by the total of these three flows or 3.236 billion m^3/year.

The net available water available for use in Armenia annually is 4.221 billion m^3. These renewable water resources are summarized in Table 2.3-1.

Water use in Armenia was reported to be 1.5 billion m^3 in 1995. This was down from a usage of 3.5 billion m^3 in 1985. (Ref. [2.3-1]). Water use continued at the lower level through 2005. (Ref. [2.3-5])**.** The major use is for agriculture, primarily irrigation. Little of the water withdrawn for irrigation is returned to the rivers. The use for hydroelectric generation is large. However, this water essentially stays in the rivers. Approximate water uses nationwide for the period from 2002 through 2006 are summarized in Table 2.3-2. The purposes for which water is used vary among river basins (Ref. [2.3-39]). The average abstraction of water during that period was 2.36 billion m^3/yr; of this, 1.68 billion m^3/yr was consumed. The balance was returned to the rivers.

The average amount of water remaining in the national water balance is close to 2.54 billion m^3/yr. During the year of peak water usage, about 0.7 billion m^3/yr is uncommitted.

2.3.2 Distribution of Surface and Ground Water in Armenia

Surface and ground waters are not distributed uniformly across Armenia. The flow from the mountainous terrain of Armenia flows downward through numerous rivers. For the most part, the rivers and their tributaries are fast flowing. There are 379 rivers greater than 10 km in length in Armenia (Ref. [2.3-3]). There are 14 rivers longer than 35 km (Ref [2.3-1]). The characteristics of 18 of the larger rivers are listed in Table 2.3-3 (Ref. [2.3-6]). Some of these larger rivers might have the potential to support a large power plant.

The RoA Hydromet Office monitors water flow and surface elevation at 92 gauging stations throughout the country (Ref. [2.3-6])**.** Figure 2.3-2 shows the location of hydrological monitoring stations (Ref. [2.3-7]).

The variability of flow at seven monitoring stations on major rivers is shown in the Resolution of the Republic of Armenia establishing the water balance of the country (Ref [2.3-39], Attachment 8). The Resolution presents average flow for each monitoring station and the flow that is exceeded 25% and 75% of the time. Two monitoring stations on the Sevjur (Metsamor) River are included.

Mott McDonald Associates presented flow data for 36 hydrological monitoring stations on the Rivers (Table 2.3-4, Ref. [2.3-8]). For each monitoring station, flows are presented that are exceeded 5%, 25%, 50%, 75%, and 95% of the time. An average annual flow rate is also presented for each station.

The monthly average flow at the downstream gauging station on each river is presented in Table 2.3-5.

Several characteristics of the rivers are evident in the data. The gradients are steep, especially on the tributary watersheds. Gradients range from 98% on the Garis River down to 1 ‰ on the Sevjur River. (98% means that the river drops 98 meters in elevation as it flows 1000 meters downstream.) The range between the low and high flows is great for most of the rivers. There are several notable exceptions, including the Sevjur River, which is fed from groundwater.

The seasonal variation in flow follows a pattern that is similar for most of the rivers. The flows are low in December through February and high in the late spring. There also some exceptions to this pattern.

The variation in flows is moderated by lakes and reservoirs. Armenia has more than one hundred small lakes, some of which regularly dry out in the dry season. By their size and economic significance, Sevan and Arpi lakes are the most important. Sevan and Arpi lakes are the sources of Hrazdan and Akhuryan rivers, respectively. In additions, there are numerous much smaller lakes with only local significance. Ref. [2.3-5]

Armenia has 74 reservoirs that were built to support the use of the river water resources and to regulate the flow of rivers. The total annual river flow regulated by the reservoirs amounts to 1272.5 million m^3. The largest is the Akhuryan water reservoir, with a volume of 525 million m^3. Reservoirs support irrigation, hydroelectric power generation, fisheries, recreation and other uses. Ref. [2.3-9]. Most of the reservoirs were built to provide water for irrigation.

Table 2.3-6 provides data on the major reservoirs of Armenia. Ref [2.3-10].

Armenia relies on the energy in the falling water of various rivers to provide a significant part of its electrical energy needs. As of January 1, 2008 there were 61 small hydroelectric power plants provide 75 MW of generating capacity. Another 60 under construction will provide an additional capacity of 145 MW. Ref [2.3-11].

The lakes of Armenia are also mountainous and small. The one exception is Lake Sevan, located in the center of the country. Lake Sevan has an area of 1326 km^2 and is 1897 m above sea level. Lake Sevan is one of the larger freshwater lakes in Asia. It supported a very large fishery at one time. In recent years it has been exploited for other needs, notably power production during the 1990s. This resulted in a drawing down of the lake, reducing its area, impacting shoreline activities and impacting the fishery. Power is still generated from the water flowing out of the lake down the Hrazdan River. Subsequently schemes have evolved and projects are in various stages of implementation to divert additional flow into Lake Sevan from other surface waters.
Because it is located remotely from the Nuclear Power Plant site, it is expected that Lake Sevan will not be impacted by the plant.

The larger of the other lakes include Arpi, Kuri, Akna, Aigr and Sev lich. Additional information on these lakes, remotely located from the plant site, can be found in Ref. [2.3-12].

There are more than 100 small lakes in the territory of the Republic of Armenia, part of these lakes periodically dry out during the warm season. Small lakes are mainly

located above 1,500 m elevation. They have insignificant surface area, 0.5 - 2.0 km^2 in average. Ref. [2.3-9].
Table 2.3-7 provides data on the major small lakes of Armenia. Ref [2.3-12].

2.3.3 Water in the Vicinity of the Site

The NPP site is in the Armavir Marz near the Sevjur River as shown in Figure 2.3-3. The Sevjur River flows into the Araks River 31 kilometers downstream of the ANPP cooling water intake. The western marzes of Shirak, Aragatsotn, and a small portion of Armavir are drained by the Akhurian River which flows southeast along the border with Turkey. (See Figure 2.3-1). The Akhurian River joins the Aras-Nehre River flowing out of Turkey to form the Araks River. The Sevjur River flows into the Araks about 70 km south of this juncture. The Araks flows downstream serving as the boundary between Armenia and Turkey for a distance of about 50 km to the point where it becomes the boundary between Azerbaijan and Turkey, then Azerbaijan and Iran. Further downstream, the Araks again forms the border between Armenia and Iran before leaving Armenia for good. Beyond the Armenian border, the Araks flows into the Kura near Sabirabad in Azerbaijan. From there the Kura flows another 241 km to enter the Caspian Sea (Ref [2.3-9]). The Caspian Sea is landlocked with no outflow.

Flow data for the rivers downstream of the site are important to the evaluation of impacts to downstream water users.

2.3.3.1 SURFACE WATER FLOW IN THE SITE VICINITY

The existing ANPP draws water from, and discharges back into, the Sevjur River. The proposed new unit willobtain water from the Sevjur. Figure 2.3-3 shows the Sevjur River and its tributaries. The figure also shows the boundaries of the Sevjur watershed and sub-basins of tributaries.

The water balance of the Sevjur River was examined to show the impact of the water to be used by ANPP Unit 3. Table 2.3-4 shows that the Sevjur River has a fairly steady flow year-round. During the planning for the existing project, it was determined that the Sevjur could provide adequate flow for the four units to be built. Although the capacity of the new unit will be close to the capacity originally planned for the four unit site, the availability of water must be ensured.

It is not possible to determine the natural flow of the Sevjur from recent monitoring data because of the numerous withdraws from and discharges to the river. The average annual flow of the Sevjur has been reported as 21.7 m^3/sec (Ref. [2.3-6]). Table 2.3-4 lists the average flow at the Taronik gauging station as 20.6 m^3/sec. This is the gauging station closest to the existing ANPP cooling water intake and thus is of interest. The flow has been reported elsewhere as 33.1 m^3/sec in the Sevjur, 6.35 m^3/sec in the Kasakh, and 86.2 m^3/sec in the Araks (Ref. [2.3-12]) below the confluence with the Sevjur. The ANPP Unit 2 Safety Analysis Report describes the water availability as follows:

> "The estimated discharges of the Sevjur River at the intake site of the auxiliary water pumping station (right by the existing diversion dam) at 95% exceedance probability are a minimum of 11 m^3/sec and a maximum of 24.3 m^3/sec. The Sevjur River's runoff is used during the summer for irrigation. The maximum extraction rate is 10.02 m^3/sec. Therefore, during the minimum average daily discharges that can occur in any of the months in this period, the

> ANPP's water consumption needs can be met only by reducing the discharges from the Sevjur River for irrigation." (Ref. [2.3-6], Section 1.4.9)

The Sevjur flow is derived from ground water originating high up on Mt. Aragats, and apparently includes flow from precipitation falling outside of the basin. The groundwater surfaces in a number of springs and produces the fairly constant flow in the river that is shown in Tables 2.3-4 and 2.3-5.

The Safety Analysis Report on ANPP Unit 2 (Ref. [2.3-6]) describes the Sevjur River as follows:

> "The Sevjur River is 38 km long. The river is spring-fed. The hydrogeological characteristics of the Sevjur River:
> - average river width, 20 m;
> - average river depth, 2.5 m;
> - average annual velocity of current, 0.3 m/sec;
> - average annual river discharge, 21.7 m^3/sec."

Much of the flow of the Sevjur has been withdrawn for other uses before the river reaches the ANPP intake. The locations of flow monitoring stations in the vicinity of the NPP site are shown on Figure 2.3-3. Station 39 is on the Sevjur River immediately downstream of the NPP water intake near the village of Taronik. There is a small irrigation diversion dam there forming the pool from which the NPP draws water. Station 40, the Sevjur-Echmiadzin station, is on the Sevjur downstream of the confluence with the Kasakh River. Station 41 is further downstream, near Ranchpar. Station 32 is on the Akhurian River at the irrigation diversion dam above the confluence of the Akhurian with the Aras-Nehre. Station 25 is on the mainstream of the Araks River.

The data for stations on the Sevjur, Akhurian, and Araks rivers have been obtained from Hydromet Office records for three years and are summarized in Table 2.3-8. The flow is measured after water is withdrawn for irrigation and other uses including the operation of the existing NPP. The data are a crude indication of the amount of water currently not being used. The historic flow data discussed above along with information about the competing water uses must be relied on to assess the impact of the new power plant on water.

2.3.3.2 FLOOD FLOWS

The seasonal variation in flow is not readily apparent in the monthly average flows in Tables 2.3.5 and 2.3.8. The seasonal variation in irrigation withdrawals may mask some of the naturally occurring seasonal variation. Peak flows are not evident from the monthly averages either. The gradients of the rivers of Armenia are steep and flooding events are often of short duration. The daily flow measurements recorded and kept in the Hydromet Office records are of more value in determining peak flows.

Most of the flow in the Sevjur is derived from groundwater exiting the ground as springs. Without the influence of irrigation withdrawals, the flow would be fairly steady year round. Flows in the Akhurian and Araks are also influenced by irrigation practices.

River flows vary seasonally, with highest flows from April through July. The peaks correspond to episodes of high precipitation and high snow melt.

Flooding has not been reported in the Akhurian-Araks basin in the vicinity of the power plant. The area is low in precipitation. The ANPP reported that the average number of

days per month in which precipitation exceeds 30 mm is 0.4 per year for the month of June and zero for all other months. Working Group Four of the National Environmental Action Plan, Armenia, presented a summary of the frequency of flooding in various regions of Armenia (Ref [2.3-17]). Figure 2.3-5 is from their report. It shows that the vicinity of the plant site is not subject to flooding.

The Arpilich and the Akhuryan Reservoirs on the Akhuryan River two of the largest reservoirs in Armenia. The capacity of the Arpilich is 105 million m^3 and the capacity of the Akhurian is 525 million m^3. Because of the steep gradient of the Akhuryan-Araks river, the broad flood plain afforded by the Ararat Valley, the distance that the plant site is from the Araks, and the relative elevation of the site above the Araks River, failure of the dams should not pose a flood threat to the plant.

2.3.3.3 ENVIRONMENTAL FLOWS

There is a minimum flow that must be maintained in each river to sustain the aquatic life in the river. This environmental flow for the Sevjur River is established as 75% of the low flow that is exceeded 95% of the time. Ref. [2.3-9). This is calculated to be 75% of 16 m^3/sec, or 12 m^3/sec.

The importance of maintaining an environmental flow is widely recognized (Refs. [2.3-18] and [2.3-19]). The method used in Armenia to establish the environmental flow is arbitrary and is applied to all rivers in the country. However there are alternative ways of determining the specific flow that should be maintained in the Sevjur. The updated report on the Loriberd project, a hydroelectric project on the Dzoraget River, examined several alternative approaches to computing the flow which should be maintained to support the aquatic ecosystem. Ref. [2.3-20).

The flow as measured recently is lower than 12 m^3/s during most of the year and has averaged less than 12 m^3/s in some years. The RoA will have to determine whether the prevailing flows in the river are now the norm. The environmental flow that must be imposed in order to protect the productivity of the Sevjur will have to be established (according to the Water Code, this would be by the Akhurian Basin Management Organization, although this may be done by the WRMA in conjunction with defining allocation of water to all users – see Section 1.1.3.3).

2.3.3.4 GROUNDWATER

As was noted in the introductory paragraph to this Chapter, about 50 per cent of Armenia's water balance exists as groundwater. Table 2.3.9 provides information about the ground water aquifers of the Armavir Marz. The table shows the estimated yield of each aquifer. The ten aquifers in the Sevjur River Basin have an "Approved Operational Reserve" of 5,394,000 m^3/day. This is equivalent to 62.4 m^3/sec. Although groundwater is a potential source of cooling water for the new power plant, utilization of groundwater would ultimately reduce the water reaching the Sevjur River.

The quality of the ground water varies among the aquifers. Table 2.3-9 shows the total dissolved solids for the three sets of aquifers. Values range from 350 to 1000 ppm (approximately, mg/l).

Groundwater quality was being monitored at several springs in Armenia (Ref. [2.3-39]). That monitoring program was discontinued following the dissolution of the Soviet Union. The RoA Environmental Impact Monitoring Center is in the process of reinstituting groundwater monitoring. The ANPP radiological monitoring program samples

groundwater from monitoring wells in the vicinity of plant buildings, as well as drinking water supplies in the site vicinity, for radioactivity and radioisotope concentrations.

2.3.4 Competing Water Users

A permit must be obtained from the Water Resource Management Agency of the Ministry of Nature Protection before water can be withdrawn from the streams and rivers of Armenia. This allows the state to ensure that water is available for priority water needs. The same agency issues permits for discharging water to the streams and rivers.

Permits have been issued for the withdrawal of 18.8 m^3/sec from the Sevjur River. The uses are for four purposes: fisheries, agriculture, power production and industry (see Table 2.3-10).

Downstream of the power plant site, water in the Araks River is not as limited in quantity as in the Sevjur. Competition with the new power plant for the water resources of the Araks is not likely to be of importance. However, those using water downstream from the plant may be impacted by the operation of the plant. The water withdrawal permits issued within the Ararat marz are primarily for ground water. The primary permitted water uses here, too, are fish farming or irrigation.

2.3.4.1 AGRICULTUREIRRIGATION

Table 2.3-10 shows that the major use of water competing with the power plant for the water of the Sevjur River Basin is irrigation. Fish farms were permitted to withdraw a greater amount of water; however, most of the water withdrawn for fish farming is expected to be returned to the river. The historic growth in demand for water for irrigation is shown in Table 2.3-11.

The demand for water for irrigation in Armenia will grow during the operating life of the plant. One study estimated that 4,814 hectares of land removed from irrigation in the past will be placed back under irrigation between now and 2020 but will not change significantly between 2020 and 2050. The projected demand for water for irrigation will reach 15.2 m^3/s by 2020 (Ref. [2.3-9]). Although predictions have not been found for the Sevjur River, It is likely that the demand for water for irrigation from the Sevjur will also grow.

The projections based on current irrigation practices show that the demand for Sevjur River water for irrigation will exceed the available flow (Ref [2.3-9]). Changes in practices could alter the balance between supply and demand. In 1998 it was reported that the efficiency of the irrigation system does not exceed 45% on average. That is to say that no more than 45 % of the water entering the irrigation system infiltrates the ground near the cultivated plants. In 1989 the efficiency was around 58% on average for the republic (Ref [2.3-17]). Efforts are underway to improve the irrigation systems and practices in the Republic of Armenia (Ref. [2.3-23]). Their primary objective is to sustain or enhance agricultural productivity. Such projects should have a secondary benefit of reducing water losses. Concerns over desertification are also bringing focus on irrigation practices, again with a potential benefit of reducing water usage (Ref. [2.3-24]).

Currently water may be used periodically outside of the growing season to flood fields to wash accumulated salts out of the soil. There is no standard for this practice and it has been claimed to be potentially wasteful of water and even harmful to the soil.

Drainage systems in the irrigated areas have not all been properly maintained. Lack of maintenance of these systems has allowed ground water levels to rise causing salinization and alkalinization of the soil.

Numerous permits have been issued to withdraw ground water from the Sevjur basin to use for irrigation. Total permitted ground water withdrawals exceed 2 m^3/s as an annual average.

There is a long history of the use of canals in Armenia to redistribute water to where it is needed. Today the canals primarily serve agricultural interests. There are two irrigation canals connecting to the Sevjur River: The Hrazdan Canal and the Armavir (once called the Hoktembrian) canal. These canals were built to serve agricultural needs and currently deliver very little flow to the Sevjur. The Hrazdan canal draws water from the Hrazdan River and flows westward to the Kasakh River.

The Armavir canal draws water from the Araks River at an irrigation diversion dam near Karakala (40°02'41"N, 43°50'26"E). This canal has been refurbished recently and has the capability to bring water to the Sevjur. Under an agreement with Turkey, Armenia is entitled to withdraw about 37 m^3/sec from the river at this point. However, the canal serves agricultural requirements and at the present time the amount of water diverted into the Armavir canal is just adequate to meet those needs (about 19 m^3/sec). There is a small hydroelectric power plant generating energy from the water when the agricultural demand is low. The hydro plant returns the water to the Araks river a short distance downstream at a lower elevation.

It appears that the major canals do not have the capability to divert water away from the Sevjur River.

2.3.4.2 FISH FARMING

It is estimated that there are 200 fish farms in Armenia. About 70 of these are active. Most are small operations and most of those in the Ararat Valley use groundwater. The total fishery production from all waters in Armenia in 2003 has been estimated as 1,633 tonnes live weight. (Ref. [2.3-25])

There have been 130 permits issued for withdrawal of water from the Sevjur for fish farms. The permitted withdrawals for this purpose total 11.1 m^3/sec. The permits allow for the return of 10.3m^3/sec to the Sevjur. It has been estimated that 30% of the water withdrawn for fish farming is evaporated (Ref. [2.3-9]).

There have been 20 permits issued in the Armavir Marz to withdraw ground water to use for fish farming. Total ground water withdrawal for fish farming exceeds 2 m^3/s on an annual average.

The Armash Fish Ponds constitute one of the best known bird watching sites in the country. These ponds are more than 100 km from the power plant site and are unlikely to be impacted by station construction or operation.

2.3.4.3 DOMESTIC WATER USAGE

No permit has been issued for withdrawal of water from the Sevjur River for domestic use. Article 22 of the National Water Code allows free water uses for limited purposes (Ref [2.3-38]). Individuals may be using water from the Sevur River for domestic purposes without a permit.

No permits have been issued to withdraw water from the Araks for household use. Individuals in the Ararats marz may be using water from the Araks River for domestic purposes without a permit.

2.3.4.4 INDUSTRIAL WATER USAGE

One permit has been issued for withdrawal of water from the Sevjur River for industrial purposes. The authorized annual average withdrawal is equivalent to 0.0065 m^3/s.

2.3.4.5 MINING

There is no significant mining activity in the Ararat Valley down to the border with Azerbaijan. There are some large mining operations in Armenia further downstream where the Araks River serves as the border with Iran. There is some quarrying of stone closer to the site; however, the quarrying does not compete for the water resources of the Sevjur.

2.3.4.6 HYDROELECTRIC POWER

> "Armenia's hydroelectric power plants supply about 30% of the country's electricity. Almost all of the hydropower is generated from the Hrazdan and Vorotan Rivers. There are six hydroelectric plants on the Hrazdan River in west-central Armenia, including the Sevan plant which also acts as a water intake structure for the Hrazdan from Lake Sevan. These six power plants are known as the Sevan-Hrazdan Cascade and have a combined nominal generating capacity of more than 500 MWe. However, these hydroelectric plants suffer from aging equipment and deferred maintenance, and they generally have much less capacity than their nameplate ratings. Another problem with hydroelectric generation from the Sevan-Hrazdan Cascade is that irrigation needs reduce the amount of water available from the lake for hydroelectric power production. As a result, the hydroelectric power plants must generally be operated as run-of-the-river, which means they can only produce electricity at much less than their nameplate capacity." (Ref. [2.3-26])

There are ten power plants with nameplate capacities in excess of 10 MWe including those listed above. There are about 45 more plants of less than 10 MWe capacity. Other than the one on the Armavir irrigation canal, none of the smaller units is in the vicinity of the NPP site. (Ref [2.3-27]). The hydroelectric power plants are not competing for the water of the Sevjur River.

2.3.5 Water Balance for the Sevjur

The present flow and water use data for the Sevjur River upstream of the Taronik monitoring station have been summarized to show a water balance for the river (See Table 2.3-12). (The 5% flow condition is the flow rate that that flow does not fall below more than 5% of the time.) The average flow listed for the Sevjur River is the natural flow. The actual flow is the net available flow. The table shows that most of the water in the Sevjur at Taronik has been allotted. The net available is only slightly greater than the required environmental flow.

By letter dated November 15, 2007, the Minister of Nature Protection advised the Minister of Energy that the Sevjur River can be the source of water for ANPP Unit 3 (Ref. [2.3-40]). He advised that the water intake point and the water amount will be adjusted according to the established procedure during the evaluation of an application for a water use permit.

2.3.6 Water Quality

Water quality is important in the engineering of the new unit at the power plant. Furthermore, discharges from the power plant must be evaluated in the context of existing water quality.

Water quality of the natural water bodies is impacted by soluble minerals on and in the ground. It is also impacted by domestic wastewater discharges, by irrigation practices, by mining activity and by a number of other industrial activities. The First Report on Biological Diversity in Armenia, 1999 (Ref. [2.3-12]), describes the general state of water quality in Armenia as follows:

> "River pollution has increased as a result of increasing human pressure. Annually around 200-250 million m^3 of polluted water reaches ground water reserves, of which 56% comes from the industry and energy sector, 26% from domestic use, and 18% from agriculture. A number of major rivers are now heavily polluted, and cannot be used for agriculture or irrigation, and may pose a threat to the conservation of biodiversity. However, the current social-economic crisis has resulted in issues such as soil and water pollution being overlooked."

The Report on the State of the Environment 2002 (Ref. [2.3-28]) elaborated on the national water quality issues as follows:

> "Untreated or insufficiently treated sewage is the main cause of the pollution of water bodies. In Soviet times, the level of pollution in Armenia's rivers was quite high, which led to worsening water quality. At present, data on the pollution levels of surface water of Armenia are not precise. The analysis of the scarce data available shows that an improvement of water quality in rivers in recent years, due to the decrease in the volume of irrigation as well as the fact that the majority of industrial enterprises have ceased to operate. At present, within the framework of the limited monitoring activities implemented, it can be assumed that the quality of surface water is sufficient, except for flows from Yerevan and other large cities. It should be mentioned also that without proper attention during the large-scale recovery of industrial activity, water quality could deteriorate. The problem is aggravated by the fact that none of the 19 existing waste water treatment plants in the Republic of Armenia functions. This is partly due to the earthquake in 1998, as well as the energy crisis at the beginning of the 1990s. According to technical and economic calculations, of the 19 waste water treatment plants it is possible to restore only 6 or 7. The others need to be reconstructed using modern treatment technologies.
>
> "In Armenia, all cities and about 20% of rural settlements have sewage systems. All waste water treatment plants in the Republic were constructed before 1990. The technologies applied in the plants are not efficient and do not meet modern requirements. Moreover, the treatment technologies used were based on practically free energy (both natural gas and electricity). Under present conditions, their use is extremely expensive and the use of existing water treatment facilities cannot be justified."

The quality of the water in the Sevjur is more likely to be influenced by its origin than it is by waste discharges. In passing through the ground in its travel down from Mt Aragats, the water dissolves minerals from the soil and rocks. The water in the Sevjur River is high in mineral content. Ground passage affects the measured quality in other Armenian rivers. Agriculture practices in the Sevjur drainage basin might alter water quality also. Airborne constituents may be deposited in measurable amounts in surface waters.

Water quality of the surface waters of Armenia is monitored by the Republic of Armenia Environmental Impact Monitoring Center. Over the years, water quality has been monitored at as many as 131 points (Ref [2.3-29]). Ninety-nine monitoring stations are shown on **Figure 2.3-5.** (Ref. [2.3-30]).

Water quality parameters measured include: Temperature; Transparency; Suspension; Color; Pxtor; Oxygen ; Saturation; Carbon Dioxide; pH; Calcium1; Calcium2; Magnesium1; Magnesium2; Sodium; Potassium; Hydrocarbonate1; Hydrocarbonate2; Carbonate2; Carbonate1; Sulphate1; Sulphate2; Chloride1; Chloride2; Nitrate1; Nitrate2; Nitrate Nitrogen; Ammonia; Ammonium Nitrogen; Nitrogen Sum In Min Comp; Ionic sum; Mineralization; Orthophosphate; Silicic Acid; Rigidity; Biological Oxygen Demand (BOD); Perman Oxygen; Chemical Oxygen Demand (COD); SMAN; Petrochemicals; Gum Asphaltenes; Conductivity; Li; Be; B; Na; Manganese; Aluminum; P; K; Ca; Vanadium; Cr; Iron; Mn; Cobalt; Nickel; Copper; Zinc; Arsenic; Br; Se; Rb; Sr; Mo; Silver; Cadmium; Lead; Sn; Sb; I; Te; Cs; Ba; Tl; Bi; U; Titanium.

As a result of its ground water origin, the temperature of the Sevjur remains high and relatively constant year round. Mineral content is high, in some instances exceeding applicable water quality standards.

Table 2.3-13 gives the monthly average temperature for the three monitoring stations on the Sevjur. Temperature of the Sevjur is higher and less variable than the temperature of other rivers.

The RoA National Water Code sets the framework for establishing water quality standards for each water body within five basin planning areas (Ref [2.3-38]). The National Water Program, adopted in 2006, gives additional detail on how water standards are to be developed and applied (Ref [2.3-39]). These new standards will be one component of the basin plans. Specific standards have not yet been promulgated for the Sevjur River. Therefore, the generally applicable standards developed during the Soviet period are applicable. Those standards are included here as **Table 2.3-14.**

2.3.7 Transboundary Water Issues

Armenia shares boundary waters with its neighbors. The Araks River serves as a boundary between Armenia and Turkey and Iran. Rivers that flow across boundaries into or out of Armenia are also shared as boundary waters. There is concern about the quantity and quality of those boundary waters. The greater concern at present is the quantities of water taken.

Formal agreements specify the rights of each country to water in the section of the Araks and the Arkhurian Rivers that forms the boundary between Armenia and Turkey (Ref. [2.3-3]). The Araks River is not a large portion of the national water balance in Turkey. However, the Government of Turkey has a number of regional concerns over the use of the Araks River. (Ref. [2.3-31])

Other decrees and agreements define how the Debed River will be shared between Armenia and Georgia. Agreements between Armenia and Azerbaijan concern the use of waters of the Arpa, Vorotan, Aghstev and Tavush Rivers." (Ref. [2.3-3])

There is an awareness of the need for joint efforts to protect the quality of transboundary waters, and some preliminary steps have been taken which include all nations (see References [2.3-8], [2.3-31], [2.3-32], [2.3-33], [2.3-34], [2.3-35], and [2.3-36]). Cooperative studies of the protection of the Caspian Sea are in progress involving those

nations directly bordering the Caspian (Ref. [2.3-29]). Those studies have not extended beyond the bordering countries to include the entire drainage area.

Table 2.3-1, The renewable water resources of Armenia

Source	Annual amount, billion m^3/year
Total Armenia precipitation	18.4
Evapo-transpiration and unaccountable Losses.	12.2
One Half of the Flow in the Akhurian River above the Araks River*	0.493
One half of the Flow in the Araks*	0.964
Total Available Water*	7.457
Less water discharged to downstream neighboring countries	-3.236
Net available water available in Armenia	4.221

*One half of the Akhurian and Araks flows are included in the Armenian water balance.

Table 2.3-2, Categories of Water Use and Requirements for Each Category

From ARMSTAT National Report 2007

147. ՋՐԱՌԸ ԵՎ ՋՐՕԳՏԱԳՈՐԾՈՒՄԸ
WATER ABSTRACTION AND CONSUMPTION
ВОДОЗАБОР И ВОДОПОТРЕБЛЕНИЕ

(մլն. մ³) *(mln. m³)* (млн. м³)

	2002	2003	2004	2005	2006	
Ջրառը, ընդամենը *Total water abstraction*	1733	1976	2803	2342	2827	Водозабор - всего
այդ թվում՝ ստորգետնյա աղբյուրներից *of which, from underground sources*	475	474	622	557	611	в том числе из подземных источников
Ընդամենը օգտագործվել է ջուր *Total consumption*	1312	1430	1782	1905✧	1991	Всего использовано воды
այդ թվում ըստ կարիքների՝ *of which for:*						в том числе на:
տնտեսական և խմելու *household and drinking purposes*	109	98	78	69	102	хозяйственно-питьевые нужды
արտադրական *industrial purposes*	87	222	177	70	96	производственные нужды
գյուղատնտեսական ջրամատակարարման, ոռոգման, ջրարբիացման և այլ *agricultural water supply, irrigation, supplying with water and other*	1116	1110	1527	1766✧	1793	сельскохозяйственное водоснабжение-орошение, обводнение и другие

Շարունակություն
Continued
Продолжение

	2002	2003	2004	2005	2006	
Ընդհանուրի նկատմամբ, % *In % of total*	100	100	100	100	100	К итогу, %
այդ թվում ըստ կարիքների՝ *of which for:*						в том числе на:
տնտեսական և խմելու *household and drinking purposes*	8	7	4	4✧	5	хозяйственно-питьевые нужды
արտադրական *industrial purposes*	7	15	10	4✧	5	производственные нужды
գյուղատնտեսական ջրամատակարարման, ոռոգման, ջրարբիացման և այլ *agricultural water supply, irrigation, supplying with water and other*	85	78	86	93✧	90	сельскохозяйственное водоснабжение-орошение, обводнение и другие

Table 2.3-3, Hydrological characteristics of main rivers of Armenia

River	Flow into river	Altitude of upper point, m	Altitude of lower point, m	Length, km	Average slope, %	Catchment area, km^2
Debed*	Kura	2,100	380	154	11	3,790
Pambak	Debed	2,100	870	84	13	1,370
Aghstev*	Kura	2,985	500	81.0	31	1,730
Voskepar*	Aghstev	1,975	720	33.0	38	273
Karakhan*	Voskepar	1,960	598	31.0	44	170
Akhum*	Kura	2,810	523	41.5	55	248
Tavush*	Kura	2,000	660	29.5	45	229
Hakhindja*	Tavush	1,950	550	37.0	38	326
Akhuryan*	Araks	2,017	950	186.0	5.7	2,784
Sevjur	Araks	860	823	38.0	1.0	3,720
Hrazdan	Araks	1,897	820	141	7.6	2560
Azat	Araks	2,050	815	40.0	31	572
Vedi	Araks	2,720	810	58.0	33	633
Arpa*	Araks	3,200	960	92.0	24	2,080
Vorotan"	Araks	3,045	722	111	21	2,030
Goris*	Vorotan	3,200	820	25.0	95	146
Vokhchi*	Araks	3,650	740	43.0	68	788
Meghri	Araks	3,300	500	36.0	78	336

Source: Institute of Water Problems and Hydraulic Engineering

*) Data for Armenian part of catchment area

Table 2.3-4, Comparison of Flows in the Larger Rivers of Armenia.

No. on general map		River, calculation section	Distance from mouth	F 1000 km^2	Average flow rate	River flow, m^3/sec				
Old	New		km		m^3/sec -	5%	25%	50%	75%	95%
1	1	Pambak-Shirakamout	148	359	3.91	4.28	3.22	2.84	2.47	1.73
3	3	Pambak-Gougark	111	1070	9.04	14.01	10.29	8.68	7.69	6.00
4	4	Pambak-Toumanian	92	1370	17 0	16 88	13.32	11 75	10 42	7.79
6	5	Devbed-Akhtala	53	3430	35.5	49.43	40.70	34 34	29 80	23 69
13	11	Dzoraget-Stepanavan	27	1000	12.9	18.39	14.08	12.66	11.33	9 94
14	12	Dzoraget-Gargar	4.4	1450	17.0	21.97	19.14	16.33	14.71	11.87
21	16	Aghstev-Fioletovo	96	93.4	1.29	1.67	1.40	1.30	1.08	1.06
29'	18	Aghstev-Ijevan	54	1270	9.07	12.68	10.84	8.93	7.97	3.45
26	20	Getik-Alachoukh	17	581	3.60	5.36	4.14	3.67	3.00	1.57
31	101	Voskepar-Voskepar	7.7	184	1.32	2.46	1.74	1.27	0.91	0.35
33	23	Hakhoum-Tsaghkavan	39	169	1.56	2.62	1.93	1 67	1.23	0.65
, 34	24	Tavoush-Bend	22	102	0 69	1 75	0.74	0.61	0.46	0 25
35	25	Hakhinja-Aygedzor	42	403	3.07	4.65	3.63	3 04	2.49	1.12
40	28	Akhouryan-Paghakn	186	220	1.98	3.20	2.34	1.87	1.48	1.13
42	30	Akhouryan-Akhourik	117	1060	9.75	13.60	10.80	9.39	8 23	7 59
54	39	Karkachoun-Gharibjanyan	2.5	1020	1.59	2.47	1.89	1.35	1.12	0.95
60	43	Kasakh-Vardenis	68	441	2.45	3.64	2.89	2.19	2.08	1.14
62	45	Kasakh-Ashtarak	29	1020	7 44	10.37	8.74	7.28	6.29	5.16
56	40	Sevjur -Taronik	31	1560	20.6	24.79	22.41	20 88	19.30	16.00
57	42	Sevjur-Ranchpar	4.9	3540	33.9	39.83	37.20	33.23	29 26	27.58
36	26	Araks-Sourmalou	696	22100	87.6	142.1	97.27	84.42	73.53	48.43
70	50	Hrazdan-Hrazdan (Aghbiurak)	108	697	9.47	13.13	10.56	9.24	8.51	5.94
74	135	Hrazdan-Arzni	68	1270	13.9	19.13	15.88	13.51	12.33	7 50
77	53	Hrazdan-Massis	22	2310	22.5	27.34	24.58	23.14	20.65	14.28
79	55	Marmarik-Aghavnadzor	8.0	375	5.43	8.67	6.39	4.94	4.60	2.47
89	60	Masrik-Torf (TSovak)	3.6	673	3.97	5.06	4.39	3.94	3.45	3 15
95	65	Argichi-V. Getashen	6.0	366	5.60	7.99	6.59	5.30	4.54	3.30
101	70	Gavaraget-Noratous	7 5	467	3.80	4.79	4.03	3.74	3.50	3.23
Sayan		*lake, inflow sum.inlow*		3500	26 8	33 54	29.32	25.71	23 95	2043
105	136	Azat-Lanjazat	15	526	6.88	8 60	7.44	6 79	6.41	5 36
107	72	Vedi-Ourtsadzor	25	348	2.04	3.25	2 41	2 06	1 53	1.26
109	138	Arpa-Kechouti reservoir	97	327	8.55	12.92	9 42	8 63	7.00	6 08
111	74	Arpa-Yeghegnadzor	56 1	1220	13.1	20.81	14.76	12.96	10.41	8 72
112	75	Arpa-Aren8	42	1880	23.2	36.10	26.46	22.99	18.43	15.99
118	137	Yeleguis-Tounel	31	110	3.71	5.48	4.21	3.71	3.06	2.56
119	80	Yeleguis-Shatin	10	458	8.18	12.15	9.34	7.95	6.66	5.58
133	129	Vorotan-Tsghouk (Borisovka)	142	507	7.62	10.51	8 51	7.79	6.40	5.09

From the JRMP Final Report Kura Basin Annexes (Ref [2.3-10]).

Table 2.3-5, Monthly Average Flows in the Major Rivers of Armenia

River Section	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
Pambak-Nalband	1.71	1.55	1.50	4.34	7.28	4.29	2.62	3.97	2.02	1.88	1.41	1.53	2.84
Pambak-Gugark	4.20	4.67	4.95	18.50	21.50	14.90	9.83	6.11	5_07	4.83	5.19	4.45	8.68
Pambak-Tumanyan	4.67	4.67	10.20	22.40	33.50	15.80	8.72	9.45	15.80	5.73	5.18	4.88	11.75
Debed-Ahtala	14.50	13.60	22.50	59.80	100.0	61.80	26.20	23.80	30.40	27.40	17.00	15.10	34.34
Dzoraget-Stepanavan	6.81	7.38	7.38	19.60	40.60	19.90	11.80	7.66	8.14	8.51	8.06	6.10	12.66
Dzoraget-below gargar	7.02	7.27	10.20	26.50	45.70	29.60	12.50	11.10	14.40	12.60	10.00	9.02	16.33
Aghsev-Fioletowo	0.38	0.40	0.90	3.54	4.96	2.00	0.78	0.56	0.56	0.72	0.38	0.40	1.30
Aghstev-Ijevan	1.92	1.95	4.73	16.70	28.60	21.80	6.03	4.62	6.66	6.08	4.30	3.79	8.93
Getik-Getaberan	0.96	0.90	2.57	15.06	6.30	7.93	3.30	2.25	1.50	1.21	1.21	0.90	3.67
Voskepar-Voskepar	0.17	0.17	1.72	6.00	1.96	2.89	0.65	0.43	0.41	0.31	0.24	0.24	1.27
Karakhan-Kirants	0.35	0.41	0.45	1.57	4.72	1.82	0.85	0.32	0.36	0.24	0.21	0.18	0.96
Hakhum-Tsaghkavan	0.59	0.60	1.55	3.90	4.17	3.45	1.22	0.91	0.76	0.61	0.66	0.47	1.57
Taush-Berd	0.13	0.17	0.63	0.98	1.81	1.88	0.55	0.32	0.23	0.19	0.19	0.18	0.61
Kndzorut-Ajgedzor	0.68	1.01	1.54	7.11	8.20	9.53	3.14	0.98	0.94	0.83	1.74	0.79	3.04
Akhurian-Paghakn	0.68	0.71	1.02	3.93	8.30	3.16	1.36	0.85	0.47	0.73	0.62	0.62	1.87
Akhurian-Akhurik	6.84	5.90	6.47	24.1	22.2	9.72	7.77	6.66	6.05	5.75	5.54	5.61	9.39
Karkachun-Karibchanyan	0.51	0.50	2.09	1.60	2.40	2.68	1.95	1.25	1.12	0.74	0.73	0.58	1.35
Araks-Surmalu	34.46	34.56	47.76	152.4	164.0	162.7	106.8	80.30	66.70	61.90	60.94	39.86	84.42
Sevjur-Taronik	23.4	22.7	23.4	26.4	17.9	13.6	14.5	16.20	22.30	23.20	23.40	23.60	20.88
Sevjur-Ranchpar	30.40	28.80	29.30	49.90	46.60	34.50	31.00	30.80	30.40	29.30	29.50	28.30	33.23
Kasakh-Vardenis	0.54	0.67	0.77	6.48	5.48	3.99	1.60	1.23	1.38	1.47	1.34	1.28	2.19
Kasakh-Ashtarak	3.90	3.75	4.23	23.00	10.90	11.20	9.34	5 25	4.03	3.82	3.95	3.93	7.28
Gegharot-Aragats	0.22	0.12	0.14	0.44	0.89	4.10	2.26	1.19	0.80	0.30	0.19	0.15	0.90
Hrazdan-Hrazdan	4.79	3.92	7.92	19.60	33.30	9.76	5.63	3.34	4.07	6.89	5.92	5.72	9.24

Table 2.3-6, Major Reservoirs of Armenia. (Ref [2.3-41])

Reservoirs	Group	Catchment area km^2	Flood discharge P=0.01% m^3/s	Flood discharge P=0.1% m^3/s	Flood discharge P=1 % m^3/s
Akhuryan	II	7.990	1.220	816	605
Geghardalich	III	2.02	26.8	20.8	14.7
Sarnaghbiur	III	67.5	113	87.8	66.0
Vardakhar	IV	363	208	157	104
Upper Bazmaberd	IV	0.5	6.8	5.16	3.45
Karnut	III	93	204	155	104
Khalavar	III	39.6	134	103	76.4
Sevaberd	III	64.4	182	137	90.8
Gegharkuniq-2	III	0.69	7.26	5.63	3.93
Tavshut	III	16.5	47.2	37.4	27.1
Mantash	III	21.3	177	134	88.6
Aparan	III	656	487	293	194
Kaqavadzor-2	III	2.75	28.0	21.4	14.6
Arpilich	III	220	110	81.2	65.7
Azat	I	526	298	194	139
Ajgedzor	III	152	165	116	88.2
Tavush	II	154	197	151	89.4
Sovetashen	II	30.6	154	117	79.0
David-Bek	III	56	246	195	117
Djoghaz	I	443	295	197	140
Hakhum	I	211	98.4	71.2	54.0
Her-Her	III	160	274	210	140
Kechut	III	315	357	248	188

Table 2.3-7, Main Small Lakes of Armenia
(From The First Report on Biodiversity Ref [2.2-25])

Name of lake	Location	Altitude (m above sea level)	Surface (sq. km)	Volume (1000 cm^3)	Max. Depth (m)	Average (m)
Kari	Near summit of Mount Aragats	3190	0.12	357	8	3
Akna	Near Mount Agzdahak	3030	0.8	2500	15	6
Arnot	Eastern slopes of Mount Geghama	2350	0.04	206	12.6	5.2
Gazana	At the head of Geghi river	3590	0.06	360	10	-
Kaputan	At the head of Kajarants river	3300	0.1	1500	22	-
Al	Mount Gharabagh	2990	0.6	180	4.5	3
Sev	Mount Ishkhanasar	2666	2	9000	7.5	5
Arpi	East of Ashotsk basin	2025	22	100 000	8	4.2
Aighr	North of Ararat Valley	860	0.07	310	9.4	4.3
Parz	North of Areguni mountains	-	0.27	84	-	-

Table 2.3-8, Flow as Measured at the Hydromet Stations on the Sevjur, Arkhurian, and Araks Rivers, m^3/s.

	34. Sevjur-Taronik			35. Sevjur-Echmiadzin			36. Sevjur-Ranchpar		28. Akhurian-Bagaryan			22. Aaraks-Surmulu		
	2004	2005	2006	2004	2005	2006	2003	2004	2004	2005	2006	2004	2005	2006
Jan	11.3	15.9	12.1	20.7	15.5		22.2	25.1	3.71	6.83	14.3	43	40.1	28.0
Feb	15.8	15.1	12.6	21.3	17.5	18.4	22.2	26.2	6.28	6.41	18.5	48.9	40.2	30.3
Mar	20.8	14.9	12.4	28.9	24.7	22.1	22.2	29.8	70.7	8.1	22.1	254	42.2	41.2
Apr	11.6	14.2	11.6	13.3	28.2	32	38.4	25.4	43	40.9	82.3	242	272	304
May	6.66	8.43	9.01	8.07	16.7	18.5	12.3	21.9	68.9	38.3	91.8	317	187	259
Jun	6.89	8.13	7.61	6.07	8.37	5.04	7.16	15.2	39.6	25.1	43.1	153	87.9	62.4
Jul	8.03	8.05	7.69	6.76	10.5	2.84	7	12.6	34.3	31.4	47	64.1	50.7	57.9
Aug	8.65	8.11	7.75	6.92	10	2.21	8.81	11.5	45	36.9	55.5	55.8	46.1	50.9
Sep	8.21	9.31	7.68	9.27	12.5	4.25	9.54	13.6	31.7	35.1	30.9	42.2	40.1	53.1
Oct	6.58	8.04	7.95	10.7	17	8.42	11.8	19.4	18.6	29.7	9.7	35.9	41	41.6
Nov	7.24	8.31	8.48	11.3	18.5	7.44	16	22.9	13	21.5	8.76	34.1	47.4	39.7
Dec	12.9	11.8	12.7	11.9	21	8.75	18.8	30.2	6.03	14.3	6.94	24.4		36.8
Annual Avg	10.4	10.9	9.8	12.9	16.7	11.8	16.4	21.2	31.7	24.5	35.9	109.5	81.3	83.7
Low for yr	6	7.66	7.49	5	7	1.85	7	9.12						
High for yr	21.3	16.9	12.8	138	34.5	40	76.5	152						

Table 2.3-9, Groundwater Aquifers

N/N	Aquifer (explored section)	River Basin	Areal Extent (km^2)	Approved Operational Reserve ($1000\ m^3$/day)	Depth (m below land surface)	Aquifer Thickness (m)	Piezometric Head (m above land surface)	Permeability (m/day)	Porosity	Rock Type (profile)	Total Dissolved Solids (ppm)	Notes
1	Guy-Haykashen section, unconfined aquifer	Metsamor	-	**437.5**	0-40	36.4	-3.6	12-28	-	fine gravel with sandy filler	-	Report No01532
2	Guy-Haykashen section, I confined aquifer				68-149	81	+11.6		very high	fine gravel with gruss inclusions	380-600	
3	Guy-Haykashen section, II confined aquifer				195-225	30	+12.5		very high	slagged andesite-basalts with scoria sand		
4	Guy-Haykashen section, III confined aquifer				262-297	35	+12.6		very high	slagged, crumbling and splintered andesite-basalts		
5	Hoktemberyan trough, unconfined aquifer	Metsamor	680	**4791.9**	0-35	33.5	-1.5	-	-	gruss-boulder sediments	-	Report No01532
6	Hoktemberyan trough, I confined aquifer				50-77	70	-35	3.8-12.6	high	slagged crumbling, porous and splintered andesite-basalts	350-700	
7	Hoktemberyan trough, II confined aquifer				170-200	30	-34.9		high			
8	Arteni-Aragats field, I confined aquifer	Metsamor	925.6	**164.6**	70-88	18	-69	5.6-17.75	average	Sediments of massive volcanic boulders with sandy filler	600-1000	Report No3006
9	Arteni-Aragats field, II confined aquifer				133-218	85	-64.5		average	crumbling, porous and splintered andesite-basalts		
10	Arteni-Aragats field, III confined aquifer				218-245	27	-64.5		average	slagged andesite-basalts with scoria sand		
11	Aragats-Jajur field, confined aquifer	Qasakh	120	**170.5**	60-90	30	-21.5	16.42	low	modern pebble sediments with anisomerous sand	200-400	Report No5127
12	Nazrvan field, unconfined aquifer	Qasakh	1100	**101.7**	0-55	45	-7,5	-	-	basalt rock debris with sandy filler	-	Report No3189
13	Nazrvan field, I confined aquifer				110-145	35	-23	2.12-6.83	high	modern basalt rock debris with anisomerous sand	up to 600	
14	Nazrvan field, II confined aquifer				175-200	25	-25		high	modern basalt rock debris with anisomerous sand		

Table 2.3-10, Sevjur River Withdrawals

Summary of Authorized Withdrawals from the Sevjur River by Use			
Uses by the priorities of Article 13 f Fundamental Principals of National Water Policies	**Authorized Total Withdrawal, m^3/s**	**Return Discharge Flow, m^3/s**	**Number of Permits in Category**
Reserves	0		
In-Stream Uses	0		
Uses pertinent to legislation and treaties	0		
Household water use	0		
Agriculture -Irrigation	6.3	0.0006	11
Energy	1.2	0.33	1
Industry	0.0065	0.0002	1
Recreation	0		
Others	0.2		8
Fisheries	11.1	10.3	130
Total for Sevjur	18.8065	10.6308	151
Data are taken from a listing of Water Use Permits issued by the Ministry of Nature Protection in Armavir Marz as of 11 February 2008.			

Table 2.3-11, Water Use for Irrigation at 5 Year Intervals (Ref [2.3-37])

River-station	Years						
	1965	1970	1975	1980	1985	1990	1995
Akhinja-Aygedzor	0.019	0.021	0.045	0.36	0.71	0.22	0.11
Akhurian-Akhurik	2.45	2.94	2.59	3.03	2.63	2.20	2.24
Akhurian-Haykadzor	3.11	4.51	4.25	5.08	7.72	5.92	2.95
Akhurian-Yervandashat				10.7	18.3	15.7	9.14
Ashotsk-Krasar	0.013	0.014	0.015	0.11	0.055	0.19	0.050
Iliget –Jradzor	0.035	0.042	0.030	0.051	0.11	0.077	0.070
Karkachoun-Gharibjanyan	0.61	1.20	0.77	1.28	1.38	0.23	0.56
Sevjur-Taronik	3.30	9.40	7.64	7.49	6.41	7.54	6.09
Sevjur-Echmiadzin	6.91	15.0	13.3	10.3	8.87	11.1	9.37
Sevjur-Ranchpar	7.15	15.4	17.4	10.9	9.11	11.5	10.8
Kasakh-Vardenis	0.27	0.17	0.28	0.32	0.47	0.61	0.35
Kasakh-Artavan	0.79		0.55	0.41	1.60	1.66	1.04
Kasakh-Ashtarak	1.56	2.10	2.52	1.50	1.40	4.24	3.26
Gegharot-Aragats	0.006	0.21	0.55	0.23	0.14	0.25	0.43
Shahverd-Parbi			0.80	0.30	0.22	0.25	0.28
Hrazdan-Hrazdan		0.19	0.24	0.22	0.60	0.44	0.16
Hrazdan-Lousakert		0.19	0.24	0.48	0.68	0.78	0.36
Hrazdan-Masis	20.4	23.1	26.9	19.1	20.4	13.5	18.0
Hrazdan-Getaberan				23.6	25.1	18.7	22.7
Marmarik-Aghavnadzor	0.13	0.13	0.10	0.12	0.098	0.19	0.176
Masis –Tsovak	0.72	0.95	1.03	0.78	0.52	0.52	0.41
Karkachaghbyur-Karkachaghbyur	0.31	0.34	0.22	0.27	0.20	0.15	0.002
Vardenis-Vardenik	0.20	0.44	0.14	0.21	0.24	0.22	0.11
Martouni-Geghovot	0.10	0.19	0.042	0.080	0.11	0.14	0.13
Argich-Getashen	0.12	0.24	0.12	0.19	0.18	0.23	0.11
Gavaraget-Noratuos	0.44	0.59	0.69	0.31	0.28	0.47	0.11
Azat-Garni	0.37	0.38	0.46	0.40	0.34	0.20	0.13
Vedi-Urtsadzor	0.13	0.14	0.13	0.83	0.45	0.42	0.086
Arpa-Yeghegnadzor	0.58	0.90	0.53	0.86	0.90	0.86	0.29
Arpa-Areni	1.38	2.12	2.00	1.92	2.06	1.98	1.37
Vayk-Zaritap	0.052	0.040	0.036	0.026	0.087	0.069	
Elegis-Shatin	0.40	0.48	0.41	0.12	0.16	0.20	0.21
Saliget-Stalin	0.15	0.17	0.26	0.057	0.079	0.13	0.047
Meghriget-Lichk	0.063	0.065	0.010	0.017	0.050	0.013	0.026
Meghriget-Meghri	0.22	0.33	0.52	0.24	0.19	0.18	0.60
Vokhchi-Kapan	0.044	0.045	0.062	0.37	0.65	0.12	
Vorotan-Gorayk	0.044	0.62	0.40	0.49	0.50	0.40	0.47
Vorotan-Vorotan	1.14	1.53	2.29	1.73	1.51	2.40	2.36
Gorisget-Goris	0.087	0.17	0.060	0.025	0.057	0.095	0.092

Table 2.3-12, Water Balance for the Sevjur River

	Average Flow conditions (m^3/sec)	**5% Flow conditions (m^3/sec)**
Sevjur Flow	20.6	16.0
Approved withdraws	18.8	
Approved Discharges	10.6	
Net available flow	12.4	7.8
Environmental Flow Requirement		11.2

Table 2.3-13, Sevjur River Temperature Summary

Monitoring Station	Period of Record	Number of Measurements	Maximum, ºC	Average, ºC	Minimum, ºC
40	14Feb98 to 14 Dec05	26	22.5	16.9	8
41	14Feb98 to 14 Dec05	31	23	16.4	8
42	14Feb98 to 14 Dec05	33	25	16.2	8.5

Table 2.3-14, Water Quality Standards in Use in the Republic of Armenia

Parameter/Indicator	Raw Drinking Source [5]	Recreation [1]	Fisheries Protection [1]
Temperature, °C	In general, cool water has more palatable taste, than the warm one. Higher temperatures of water accelerate bacterial growth, and may aggravate problems concerned with taste, odor and color[4]	Summer temperatures of water should not rise for more than 3°C, as a result of wastewater discharges, compared to the monthly-average temperature of water of the hottest month of the year, for the last decade	Water temperature should not rise for more than 5°C, compared to the natural temperature of the water body: not exceeding 20°C in summer, and 5°C in winter for the water bodies for cold-water fishes (salmon, trout, white-fish). For other water bodies, at the most 28°C in summer and 8°C in winter
pH	6 – 9	6.5 – 8.5	6.5 – 8.5
Suspended Solids, mg/l	No Turbidity[3]	0.75	0.25
Dissolved Oxygen, mg/l	4.0[4]	n.l.t 4.0	n.l.t 6.0
BOD_5,, mg/l	3.0[4]	6.0	3.0
COD, mg/l	15.0[4]	30.0	30.0
$NH_4^{+,}$, mg/l	1.5[3]	2.0	0.05
NO_2^-, mg/l	3.0[3]	0.08	0.02
NO_3^-, mg/l	45.0	40.0	9.1
Phosphates (as PO_4^{3-}), mg/l	3.5	3.5*	3.5*
HCO_3^- (alkalinity), mg/l	NS	NS	NS
Cl^- mg/l	350	350 (1.5)	300 (-)
SO_4^{2-}, mg/l	500	500	100
Total Dissolved Solids, mg/l	1000	1000	1000
Oil and Grease, mg/l	0.1	0.1	0.01
Na^+, mg/l	200.0[3]	120.0	120.0
K^+, mg/l	3.9[3]	50.0	50.0
Ca^{2+}, mg/l	Total Hardness – 7-10 mmol/l	180.0	180.0

Parameter/Indicator	Raw Drinking Source [5]	Recreation [1]	Fisheries Protection [1]
Mg^{2+}, mg/l	Total Hardness – 7-10 mmol/l	40.0	40.0
Total Iron (Fe^{2+}/Fe^{3+}), mg/l	0.3-0.5	0.5	0.05
$\Sigma\alpha/\Sigma\beta$ Radioactivity, Bq/l	$0.1^{\alpha}/1.0^{\beta}$ Bq/l	$0.1^{\alpha}/1.0^{\beta}$ Bq/l (3)	$0.1^{\alpha}/1.0^{\beta}$ Bq/l (3)
Hg, mg/l	0.0005	0.005	0.001
As, mg/l	0.05	0.05	0.05
Pb, mg/l	0.03	0.1	0.01
Cd, mg/l	0.001	0.01	0.005
Cr^{6+}, mg/l	0.05	0.5	0.001
Cr^{3+}, mg/l	0.5	0.5	0.5
Ni, mg/l	0.1	0.1	0.01
Cu, mg/l	0.1	0.01	0.001
B, mg/l	0.5	0.01	0.001
Al, mg/l	0.5	-	0.2
Zn, mg/l	0.5	-	0.01
CN^{-}, mg/l	0.035	0.05	0.001
Phenols, mg/l	0.25	0.25	0.001
Coli index/l	-	1000	-
Coli count (lactose positive)/l	50	5000	-
Coliphags/l	100	100	-
Pathogens/l	absence	absence	absence

1. Regulations for Surface Waters Protection from Pollution Caused by Wastewater Discharges, USSR Ministries of Water Economy, Health and Fisheries, Moscow 1975 [Rus.].
2. Abbreviations: NS - No defined Standard; N/A - not applicable; **n.l.t.** - not less than; **–** dash means either no data or absence of the parameter in the table;
3. The MACs (Maximum Allowable Concentrations) and approximate safety levels of harmful materials in water of water objects for drinking, domestic-household and recreational uses. Moscow, USSR Min. of Health, 1983, page 61.
4. Sanitary Regulations and Norms for Surface Water Protection from Pollution; USSR Ministry of Health Official Publication, Moscow 1988.
5. RoA MoH Order No. 876 of December 25, 2002: “Drinking Water. Hygienic Requirements on Water Quality of the Centralized Water-Supply Systems. Quality Control” Sanitary Regulations and Norms № 2-III-A 2-1.

Figure 2.3-1. Kura Araks Basin

Figure 2.3-2, RoA HYDROMET Hydrological Monitoring Stations

Figure 2.3-3, Site in Sevjur

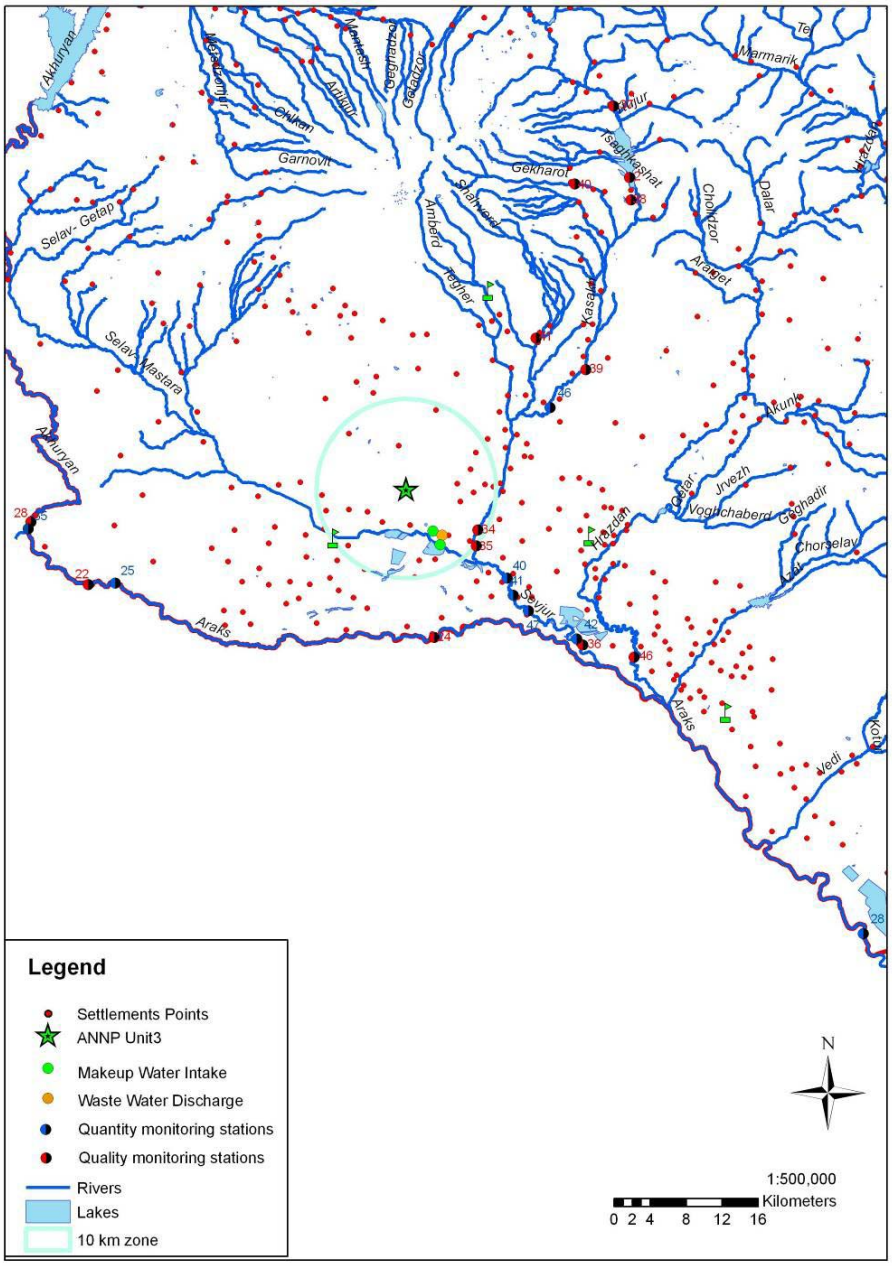


Figure 2.3-4, Sevjur River Catchment Area

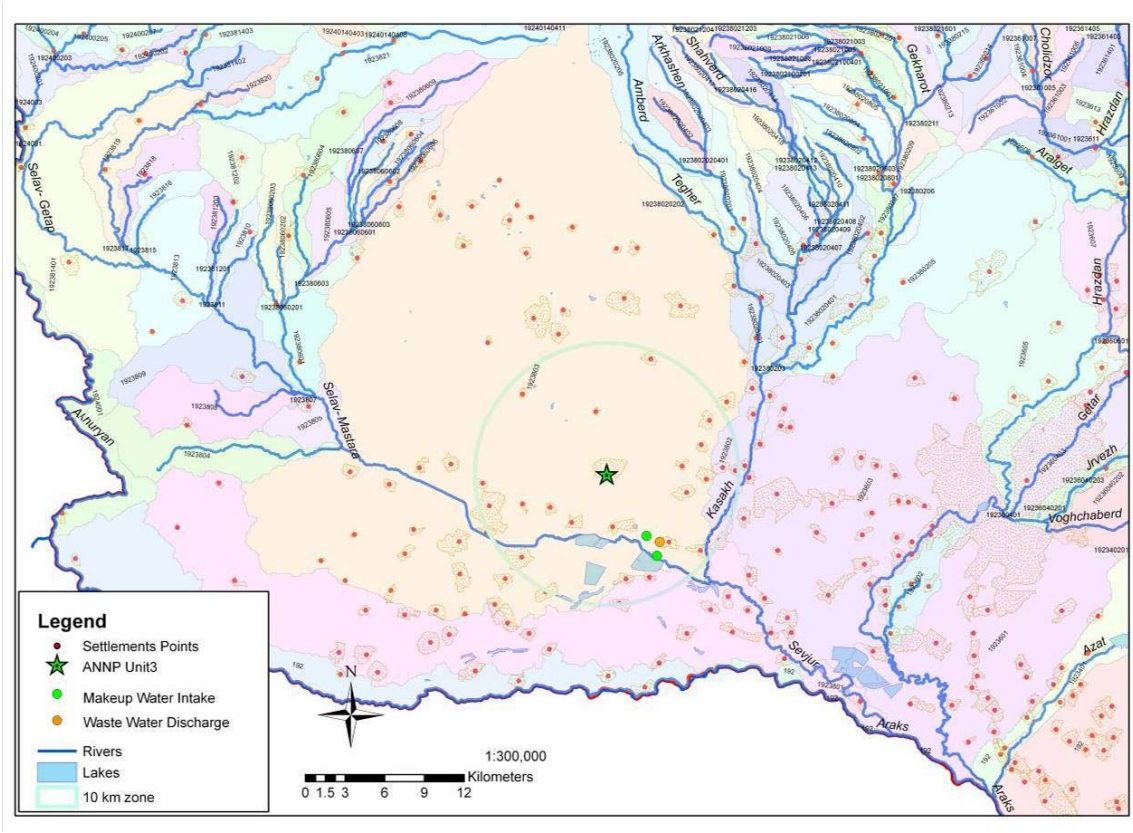


Figure 2.3-5, Frequency of Flooding in Various Regions of Armenia.

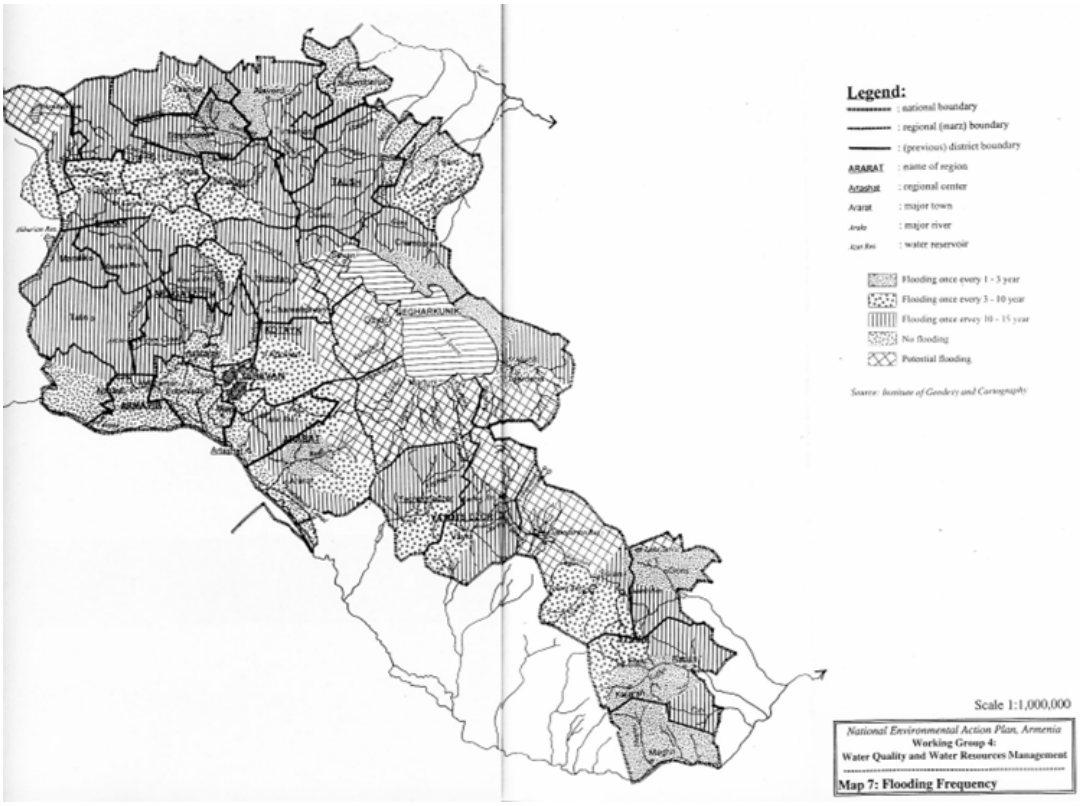


Figure 2.3-6, Water Quality Monitoring Stations

REFERENCES:

[2.3-1] Ministry of Nature Protection of the Republic of Armenia, *State of the Environment '98, Armenia*, only available on the web at: http://enrin.grida.no/htmls/armenia/soe_armenia/soeeng.htm.

[2.3-2] Environmental Information Coalition, *The Encyclopedia of Earth, Water Profile of Armenia*, last updated August 8, 2007, found at: http://www.eoearth.org/article/Water_profile_of_Armenia.

[2.3-3] Ministry of Nature Protection of the Republic of Armenia, 2002, *Water Resources of the Republic of Armenia,* Environmental Impact Monitoring Center, from the web at http://www.armmonitoring.am/pdf/engText.pdf.

[2.3-4] Food And Agriculture Organization Of The United Nations, 1997, *Irrigation In The Countries Of The Former Soviet Unions In Figures*, Water Report 15, Natural Resources Management And Environment Department, Rome, Available on the web at http://www.fao.org/docrep/W6240E/w6240e06.htm.

[2.3-5] Ministry of Nature Protection of the Republic of Armenia, 2006, "*Ministerial Report, 2003 – 2005*, Yerevan.

[2.3-6] CJSC Armenian Nuclear Power Plant, 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Rev.1.

[2.3-7] Ministry of Nature Protection of the Republic of Armenia, 2002, *Hydrological Stations and Water Quality Points in Armenia*, Environmental Impact Monitoring Center, from the web at http://www.armmonitoring.am.

[2.3-8] Mott MacDonald, February 2004, *Joint River Management Programme, Volume 1, Overview Report*, Joint River Management Programme Project Number SCR-E/111231/C/SV/WW, , Cambridge, UK, a UN TACIS project funded in part by the European Union.

[2.3-9] The RoA Government Decree No. 592 dated May 22, 2003, "*531 On Approval Of The Procedure For Determination Of Permitted Marginal Volumes Of Unrecoverable Water Withdrawal For Each Water Resource In The Section of Ecological Discharges And Surface Flow*.

[2.3-10] Mott MacDonald, February 2004, *Joint River Management Programme, Volume 1, Overview Report*, Joint River Management Programme, Volume 4a, Kura Basin – Annexes."

[2.3-11] ARKA News Agency, April 7, 2008,121 *Small Hydro Power Plants To Operate In Armenia By 2011*, Yerevan.

[2.3-12] Ministry of Nature Protection of the Republic of Armenia, March 1999, *First National Report to The Convention on Biological Diversity, incorporating A Country Study on the Biodiversity of Armenia*, Yerevan.

[2.3-13] Ministry of Nature Protection of the Republic of Armenia, May 15, 2001, *Second National Report to the Convention on Biological Diversity*, Yerevan.

[2.3-14] Ministry of Nature Protection of the Republic of Armenia, 2006, *Third National Report to the Convention on Biological Diversity*, Yerevan.

[2.3-15] *Water Code of the Republic of Armenia*, June 4, 2002.

[2.3-16] Republic Of Armenia, Law Adopted November 27, 2006, 1384, *On The National Water Program Of The Republic Of Armenia*.

[2.3-17] Norwalk International A. S. of Norway, August 1998, *National Environmental Action Plan, Armenia, Working Group 4, Water Quality and Water Resources Management, Final Report, Volume A: Main Report*, IWACO of the Netherlands, and Jinj Co Ltd of Armenia.

[2.3-18] Savis, Richard E., and Rafik Hirji Emu, March 2003, *Water Resources and Environment, Technical Note C. 1, Environmental Flows: Concepts and Methods*, The World Bank, Washington, D C.

[2.3-19] Dyson, M., Bergkamp, G., Scanlon, J. (eds)., 2003, *Flow. The Essentials of Environmental Flows*, International Union for Conservation of Nature and Natural Resources, Gland, Switzerland and Cambridge, UK. xiv + 118 pp., 2003.

[2.3-20] Ministry of Energy of the Republic of Armenia, *Update of Feasibility Study of November 2004 and Elaboration of Additional Data Loriberd Hydropower Development (LHD), Armenia*, Kreditanstalt für Wiederaufbau.

[2.3-21] USAID, South Caucasus Water Metadata and Information Portal, *Tabular Data: Water Use and Wastewater Discharge*, available on the web at: http://portal.scaucasuswater.org/index.php?article_id=25.

[2.3-22] USAID, South Caucasus Water Metadata and Information Portal, *State Committee on Water Systems*, (SCWS), available on the web at: http://portal.scaucasuswater.org/index.php?article_id=26.

[2.3-23] The World Bank, May 5, 2004, *Project Performance Assessment Report, Armenia Irrigation Rehabilitation Project (Credit 2667-Am)*, Document of The World Bank, Report No.: 28847.

[2.3-24] Ministry of Nature Protection of the Republic of Armenia, 2002, *National Action Programme to Combat Desertification in Armenia*, Yerevan.

[2.3-25] Food and Agriculture Organization of the United Nations, December 2004, *Fishery Country Profile for the Republic of Armenia*, on the web at: http://www.fao.org/fi/fcp/en/ARM/profile.htm.

[2.3-26] Global Energy Network Group (GENI), *An Energy Overview of the Republic of Armenia*, San Diego, California.

[2.3-27] State Cadastre of the Republic of Armenia, October 2007, *Atlas of Armenia*.

[2.3-28] Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment in Armenia in 2002*, in collaboration with the UN Economic Commission for Europe (UNECE), Yerevan.

[2.3-29] Ministry Of Nature Protection Of The Republic Of Armenia, undated, *Hydrometeorology and Environmental Monitoring Agency Hydrological Stations and Water Quality Points in Armenia*. Available on the RoA EIMC web page: http://www.armmonitoring.am/pdf/hyromet_english.pdf.

[2.3-30] Environmental Monitoring Center of Armenia web site: http://www.armmonitoring.am/eng/maps/index-3.html.

[2.3-31] Kibaroglu, Aysegül, Axel Klaphake, Annika Kramer, Waltina Scheumann, Alexander Carius, October 2005, *Cooperation on Turkey's Transboundary Waters, Status Report commissioned by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety*, F+E Project No. 903 19 226, Available on the web at: http://www.landschaftsoekonomie.tu-berlin.de/fileadmin/a0731/uploads/publikationen/edocuments/turkey_transboundary_water_final.pdf.

[2.3-32] Tarverdyan, A.I., 2003, *Goals of transboundary nature and use of water resources based on the case of basins of the rivers Kura and Araks*, Deputy Chief Engineer of "Armwodproekt Institute" Ltd., Yerevan, Armenia, 2003

[2.3-33] National Report Of Islamic Republic Of Iran, June 2006, *Transboundary Diagnostic Analysis, Aras River Basin*,, Part of UNDP/GEF Reducing Transboundary Degradation of Kura-Aras River Basin.

[2.3-34] Jeneredjian, K., 2006, *Transboundary Management of Kura Basin Wetlands As An Important Step Towards Waterbird Conservation In The South Caucasus Region* , Waterbirds Around the World, Editors. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. 2006, pp. 731-732.

[2.3-35] *Transboundary Water Cooperation In The Newly Independent States*, Moscow-Geneva 2003.

[2.3-36] GEF Implementing Agency: United Nations Development Programme, 11/29/01, *Global Environment Facility, Concept Paper For A Full Sized GEF Project titled "Reducing Transboundary Degradation Of The Kura-Aras River Basin,"* from the web at: http://www.gefweb.org/Projects/Pipeline/Pipe9-5/Regional_Kura-Aras_River_Basin.pdf.

[2.3-37] Hydroenergetica LTD, 2004, *Study Of Water Resources For The Part Of Araks River Basin Located In Armenia*" Armenia, p. 44.

[2.3-38] USAID Program for Institutional and Regulatory Strengthening of Water Management in Armenia, August 2008, Water Resources Atlas of Armenia, PA Government Services, Yerevan

[2.3-39] Republic of Armenia, May 29, 2008, Resolution Number 549, On Establishment of the Water Balance Items of the Republic of Armenia, per the River Basins, as well as the Allocation of Water Resources and Reserves.

[2.3-40] Harutyunyan, A., Minister of Nature Protection, November 15, 2007, Letter to A. Movsisyan, Minister of Energy advising that the source of technical water for Unit 3 can be the Sevjur River, No. 1-18/1609.

2.4 ECOLOGY

Ecological impacts are likely to be limited to an area on or near the site of Unit 3 and its support facilities. Support facilities may include intake and discharge structures, pumping stations, and pipelines. The electrical distribution system and communication and transportation corridors should also be included. Information about ecology remote from the site may of value in examining transmission corridors, or in considering alternative locations for the new unit or for additional support facilities. Information about areas remote from the site may be of interest in determining the relative value of ecological losses resulting from the project, if any.

Ecological information about areas away from the site are included as Appendix A to this Section. The main body of the section will focus on the site and its immediate vicinity.

2.4.1 The NPP Site Vicinity

The site is in the desert and semi-desert landscape zone. Nearby is the transition to the dry mountain steppe zone. Impacts to the ecosystem, if expected anywhere, will be most pronounced at and near the site. The site area has not been the subject of intense ecological study. No field work was done at the site for this study. Existing data have been obtained from RoA Ministries, from numerous contractor reports prepared for the Ministries and from the open literature.

The portion of the land under the control of the ANPP that is proposed to be used for the new unit has been disturbed by previous construction activity. The site was cleared, graded and partially excavated. Most of the earlier construction work has been removed. However the site is not in a natural state as seen in the photographs in Figure 2.4-1.

The area surrounding the site has been disturbed by agricultural activities. Very few natural values remain there either.

The desert and semi-desert landscape zones have not received the attention that other landscape zones have. From visual observation, the additional parcel to be transferred to the CJSC “ANPP” is typical of the semi-desert landscape zone. There are about nine lava cones in the area.

This study relies on published information and forms a reasonable basis for identifying potential impacts. It is recommended that a through survey of the site be performed to identify and inventory the specific flora and fauna of the site and their habitats at and near the site. This information should be used to supplement this assessment of the potential impacts to those species. It is recommended that this survey be conducted over at least one year to observe seasonal variations in species.

The plant site is at an elevation of 920 to 945 meters above sea level. Elevations rise to the north and west and the steppe landscape zone is not far away.

Flora and fauna typical of the desert and semi-desert landscapes have been identified in RoA reports and are shown in Tables 2.4-1 and 2.4-2.

The Ministry of Nature Protection Ministerial Report for 2003-2005 (Ref [2.4-39]) identifies conservation of landscape and biological diversity as national priorities. Semi-desert and steppe ecosystems are included among those listed as hardest hit by anthropogenic pressures. The Report states the following:

> "In the semi-desert zone, where 80-90 percent of land is cultivated, land erosion, salinity, hardening resulting from unregulated irrigation, as well as municipal, industrial and agro-chemical pollution cause serious damages to the natural landscape. The mentioned phenomena resulted in the expansion of desertification in Armenia and degradation of various types of landscapes."

2.4.1.1 WETLANDS

The Sevjur River and other rivers cross the desert landscapes and are bordered by localized wetlands. The Sevjur River, fed primarily by springs bringing water from underground aquifers to the surface creates wetlands in the site vicinity. There are wetlands bordering the Kasakh and Araks Rivers. The Araks River is slightly more than 16 km from the site.

The flora and fauna typically associated with wetlands vary among the types of wetlands (Ref [2.4-40]). Species of the flowing river wetlands are often not as diverse as species found in the stiller wetlands. However, the wetlands along the Sevjur provide habitat for a number of unique biota.

The Sevjur River supports many aquatic and marshland species, including nationally and regionally rare species. This is partly explained by its high water quality and slow speed.

2.4.1.2 FLORA

Although the Sevjur River is several kilometers from the site, it will be an important source of water for the plant. Thus two distinct landscapes are of interest: the desert and semi-desert zone surrounding the site and the wetland zone along the Sevjur. The Metsamor (Sevjur) river supports many aquatic and marshland plant species, including nationally and regionally rare species. This is partly explained by its high water quality and slow speed (Ref [2.4-9]).

Alisma lanceolatum is an important species reported to exist along the Sevjur River (Ref [2.4-41]).

The town of Metsamor is in the desert landscape closer to the site. The recent Master Plan for Metsamor reported that according to the work of A. Maghakyan, there are 130 species of plants in the Metsamor area (Ref [2.4-42]). The Plan listed 28 of the most important species. (See Table 2.3-3). No reference to Maghakyan was provided in the Master Plan. The listing may be from studies published by A.K. Maghakyan in 1941(Vegetation of Armenia SSR). The study may no longer be fully accurate. However, it is specific to the site area.

The Plan also reported 14 protected plant species known to the Metsamor area. These are shown in Table 2.4-4.

2.4.1.3 FAUNA

The Metsamor Master Plan reported that according to information published by S.Dali, the desert and semi-desert landscape zone contains 113 different types of vertebrates (from which 72 are common for out of zone areas), including 28 (20) mammals, 67 (41) birds, 15 (8) reptiles, and 3 (3) amphibious species.

As was the case for the floral species, no reference was included for the work of S. Dali. This may be from the 1954 work of S.V. Dal, *Vertebrates, Animal Life of SSSR Armenia, Volume 1*. The inclusion in the Metsamor Master Plan is also of value because of its specificity to the site region.

The mammals are mostly rodents. The most common wild animals and birds are*: Crocidura, Cricetus auratus Nat, Mucrotus arvalis Pall, Vulpes vulpes, L, Perdix perdix L, Grus grus L.*

The Metsamor Master Plan listed endangered species included in the Red Book. These are listed here in Table 2.4-5. The animals are ranked according to their status of protection (1 – endangered, exceptional; 2 – disappearing, descending).

2.4.1.4 BIRDS

Armenia has such a diverse bird population that it has long been attractive to tourists interested in birdwatching. Birds known to the site area are primarily species that are common in open areas. There are numerous birds in winter and in fall and some that arrive during the spring breeding season.

Tour Armenia describes the diversity of bird life in the country as follows (Ref. [2.4-43]):

> Armenia has an extraordinary 349 species of birds. By comparison, the whole of Europe has 550 species and the entire landmass of the former Soviet Union has 750. Of the 29 orders and 187 families of birds worldwide, Armenia is home to 18 orders and 58 families.
>
> The country lies on the main migration route between the Northern and Southern Hemispheres, with species flying from as far away as South Africa. With its diverse terrain and vegetation zones overlapping each other in such a compact area, Armenia attracts diverse bird species that do not normally inhabit the same terrain.
>
> Thus it is possible to observe desert and forest birds, waterfowl, high plains and alpine species living in the same area (sometimes in the same square mile)."

Tour Armenia gives a list of 51 bird species which might be seen in the semi-desert landscape. Similar information is found at other birding sites (see [2.4-44] and [2.4-45]).

The white stork has been observed nesting on transmission towers and power poles in the Village of Taronik.

The Birds of Armenia Project affiliated with the American University of Armenia Environmental Monitoring and Research Center has published a guide to the birds of Armenia that includes information on habit requirements of each species (Ref [2.4-46]).

2.4.1.5 FISH

Dr. Gabrielyan, Director of the Institute of Hydroecology and Ichthyology at the RoA National Academy of Sciences presents a list of 39 freshwater fishes of Armenia with current data on ecology and distribution (Ref. [2.4-47]). Those reported as known in the Sevjur or Araks River are indicated in Table 2.4-6.

Species known to be found in the Sevjur River have been reported by the Republic of Armenia Ministry of Nature Protection (Ref. [2.4-48]. They are listed in Table 2.4-7.

Dr. Gabrielyan reported (Ref. [2.4-49]) some unpublished personal observations regarding fish species collected on or near the Sevjur River. The following species were collected from the Sevjur: *Alburnoides bipunctatus, Alburnus filippi, Alburnus hohenackeri, Acanthalburnus microlepis, Blicca bjoerkna derjavini, Leuciscus cephalus, Chondrostoma cyri, Capoeta capoeta, Barbus lacerta cyri, Barbus capito, Gobio gobio, Neogobius fliviatilis.*

Many hybrids, various on appearance and morphological characteristics are caught also. Part from them is identified as: *B. bjoerkna derjavini x A. hohenackeri.*

Also found were a high relative number of such rare kinds (according to literature data), as asp and especially barbel-chanary, noted in Metsamor river and in system of Araks above estuary. In our catches and in fishermen catches the barbel–chanary was predominant type.

In the Metsamor (Sevjur) River, there were observed a high relative number and a variety of hybrid carp fishes of the dace subfamily. The quantity of hybrids in our and fishermen catches is comparable to number of "pure" kinds. Among possible parents it is possible to name with the big degree of confidence chub, Armenian silver bream, Transcaucasian bleak and, apparently, Kura river bleak. Such high intensity of hybrid fish formation, most likely, is connected with a temperature regime of river Metsamor, where because of small seasonal fluctuations of temperature, the overlapping of spawning seasons of various kinds of fish is possible. Hybridization in other reservoirs is rare.

A study of the reproduction of the fish of the Sevjur should be undertaken. When the final design of the intake for Unit 3 is evaluated, the losses of eggs and larvae at all water intakes along the stretch of the Sevjur above the ANPP should be assessed to determine the cumulative impact of water withdrawals in the Sevjur River system.

2.4.1.6 OTHER MAMMALS

The Ministry of Nature Protection has identified other mammals known to the various landscapes of Armenia including the near desert and desert ecosystems (Ref. [2.4-1]). However, information specific to the vicinity of the plant is not identified.

2.4.2 Protected Areas

Studies at several nearby protected areas may include findings relevant to the examination of the flora and fauna at the site for the new unit. These areas are generally too far from the site to be impacted.

The Vordan Karmir Reservation is an area where endemic cochineal (*Porphyrophora hamelii*) occurs in saline soils of the Ararat plain along with halophyte vegetation. *Aeluropus littoralis (Gouan) Parl*. and *Phragmites australis (Cav.) Trin. ex Steud*. growing in this area are the main fodder species for the cochineal (Ref. [2.4-50]).

The flora of the "Gorovan sands", a miniature desert located in the Ararat Valley, is known to include some endemic and rare species -*Rhinopetalum gibbosum, Salsola tamamschjanae, Astragalus paradoxus, Allium akaka* , and perhaps others.

The salt marshes of the Ararat Valley also include rare and endemic species adapted to the specific conditions of this habitat - Linum seljukorum, Inula aucheriana, Iris musulmanica, Sonchus araraticus, Orchis laxiflora, Merendera sobolifera , and others. Studies of the Khor Virap Marsh in the Ararat Marz, approximately 50 kilometers from the ANPP, may be of interest.

The Khosrov Forest Reserve, about 70 km ESE of the site is of special ecological value. It is reported that the flora of the reserve includes about 1800 species of vascular plants. This is over half of all plant species known in Armenia (Ref. [2.4-51] page 18). The Khosrov reserve covers about 29,000 ha and extends from the semi-desert to the upper limit of the forest landscape zone. The fauna population is also highly diverse and includes 50 species of mammals. The mammals include well-known predecessors of domesticated goat and sheep, namely wild goat, Caucasian bearded goat, and Armenian moufflon or Transcaucasian wild sheep [2.2-17, page 21].

Table 2.4-1, The Flora and Fauna of desert ecosystems (Ref [2.4-37]).

Group	Comments	Examples of distinctive species
Fungi		*Agaricus, Montagnea, Tulostoma, Disciseda*
Higher plants	Most plants are specific to deserts and relatively rare throughout Armenia. Distinctive vegetation structure and composition is associated with saline and chalk substrates in the Ararat Valley	*Calligonum polygonoides, Achillea tenuifolia, Seidlitzia florida, Rhinopetalum fibbosum, Ceratocarpus arenrius, Salsola spp., Kalidium caspicum, Halostachys caspica, Halocnemum strobilaceum, Gypsophila spp., Halanthium rarifolium*
Invertebrates	Distinctive invertebrate fauna, including several endemic species (particularly at Gorovan).	*Pharaonus caucasicus, Cardiophorus araxicola, Sphenoptera khnzoriani, S. vediensis*

Table 2.4-2, Description of Flora and Fauna of semi-desert ecosystems (Ref [2.4-38]).

Group	Comments	Examples of distinctive species
Higher plants	Higher plants Semi-deserts often covered by ephemeral plants in spring; xerophytes occur in these habitats (both plants and bushes); flowering vegetation occurs in some lowland sites	*Artemisia fraganas, A. araxina, Ceratocephala falcata, Anisantha tectorum, Capparis spinoza Zygophyllum fabago, Rhamnus catharticus*
Invertebrates	Many endemic invertebrate species. Invertebrates from different regions occur (including species of Mediterranean, Iranian, Caucasian and Crimean origin). Some of the same species occur in steppe habitats.	*Phytodrymadusa armeniaca, Nocarodes armenus, Dictyla subdola, Geotomus punctulatus , Amphicoma eichleri, Cantharis araxicola, Tomomyza araxana, Bombilius schelkovnikovi, Shadinia akramowskii, Gabbiella araxena, Pupilla bipapulata, Zodarion petrobium*
Amphibians		*Bufo viridis, Hyla arborea*
Reptiles	Some reptiles are specifically associated with small patches of desert habitat with xerophyte vegetation.	*Lacerta raddei, L.strigata, Ophisops elegans, Testudo graeca, Eumeces schneideri, Mabuya aurata, Elaphe hohenackeri. Telescopus fallax, Eryx jaculus, Vipera lebetina, Malpolon monspessulanus, , T.vermicularis, Eirenis quatorlineata, E. collaris, E. punctatolineatus, Phrynocephalus persicus, Eremias pleski, E. strauchii*
Birds	Over 50 species recorded in total	pheasant (*Phasianus colchicus*), black francolin (*Francolinus francolinus*), rufus wheatear (*Oenanthe xanthoprymna*)
Mammals	Mammals Desert and semi-desert mammals are found mainly in the south of the country	common vole, beech marten, fox, long-eared hedgehog, noctule bat, grey long-eared bat

Table 2.4-3, Floral species known in the Metsamor area (Ref [2.4-42])

1. *Alismataceae;*
2. *Alisma lanceolatum;*
3. *Sagitaria sagittifolia l;*
4. *Sagitaria trifolia l;*
5. *Actinolema macrolema;*
6. *Aphanopleura trachisperma;*
7. *Eringium vanaturii;*
8. *Amberboa moschata;*
9. *Caucinia tenella;*
10. *Gundella turnefortii;*
11. *Lactuca takhtadzhianii;*
12. *Isatis ornitorhynchus;*
13. *Ssambucus tigranii;*
14. *Acanthophyllum pungens;*
15. *Allochrusa bungei;*
16. *Dianthus libanotis;*
17. *Bienertia cycloptera;*
18. *Salsola tamamschjanae;*
19. *Spinacia tetronda;*
20. *Astragalus paradoxus;*
21. *Trigonella capitata;*
22. *Frankenia pulverulenta;*
23. *Nitraria schoberi;*
24. *Aegilops crassa;*
25. *Triticum araraicum;*
26. *Aamarix;*
27. *Tanarix octandra;*
28. *Tetradiclis tanella.*

Table 2.4-4, Protected Plant Species in the Metsamor community area (Ref [2.4-42]).

	Items		Status of protection
	Latin name	Armenian name	
1	*Acorus calamus L.*	Խնկեղեգ ճահճային	1= Endangered
2	*Allium akaka Gmel*	Սոխ ակակա	2=Rare
3	*Amberboa moschata (h)*	Վարդատերեփուկ մուշկային	3=Nearing extinction
4	*Bienertia cicloptera Bunge*	Բիեներցիա շուրջաթև	1
5	*Cicer anatolicum Alef*	Սիսեռ անատոլիական	1
6	*Connvolvulus commutatus Boiss*	Պատատուկ փոփոխական	2
7	*Diospyros lotus*	Խուրմա կովկասյան	1
8	*Ferula persica Willd*	Նարդես պարսկական	2
9	*Hedysarum micripterum Bonge*	Կուրկուրան մանրաթև	2
10	*Inula aucherana DC*	Կղմուխ Օշեի	1
11	*Lactuca Takhtadzani Sosn*	Կաթնուկ Թախտաջյանի	2
12	*Linum seljukorum Davis*	Կտավատ սելջուկյան	1
13	*Merendera sobolifera Fischet C.A. Mey*	Խլոպուզ ընդյուղակիր	1
14	*Orchis laxiflora Lam*	Խոլորձ նոսրածաղիկ	1

Table 2.4-5, Protected Fauna Species in the Vicinity of Metsamor (Ref [2.4-42]).

	Name of species		Name of Red Book		
	Latin name	Armenian name	RoA	USSR	IUCN
1	*Erinaceus auritas Gmelin*	Լայնականջ ոզնի	1	-	-
2	*Rhinolophus euryales*	Հարավային պայտաքիթ	1	1	-
3	*Rhinolophus Mehelyi*	Մեհելիի պայտաքիթ	2	-	-
4	*Myotis nattereri Kuhl.*	Նատերերի արաքսյան գիշերային չղջիկ	1	-	-
5	*Miniopterus schreibersi Kuhl.*	Սովորական երկարաթև չղջիկ	1	1	-
6	*Vormela peregusna peregusna Guld.*	Հարավռուսական խայտաքիս	1	1	-
7	*Pelecanus onocrotalus Linneaus*	Վարդագույն հավալուսն	1	-	-
8	*Phalacrocorax pygmaeus Linneaus*	Փոքր ձկնկուլ	2	-	-
9	*Egretta alba Linneaus*	Մեծ սպիտակ տառեղ	1	-	-
10	*Plagadis falcinellus Linneaus*	Քաջահավ	2	-	-
11	*Anser anser Linneaus*	Մոխրագույն սագ	2	-	-
12	*Circaetus gollicus gollicus Gmelin*	Եվրոպական օձակեր	1	1	-
13	*Falco vespertinus vesoertinus*	Սովորական մանրաբազե	1	1	-
14	*Haematopus ostralegus longipes Buturlin*	Կտցար-կաչաղակ	2	-	-
15	*Vipera raddei Boettger*	Հայկական իժ	1	1	1

Table 2.4-6, Fish found in or likely to be in the Sevjur River by Gabrielyan (Ref [2.4-47]).

ORDER I. SALMONIFORMES **Family 1. SALMONIDAE**	**Distribution**
Salmo trutta fario	Found in most rivers of Armenia
Salmo trutta trutta	swims upstream to Araks river and its tributaries to spawn
Salmo ischchan (Kessler 1877)	Not reported in Sevjur
Oncorhynchus mykiss	Bred in fish farms
Family 2. COREGONIDAE	
Coregonus lavaretus	Not reported in Sevjur
ORDER II. CYPRINIFORMES **Family 3. CYPRINIDAE**	
Alburnus filippi	Known in all rivers
Alburnus alburnus hohenackeri	Range not reported
Alburnoides bipunctatus	Found in most rivers
Aristichthys nobilis	Introduced for aquaculture Some individuals have been observed in the Akhurian and Araks rivers.
Aspius aspius	Found in Sevjur
Barbus lacerta cyri	Found in Sevjur
Barbus goktschaicus	Not reported in Sevjur
Barbus capito	Found in Sevjur
Barbus mursa	Found in Sevjur
Blicca bjoerkna	Only reported in Sevjur
Carassius gibelio	Found in most rivers of the Ararat Valley
Chondrostoma cyri	Recorded from Sevjur
Ctenopharyngodon idellus	Introduced from Far East for weed control in reservoirs and irrigation systems. Not reported in Sevjur
Cyprinus carpio carpio	Inhabits Sevjur
Gobio persus	Recorded from Sevjur
Hypophthalmichthys molitrix	Imported from Far East for aquaculture
Leucaspius delineatus	Not reported in Sevjur
Leuciscus cephalus	Not recorded in Sevjur

Mylopharyngodon piceus	Individuals recorded from the Araks river
Pseudorasbora parva	Introduced and now inhabits all reservoirs of Ararat Valley and neighboring territories
Rhodeus amarus	Widespread in all reservoirs of Ararat Valley
Rutilus rutilus	Found in Sevjur river basin and Lake Aygerlich
Varicorhinus capoeta sevangi	Not reported in Sevjur
Capoeta capoeta	Not reported in Sevjur
Family 4. COBITIDAE	
Sabanejewia aurata	Known in all rivers
Family 5. BALITORIDAE	
Nemacheilus angorae	Recorded from all rivers
Barbatula barbatula caucasica	Recorded from all rivers
ORDER III. CYPRINODONTIFORMES	
Family 6. POECILIIDAE	
Gambusia affinis	Range not reported
Gambusia holbrooki	Introduced from US and Mexico for mosquito control
ORDER IV. SILURIFORMES	
Family 7. SILURIDAE	
Silurus glanis	Recorded from Metsamor
Family 8. ICTALURIDAE	
Ictalurus punctatus	Known in Araks River and Ararat Valley
ORDER V. PERCIFORMES	
Family 9. GOBIIDAE	
Knipowitschia caucasica	Widespread in Sevjur and Ararat Valley reservoirs
Neogobius fluviatilis	Not reported in Sevjur

Table 2.4-7, Fish Species reported in the Sevjur River by the Ministry of Nature Protection. (Ref [2.4-48]).

Salmo Caspius

Rutilus rutilus schelkovnikovi

Chondrostoma cyri leptosoma

Barbus lacerta cyri

Barbus capito

Alburnoides bipunctatus armeniensis

Cyprinus carpio

Aspius aspius taeniatus

Gobio persa

Barbus mursa mursoides

Alburnus filippi Kessler

Blicca bjoerkna derjavini

Nemachilus brandti

Nemachilus angorae

Cobitius aurata

Silurus glanis

FIGURE 2.4 – 1, CONDITION OF THE ANPP UNIT 3 CONSTRUCTION AREA

REFERENCES

[2.4-1] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.13.

[2.4-2] Republic of Armenia State Committee of Real Estate Cadastre, October 2007 *Atlas of Armenia*, plate 86

[2.4-3] First Caucasus Environment Outlook (CEO) 2002 http://www.grid.unep.ch/product/publication/CEO-for-Internet/CEO/index.htm

[2.4-4] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.53.

[2.4-5] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.54.

[2.4-6] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.56

[2.4-7] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.55.

[2.4-8] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.22.

[2.4-9] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.27.

[2.4-10] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.26.

[2.4-11] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.36.

[2.4-12] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.38.

[2.4-13] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.37

[2.4-14] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.44.

[2.4-15] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.49.

[2.4-16] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.34.

[2.4-17] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*, This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.38.

[2.4-18] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*, This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.36.

[2.4-19] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.39.

[2.4-20] The Republic of Government February 2, 2006, *Decree No 98 On Approval of the List of Animals of the RoA Red Book of Animals and the List of Plants of the RoA Red Book of Plants*.

[2.4-21] Government Of The Republic Of Armenia, August 3, 2006, *On Approval Of The Program Of Activities Aimed To Study And Conservation Of Representatives Of Flora And Fauna Included Into The Red Book Of The Republic Of Armenia,* Resolution No. 1075 –N

[2.4-22] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 32.

[2.4-23] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.40.

[2.4-24] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.41.

[2.4-25] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.45.

[2.4-26] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.50.

[2.4-27] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.52.

[2.4.28] Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.40..

[2.4-29] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.41.

[2.4-30] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.42.

[2.4.31] The International Union for the Conservation of Nature and Natural Resources (IUCN), October 2007, *The IUCN Red List of Threatened Species,* Gland, Switzerland, October, 2007. Information on their Red List is only available from them on the internet at: http://www.iucnredlist.org/info/programme

[2.4-32] Critical Ecosystem Partnership Fund (CEPF), *Ecosystem Profile, Caucasus Biodiversity Hotspot, Final Version,* July 31, 2003 (Updated: September 2004), p.4.

[2.4-33] Republic of Armenia, Ministry of Nature Protection, *Biodiversity of Armenia,* an internet report based on material and data supplied by the Ministry of Nature Protection of Armenia. The content of the report is a sole responsibility of the ministry, on the web at: http://enrin.grida.no/biodiv/biodiv/national/armenia/index.htm.

[2.4-34] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 32.

[2.4-35] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 33.

[2.4-36] Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared

in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.40.

[2.4-37] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.52.

[2.4-38] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.53.

[2.4-39] Republic Of Armenia, Ministry Of Nature Protection, 2006, *Ministerial Report 2003–2005*, Yerevan, p.74

[2.4.40] Karén Jenderedjian, 2004, *Wetlands In Armenia – Their Values And Threats And Their Contribution To Sustainable Development And Poverty Alleviation,* Standing Committee, Ministry of the Nature Conservation, 5th European Regional Meeting on the implementation and effectiveness of the Ramsar Convention, 4-8 December 2004, Yerevan, Armenia. This an be found on the web at: http://www.ramsar.org/mtg/mtg_reg_europe2004_docs05.pdf

[2.4-41] Alisma lanceolatum, from the Armeniapedia on the web at: http://www.armeniapedia.org/index.php?title=Alisma_lanceolatum&redirect=no

[2.4-42] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007.

[2.4-43] "Birds in Armenia, Birds, Lists, Regions," Birding Armenia, Tour Armenia, on the web at http://www.tacentral.com/nature/birding.asp#1enia

[2.4-44] "Birding…..Armenia," Fat Birder, on the web at: http://www.fatbirder.com/links_geo/middle_east/armenia.html

[2.4-45] "Birds in Armenia, National Birds List," on the web at: http://www.armeniabirding.info/index.html

[2.4-46] M. S. Adamian and D. Klem, Jr. 1997, *A Field Guide to Birds of Armenia*, published by the American University of Armenia Project.

[2.4- 47] Gabrielyan, B.K., December 2001, *An Annotated Checklist of Freshwater Fishes of Armenia,* Fishbyte, Fisheries Section of the Network of Tropical Aquaculture and Fisheries Professionals (NTAFP), Naga, The ICLARM Quarterly (Vol. 24, Nos. 3 & 4), pp. 23-29.

[2.4-48] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* , Yerevan, p.92.

[2.4-49] Gabrielyan, B.K., October, 2007, *Personal Communication*, at a meeting with the Scientech and PA staff on October 17, 2007

[2.4-50] Khanjyan, Nazik, 2004, *Specially Protected Nature Areas Of Armenia,* Ministry Of Nature Protection Of The Republic Of Armenia, Yerevan, p.44.

APPENDIX 2.4.A: ECOLOGY OF ARMENIA

Ecological impacts are likely to be limited to an area on or near the site of the new generating unit. However, the terrestrial and aquatic environments of Armenia are described in order to give perspective to potential impacts. Information for the Unit 3 site and its immediate vicinity is provided in the main body of Section 2.4

The mountainous terrain of Armenia and the Caucasus results in a broad spectrum of landscape zones from the desert zone at low elevations to the alpine meadows at high elevations. Within Armenia are found a large number of endemic, relict, and introduced plants and animals, including wild and cultivated plants, wild and locally bred animals, and migratory species. There are numerous rare species and many threatened or endangered species. The range of species is seen in all orders including microorganisms, algae, fungi, lichens, mosses, vascular plants, invertebrates, fish, reptiles, birds and mammals.

Agricultural practices, economic development and growth have produced numerous stresses that may challenge the survival of some species. There is concern in the Caucasus and in Armenia over the sustainability of this diversity.

2.4.A.1 THE LANDSCAPE ZONES OF ARMENIA AND THE CAUCASUS

Seven distinct landscape zones are defined in Armenia: deserts, semi-deserts, dry steppes, steppes, woodlands, sub-alpine and alpine lands (Ref [2.4A-1]). The landscape zones are associated with altitude. Each landscape zone is usually found within a narrow elevation range (See Table 2.2-1). Sub-landscapes are sometimes found scattered among these seven zones independently of elevation. The landscape zones themselves are also broadly distributed across Armenia. Figure 2.4A-1 shows the distribution and relative abundance of the zones (Ref [2.4A-2]). Table 2.2-1 also indicates the approximate portion of the land area of Armenia within each landscape zone.

The use of each landscape zone by humans is somewhat distinct. The diversity of uses is primarily related to agricultural activity but as was noted in Section 2.2, certain mining activities may be limited to specific terrain. In order to obtain access to cooling water power production facilities are usually located in the zones at lower elevations

The First Report on Biodiversity in Armenia (Ref [2.4A-1]) described the landscape zones and activities within them as follows:

- ***Deserts and Semi-deserts*** occur in the Ararat Valley and adjacent mountain slopes at altitudes of 1200-1300m, in the Vaik lowlands, and the Meghri gorge. Sand accumulations in the Arax area result in a desert landscape, which are also found in saline lowlands. In these landscapes climate is dry and continental, with hot summers and moderately cold winters. The soils are generally of the semi-desert grey type, and have been managed for cultivation over the last millennia. Cultivation has required intensive irrigation, and these areas now support fruit, vegetable, flower, and wine production, but have suffered major impacts from human activities (Ref [2.4A-1]).

The few semi-deserts and deserts that have been preserved are made up of either predominately wormwoods such as *Artemsia fragrans* and *A araxina* and other associated

plants. Other salt habitat species may be found (Ref [2.4A-3]). Additional information on desert and semi-desert flora and fauna are included in Section 2.4.5.

- ***Dry mountainous steppes*** are found at higher altitudes than semi-deserts (above 1500m) in the Ararat Valley, and some other areas, but are also found at lower altitudes (above 800m) in the lowlands to the north-east of the country, which were originally forested. The climate in the dry steppes is characterized by warm, dry summers and mild winters. A range of soils are found, but in the Ararat Valley these lands are typically stony. Irrigation of dry steppes allows cultivation of crops, vegetables and fruit, and these landscapes have also suffered severe human impact (Ref [2.4A-1]).

  Steppe vegetation used to be widespread on the Caucasus Isthmus, but today only fragments of primary steppe communities have survived on slopes that are unsuitable for agriculture. Steppe communities are found in the plains and foothills of the eastern and southern Caucasus (Ref [2.4A-3]).

- ***Mountain steppes*** are the dominant landscape for most of the country, particularly at altitudes above 1500m (and at altitudes up to 2000m in the north, 2400-2500m in the south). Meadow steppes occur in the highlands, while patches of forest also occur on ridge tops among steppes in the north-east and Syunik regions. Climate is generally moderate, with warm, cool summers, and moderate or cold winters. Soils generally have a humus content of between 6-7%. Steppes are used for agriculture (including cultivation of crops, vegetables, frost-tolerant fruit trees (in lower altitudes) and fodder plants (in highland areas) (Ref [2.4A-1]).

  Highland steppe communities, primarily found in dry mountain regions of the southern Caucasus, are diverse in species composition and have a number of endemic plants (Ref [2.4A-3]).

  Mountain steppes represent the dominant ecosystem of Armenia, and occur throughout the country at altitudes between 1200 and 2000m (sometimes as high as 2500m). Vegetation cover is varied, but particularly important plants include fescue (*Festuca sulcata*) and feather grass (*Stipa spp*.). The flora and fauna of this ecosystem are described in Table 2.4A-1. (Ref [2.4A-4]).

- ***Forests*** generally cover the mid-zone of mountains, occurring at altitudes between 500m and 2100m in the north (up to 2500m in the south). In central Armenia forests occur in small areas rather than as a continuous zone, and forests can be found on steep slopes, and other areas with limited human access. Soil types include red soil in the lowlands and forest gray soils in the highlands [2.4A-1].

Almost all forests in Armenia are state-owned and the Government is responsible for forest conservation, management and planting. In most forests timber extraction is strictly prohibited, however such rules are often broken. Forest cover is relatively low in Armenia, with less that 10% of the land being forested. Armenian forests are predominantly broadleaved (97%), and are dominated by oak, beech and hornbeam. Other species

occasionally found in forests include juniper, pine and yew.

Forest habitats are typically found on mountain slopes between 500 and 2400m altitude, although beech and oak forests are typically concentrated at moderate altitudes (1300-1600m). Flora and fauna of the forest landscape zone are described in table 2.4A-2. The forest zone includes four major forest types, and associated tree species.Oak forests, represent about a third of forest cover (c. 90,000 ha) and are widely distributed across the country. Two oak species (Quercus spp.) found in Armenia(broad-leaved and Georgian oak) are typical of forests. The broad-leaved oak is the more frost tolerant species and is found throughout the country at altitudes as high as 2600 m. Georgian oak is found at altitudes between 500 and 1400 m, most often in the north and in Zangezour region. Other species which found in the oak forests are ash (Fraxinus excelsior), hornbeam (Carpinus betulus) Georgian maple (Acer sp.), cork elm (Ulmus sp.), and field maple (Acer campestre). A third oak species (Arax oak) is now declining as a result of climatic warming and human impacts.

Beech forests, dominated by Oriental beech (Fagus orientalis), represent about a third of forest cover. The are widespread in northern Armenia, particularly on north-facing slopes at altitudes of 1000-2100m. Other species found in beech forests include Caucasian lime (Tilia euchlora), Litvinov beech (Fagus sp.) and spindle-tree (Euonymus europaeus), and substantial grass cover is supported in these forests.

Hornbeam forests are less common than those of beech and oak, and occur at altitudes of 800-1800m. Other trees found in these forests include oak, field maple, common ash, Caucasian pear (Pyrus sp.), and Oriental apple (Malus sp.).

Dry scrub forests are found in both north and south of the country occurring at altitudes of 900-1000m in the north, but at much higher altitude in the south (1800-2000m). These forests support around 80 species of xeric trees and shrubs, all of which are drought tolerant and light-loving. As well as thorn forests, dominated by juniper (Juniperus spp.), broad-leaved forests also occur (characterised by species such as pistachio (Pistacia vera),
Georgian maple, and almond (Prunus dulcis), among others). A range of shrubs is also found in these forests, including buckthorn (Rhamnus catharticus), cherry (Prunus spp.), and jasmine (Jasminium).

- ***Sub-alpine meadows*** occur at higher altitudes than steppes and forests, including highland mountain ranges. Climate is moderate with short, cool summers and long, cold winters. Much of the land here is meadow, with soils of high humus content (Ref [2.4A-1]).

- ***Alpine meadows*** occupy the highest altitudes above sub-alpine meadows (up to 3000m in the north, 3800m in the south). These meadows represent the principal pasturelands for the country, with meadow and alpine vegetation. Climatic conditions are severe, with

long, cold winters, and annual temperatures average less than -4º. Snow cover lasts up to 9 months, and permanent snows may occur in some areas (Ref [2.4A-1]).

High mountain meadows are dominated by herbaceous species. About 1,000 vascular plant species are found in the Greater Caucasus high mountains and half of these are endemics. Caucasian rhododendron thickets grow on slopes with northern exposure in the Greater Caucasus Range and in the northern part of the Lesser Caucasus Mountain Chain. Alpine mats, formed by dense low-lying perennial plants, cover the terrain on the upper belts of these two mountain systems. Alpine meadows and grasslands are used intensively for livestock grazing in the summer throughout the region, resulting in decline in plant species diversity. Unique communities of cliff and rock vegetation are distributed throughout the high mountains of the Caucasus (Ref [2.4A-4]).

Meadows are typically found above 2000m altitude, and support a wide floral diversity (See Table 2.4A-3). Sub-alpine meadows often support a distinct assemblage of grasses, particularly in northern regions. Alpine meadows (over 2700 m) are rich in *Poaceae* (such as *Poa alpina*) and the carpet vegetation of such meadows represents an unusual and interesting habitat (Ref [2.4A-5]).

- ***Azonal landscapes*** are not associate with specific altitudes. Such landscapes cover over 10% of the territory of Armenia.

  Azonal landscapes include woodlands and wetlands. They also included the saline and alkaline lands, which cover about 25,000 ha., Saline and alkaline lands including areas in the Ararat Valley where the underground waters are close to the earth surface, resulting in water vaporization and salt precipitation. Upland wetlands are dominated by fresh (non-brackish) water, while lowland wetlands (particularly those around the River Arax) are usually drained in summer, resulting in high salinity (Ref [2.4-1]).

The main azonal ecosystems in Armenia are wetlands, with rich floristic diversity. In addition to aquatic systems and marshlands, the vegetation of open rocks is azonal. and different species are supported depending on the type of rock substrate. Species associated with wetlands include higher plants (*Astragalus, Acantholimon, Lonicera iberica, Rhamnus pallasii, Cerasus incana, Spirae hypericifolia*), invertebrates (*Lestes sponsa, Puella lunulata, Orthetrum cancellatum,Enochrus melanocephalus, Lymnaca stragnalis, Planorbis planorbis*), amphibians and reptiles (for example, the grass snake *Natrix natrix*) and mammals such as coypu, and water rat (Ref [2.4A-6]).

2.4.A.2 FLORA AND FAUNA

Armenia contains endemic and relict species. Endemic species are those known only to a defined geographical area. Some species are endemic to the Caucasus. There are species endemic to Armenia and within Armenia there are species endemic to a region. There are also a large variety of species known to have much broader distribution that are recognized to have importance within Armenia.

The relict species are those species that have undergone little evolutionary change over geological times. These gives these species additional importance.

Other species may be economically important. Some species of economic importance may be over exploited or otherwise impacted. Species may be of scientific interest. Endangered species take on special interest.

In addition to a focus on species, assemblages of species are of interest. Biodiversity is a value that is addressed because it is a reflection of the health of the environment. The preservation of habitat is often the only way to protect and preserve species.

2.4.A.2.1 Flora

The diverse landscapes harbor a broad number of plant species. Diversity is also enhanced by the position of Armenia between two major floristic regions. Both Mediterranean and boreal (Caucasian) flora have been recorded. The result is over 11,000 floral species in Armenia. (See Table 2.4A-4).

Studies of micro-organisms are concentrated on species important in agriculture, specifically dairy and winery applications. A number of the micro-organisms are important in these applications (Ref [2.4A-8]).

Algae occur both in soil and in water bodies, but are relatively under-studied in Armenia. In total, 143 species of algae are recorded from soil or other substrates, mainly including green, yellow-green and blue-green algae, and bacillariophyta (Ref [2.4A-8]).

A total of 245 species of phytoplankton have been recorded from the water systems of Armenia. These include representatives of the following groups: Cyanophyta (69 types); Chlorophyta (58); Bacillariophyta (101); Charophyta (2); Dinophyta (3); Xanthophyta (4); Phyrophyta (1); Rhodophyta (1); and Euglenophyta (6). Most of these are freshwater species, although some forms are found in brackish water in the Ararat Valley. Over 97 species have been recorded from Lake Sevan alone, among which the Chlorophyta are the most diverse (47 species), and Bacillariophyta are also well represented. Other rivers also show high algal diversity (Ref [2.4A-8]).

Fungi and lichen have been widely studied in Armenia but few studies have tied their occurrence to specific locations (Ref [2.4A-8]). Mosses have a wide distribution, but are generally associated with damp areas. About 430 species have been recorded in Armenia, mainly in mountain and forest habitats. Of these, around 108 species are considered to be rare (including: Dicranoweisia intermedia, Orthotrichum urnaceum, Antitrichia curtipendula, Pterogonium gracile, and Lindbergia brachyptera), but have not been designated for protection. Of particular importance is the occurrence of Sphagnum moss (a glacial relict) at wetland sites (Ref [2.4A-8]).

The species of interest near the Unit 3 site primarily the higher plants that fall within the vascular plant group. The groups of vascular plants represented in Armenia are shown in Table 2.4A-5. These include peat-moss, horse-tails, ferns, gymnosperms (open-seed flowering plants) and angiosperms (closed seed flowering plants)

The Angiosperms are the most diverse and abundant group of higher plants in Armenia, and represent almost 50% of the overall floral species of the Caucasus. This includes a number of common temperate zone species as well as a number of endemic and relict forms, with restricted distributions (Ref [2.4A-9]).

Table 2.4A-4 included 106 species of endemic plants. This represents 3% of the total Armenian plants, and 1.5% of the plants found across the Caucasus (Ref [2.4A-10]). The distribution of these 106 species by family is shown in Table 2.4A-6.

Armenia contains a number of regional endemics which are also found at a limited number of sites in neighbouring countries. For example, *Campanula massalsky* only grows in one site outside Armenia (in Turkey), and *Cousinia gigantolepis* only grows in the southern province of Armenia and in sites in northern Iran. Overall, over 300 species are endemic to the Armenian-Iranian region.

The endemic flora of Armenia are of relatively recent origin (dating from the Quaternary or Holcene), with no ancient endemic species recorded. The distribution of endemics corresponds closely with climate, and most are found in the southern and central arid zones of the country (Table 2.4A-7). In particular the floristic regions of Daralagiaz and Yerevan show high numbers of endemics (with 38 and 36 species respectively) (Ref [2.4A-12]). The Unit 3 site is within the Yerevan Floristic Region.

Relict species, which have been preserved since geological time practically unchanged, are an important component of Armenia's botanical diversity. It is estimated that the flora of Armenia include between 150 and 200 relict species. An accurate determination is limited by gaps in the fossil record. Some species (such as Oriental beech *Fagus orientalis*, which originated in the Tertiary period) are well adapted to today's conditions, and compete well with younger species. Other relicts are widely spread but are only associated with particular habitats (e.g. yew, Caucasian rosebay), while some species are restricted to specific sites or refuges (e.g. Oriental plane *Platanus orientalis* and male fern *Dryopteris filix-mas*). There is also evidence of relict fungi species occurring in deserts and steppes including *Podaxis pistillaris* and *Battarea phalloides*) (Ref [2.4A-13]).

Much of the attention given to flora has been directed at species of importance to agriculture or for other contributions to the local welfare. The flora of Armenia includes a large number of species important in agriculture. The Armenian plateau is a center of origin for cultivated plants. A total of 13 species and approximately 360 varieties of wheat are found including three species of world importance (*Triticum boeoticum, T.urartu* and *T. araraticum*). The latter two species appear to have originated in the vicinity of Armenia. A further nine species of wheat, genus *Aegilops*, are recorded in Aremnia, including some wild varieties. A number of species of rye occur (sub-species of *Secale cereale*, and wild relatives *S. vavilovii* and *S. montanum*, including 36 varieties). Barley cultivars (Hordeum *distichon, H. intermedium* and *H. vulgare*) are planted and a further eight wild species (with high intra-specfic diversity) occur naturally (including *H. sponteanum* and *H. bulbosum*) (Ref [2.4A-14]).

Native cultivars of runner beans (*Phaseolus*), lentils (*Lens)*, garden pea (*Pisum*), and broad bean (*Vicia*) are found in Armenia. In addition, wild relatives of lentils (2 species), chickpeas (*Cicer arietinum*; 2 varieties), and garden peas (3 species) are found (Ref [2.4-14]). A range of fodder plants occur, mainly from two families – *Fabaceae* (among others *Medicago* (10 species/varieties), *Trifolium* (30), *Onobrychis* (6) and *Vicia* (36) and *Poaceae* (including species and varieties of *Agropyron, Arrhanuterum, Dactylis, Festuca, Lolium, Pleum, and Bromas*) (Ref [2.4A-14]).

Fruiting plants have been grown since ancient times, and a wide range of cultivated, wild and semi-wild forms are found today. These include apples (4 varieties), pears (17), whitebeam (10), hawthorns (11), plums (4), and almond trees (4). Species and varieties of peach, quince, walnut, pomegranate, melon and fig, are cultivated as well as varieties and species of the genera *Ribes* (includes blackcurrant), *Dospyros, Cerassus, Pistacia*

(includes pistachio and turpentine), *Elaeagnus* (includes silverberry and oleaster) *Fragaria*, and *Rubus* (Ref [2.4A-14)].

Vegetables and salad crops. In addition to cultivated species of vegetables and salad crops, a number of wild crop species occur, including beetroot, spinach, carrots, coriander, mint, asparagus, and leek (Ref [2.4A-14]).

Wild species of oil bearing plants found in Armenia include flax hemp, camiline (false flax) mustard (several species), safflower, and poppies (Ref [2.4A-14]).

A wide range of edible plants have been collected from the wild since historical times, and some of these have since been brought into cultivation. The conservation of the natural diversity found within wild populations and relatives of crops is an important issue. This is most likely to succeed in protected areas (reserves and reservations) (Ref [2.4A-14]).

Many plants are of economic importance to local residents. Wild (not cultivated) plants are collected and used in Armenia for numerous purposes. Over 200 wild plants are used for food in Armenia, and different species are eaten either fresh, cooked, pickled or dried. However, of around 300 edible mushroom species only 10 are regularly used by local people. Over-collection of some species (such as hornbeam, and foxtail lilies, *Eremurus spp.*) has resulted in population declines, and some species of edible plant are now relatively rare. Many other species (around 2000) are used as fodder plants for livestock (for example clover, alfalfa, and meadow foxtail) (Ref [2.4A-15]).

Around 10% of all plants in Armenia are thought to have some medicinal value, and have been used for traditional medicine for many years. Key medicinal plants include species of hawthorn (*Crataegus*), blackthorn (*Rhamnus*), juniper (*Juniperus*), barberries (*Berberis*), roses (Rosa), and St. John's wort (Hypericum). A further 120 species are known as a source for essential oils (such as *Thymus* spp., *Helichrysum* spp., and *Artemisia spp.*), and 130 for their high vitamin content (Ref [2.4A-15]).

Around 300 plants are used for their decorative value, as a source of horticultural plants. Plants are also used in a range of other ways: for dyeing (120 species, including *Euphorbia, Rhamnus, Sambucus, and Rubia*); for tannin production (60 species); and for resin (around 60 species, including *Astragalus*) (Ref [2.4A-15]).

Other studies of floral species have documented the existence of plants, the region where they are known, and the habitat types in which they are known. An inventory of the flora of Armenia started in 1954 and is continuing. The tenth volume of the "Flora of Armenia" was published in 2001, and the eleventh and last volume is under preparation. Taxonomic studies of a number of major genera carried out before 1980 need to be updated in accordance with modern criteria (Ref [2.4A-12]). In the process of work on other taxonomic groups of plants, the composition of mosses on Mount Ara (60 species) has been classified. An inventory of algae and lichens has not been carried out (Ref [2.4A-16]).

A number of timber species are used for fuel, construction, and carpentry. Key species include oak, beech, and hornbeam. A significant amount of wood was also used in the tin mining and smelting industry.

The forests of Armenia are classified according to the Forest Code of the Republic of Armenia (2005) as either protected forests (for the water supply, prevention of erosion, protection of lands and other reasons), forests of social significance (recreational activities), or forests of special significance (specially protected areas). During the 20th century, the forests of Armenia were twice drastically impacted by over cutting: in 1930-

1950 and in 1992-1995. The more recent incident was triggered by the economic blockade, a resulting energy crisis and military events. Legal and illegal logging of oak (*Quercus),* beech (*Fagus)* and hornbeam (*Carpinus)* stands of economic importance resulted in significant reductions in the extent of forests, degradation of forest landscapes, decrease of forest productivity and biodiversity. The loss of forested areas had negative impact as well on the ecological situation and environmental functions (Ref [2.4A-17]).

An inventory in 1993 showed that about 11% of the territory of Armenia was forested.

The recovery of the Armenia's forests is of strategic national importance. A new Forest Policy is under development. It will aim to achieve sustainable use of the forests and the recovery of degraded forest ecosystems (Ref [2.4A-17]).

The recovery of the Armenia's forests is of strategic national importance. A new Forest Policy was approved by the GoA on September 30, 2004. The new policy will ensure sustainable management of forests and forest areas (Ref [2.4A-51]). Species that are threatened with extinction are given special consideration. Threatened plant species have been recorded from all regions of Armenia. Many of the rare and threatened plants are associated with wetlands. Water-marsh systems of Armenia alone contain 45 plant species which are considered to be in need of conservation attention. The greatest threat to wetland plants has been drainage of marsh and wetlands for agriculture. About 20,000 ha of wetland sites have been drained across the country to use for agricultural purposes. This inevitably results in damage to these ecosystems and associated flora. However, a number of other threats affect water plants .

A number of species (including yellow water lily (*Nuphar luteum*), bogbean (*Menyanthes trifoliata*), and flowering rush (*Butomus umbellatus*) were lost when Lake Arpi was converted into a reservoir. The drainage of Lake Gilly, and decline in water levels in Lake Sevan, severely affected populations of around 60 species of water plants (including *Peucedanum zedelmejeri, Eleocharis transcaucasica, Astragalus goktschaicus* and *Puccinellia grossehimii*), and a number of species disappeared completely following these activities.

Other species including medicinal, such as sweet flag (*Acorus calamus*), have suffered over-collection. Those species which have been recognized as needing special protection may be included in the Red Book of Armenia. The large number of plant species considered rare or endangered by the Republic of Armenia is as shown by taxonomic group Table 2.4A-8:

The distribution of the rare or endangered species are shown in Table 2.4A-9 for each floristic region.

The update of the Red Book of Armenia is under development (Ref [2.4A-17]). The published proposed list included a large number of additional plant species. The RoA Ministry of Nature Protection is coordinating studies to determine the adequacy of this list prior to replacing the 1988 list (Refs [2.4A-20] and [2.4A-21]).

Species of critical concern include sweet flag bulrush (*Acorus calamus*), a valuable medicinal herb, and the beautiful Judas tree (*Cercis griffithii*), which is endangered because of agricultural use of the land. Other examples of endangered plants include a newly discovered endemic species of saltwort *Salsola tamamschjanae,* threatened as a result of sand processing, and the regionally endemic iris, *Iris grossheimii.* In addition, the status of lower plants has not been fully assessed, but at least 15 species of mushroom are considered to be under threat. (Ref [2.4A-22]).

In October 2007, The International Union for Conservation of Nature and Natural Resources (IUCN) updated their Red List in (Ref [2.4A-24]). The IUCN has established standards for the inclusion of species in the Red List. The IUCN include species identified by participating countries after auditing the country lists for compliance with their IUCN standards. Primarily as a result of the standards set for inclusion in the IUCN list, most of the listed species are faunal. The current IUCN list includes 66 species extant in Armenia. None are plant species.

The IUCN is addressing this gap in their data base. Their discussion of plans to expand the taxonomic coverage of their Red List includes the following comment:

> *Plant species* – Although there are over 12,000 plant species on the *IUCN Red List*, fewer than one thousand of these are properly documented. To address this gap, IUCN many species of high economic value. The conifer and cycad species already on the *IUCN Red List* need to be fully documented. IUCN is also prioritizing a global preliminary assessment of all plant species as called for in Target 2 of the CBD Global Strategy for Plant Conservation. This will cover 300,000 species, and will help to identify groups of plants that require full assessment. For further information on IUCN SSC plant conservation work see http://www.iucn.org/themes/ssc/our_work/plants/indexplants.htm.

The Republic of Armenia Ministry of Nature Protection is attempting to apply the IUCN standards to their review of species in Armenia. This will ensure that a future edition of the IUCN Red List includes the species needing protection in Armenia. This should include substantially more than the 66 species.

2.4.A.2.2 Fauna

The same geographical and Climatic factors that produced such a large diversity of flora have also contributed to a large diversity of Fauna. In the relatively small territory of Armenia more than 17,500 species of animals have been documented. This includes more than 500 species of vertebrates. As shown in Table A-10, this includes 339 endemic species (Ref [2.4A-25]).

The endemic species include a wide range of invertebrates (including *Phytodrymadusa armeniaca, Nocarodes armenus, Olophrum aragatzense, Amphycoma eichleri, Cantharis araxicola, Tomomyza araxana, Bombilius schelkovnikovi, Shadinia akramowskii*, and *Gabbiella araxenai*), as well as a number of vertebrate species and sub-species (Ref [2.4A-23]).

Nine species and sub-species of fish are endemic to Armenia. These include the endemic species of Sevan trout (*Salmo ishkhan*), and its four races or sub-species (winter bakhtak *S. ishkhan; gegharkuni S. ishkhan gegarkuni; bojak S. ishkhan danilewskii*; and summer bakhtak *S.ishkhan aestivalis*), which occur in Lake Sevan and surrounding rivers. In addition, the following sub-species of fish are also endemic to Armenia, a roach (Armenian karmrakn, *Rutilus rutilus schelkovnikovi*); a schneider species (Armenian tarekhik, *Alburnoides bipunctatus armeniensis*); Sevan koghak (*Varicorhinus capoeta sevangi*); a barbel (Sevan beghlou Barbus *lacerta goktschaicus*); and a white bream species, Armenian goustera *(Blicca bjoerkna derjavini*) (Ref [2.4A-23]).

Populations of trout (*Salmo trutta*), which until recently was found in all rivers in Armenia and Wels catfish (*Silurus glanis*) have reduced significantly as a direct result of human activities such as intensive poaching, reservoir pollution, unlimited water use and uncontrolled fishing (Ref [2.4A-23]).

Of the 53 reptile species found in Armenia, over 13% are endemic. These include several species of rock lizards including *Lacerta unisexualis* (white-bellied lizard, found in the Sevan basin, and surrounding areas), *L. armeniaca* (the Armenian lizard, found in the north of the country), and *L. nairensis* (found around Hrazdan river and Lake Sevan). Other endemic species and sub-species include *Eremias arguta transcaucasika* (the racerunner, from Lake Sevan basin), *Vipera darevskii* (Darevsky's viper, from Djavakhk mountain range at 2000-53000 m), and *V. raddei boettger* (endemic sub-species of Russian viper, from Armenian Plateau and Minor Caucasus). Regional endemics (restricted to the Armenian plateau) include several rock lizards (*Lacerta dahli, L. rostombekovi and L. valentini*). In addition, one amphibian, the Syrian spadefoot toad (*Pelobates syriacus*), is endemic to the country (Ref [2.4-23]).

No true endemic bird species are found in Armenia, although the Armenian gull (*Larus argentatus armeniacus*) is considered to be an endemic sub-species, and has been recorded in the Lake Sevan basin, along the Arax, Hrazdan, and Akhurian rivers, and in recent years in the Ararat valley. In addition, the Caucasian grouse (*Tetrao mlekosiewiczi*), which is endemic to the Caucasus, is common in Armenia (Ref [2.4A-23]).

Among 83 mammals recorded in Armenia, six endemic species or sub-species are recorded - the northern mole vole (*Ellobius lutescens*), Vingradov's jird (*Meriones vinogradovi*), a jeroboa (*Allactaga williamsi*), the Caucasian birch mouse (*Sicista caucasica*), the Armenian mouflon (*Ovis orientalis gmelinii*), and a sub-species of Natterer's bat (*Myotis nattereri araxen*). Of particular note is the Armenian mouflon which is now restricted to areas in southern Armenia (Ref [2.4A-23]).

Few relict animal species have been recorded from Armenia. One sub-species of fish, a roach ('Armenian karmrakn', *Rutilus rutilus schelkovnikovi*) appears to be a relict of Tertiary origin, which has been preserved within the Sevjur basin. Two birds, the white - winged scoter (*Melanitta fusca*) and the boreal owl (*Aegolius funereus*), are also considered to be relict Species (Ref [2.4A-24]).

As with the flora, a number of species of fauna are of important because of their economic or utilitarian value. Armenia appears to have been the source for a number of wild relatives of domestic livestock, including sheep, horses, and goats. Recent studies suggest that the endemic Armenian mouflon (*Ovis orientalis gmelinii*) may be the ancestor of domestic sheep.

The Kharabaghian breed of horse appears to have derived from native wild horses of the Armenian Plateau. Armenia also appears to have been a centre for goat breeding (Ref [2.4A-25]).

There is a long history of animal breeding in Armenia, with archeological studies showing the keeping of livestock since Neolithic times (including horses, cows, sheep and pigs). Cuneiform records from Urartu also indicate that all the main agricultural species in Armenia were also bred at that time. Further evidence for the history of livestock breeding comes from ancient Armenian chroniclers (3rd - 4th centuries AD). Since that period there is extensive evidence for artificial selection and the development of distinctive animal breeds in Armenia (Ref [2.4A-25]):

- The Causcasian breed of cow was derived from the crossing of native Caucasian, Lebedinian and Castroma varieties .

- Native varieties of domestic sheep derive from the Armenian mouflon, while the Armenian semicoarse-wool sheep derives from selective breeding of Balbas-American and Ramboulije-British Lincoln breeds. A range of sheep bearing semi-fine wool have also been developed through mixed breeding.
- The 'Armenian manufacturing pig' was developed from crosses of big white pigs, and Landras, Wales and Djurok breeds.
- 'Yerevan chickens' were developed from crossing Rhode Island, Austalorp and New Hampshire breeds.
- A native breed of rabbits ('Armenian marder') were bred from blue-coated rabbits crossed with Himalayan and chinchilla breeds.
- Buffaloes bred in Armenia were originally derived from the Asian water buffalo.
- In addition, coypu (originating in South America) have been bred in Armenia since 1940.

Sport hunting is widely practiced in Armenia, although there is little commercial hunting. In order to limit the impact on the environment, hunting is regulated through the use of a licensing system (Ref [2.4A-26]).

Fishing in Armenia has long been of importance for both sport and commerce, and is allowed anywhere apart from protected areas. Lake Sevan supports extensive commercial fishing, representing 90% of fisheries. Following the decrease in the level of the lake, the key fish species caught have changed from Sevan trout and 'koghak' to whitefish and goldfish. Since 1996, commercial fishing in Lake Sevan has been based on licences and contracts issued through the Ministry of Nature Protection.

Snake venom is used in traditional medicine to treat conditions such as epilepsy, haemophilia, cancer, and asthma. Snakes including the bluntnose viper (*Vipera lebetina*) and the Russian viper (*V. raddei*) are therefore collected for their venom, resulting in substantial declines in populations of these species (particularly *V. lebetina*) (Ref [2.4A-27]).

Of the 17,532 species of invertebrate and vertebrates recorded in Armenia, approximately 300 are considered to be rare or declining. A total of 48 invertebrates in Armenia were registered in the Red Data Book of the USSR. A total of 99 vertebrate species were registered in the Red Data Book of Armenia, A new determination of which species are in need of protection is in progress. A summary of the listing of endangered vertebrates is given in Table A-11 (Ref [2.4A-28]).

Among the species listed in the Armenian Red Data Book are 15 species of amphibians and reptiles and 18 mammal species or sub-species (See Table 2.4A-12). The following mammals appear most at risk: Mehely's horseshoe bat (*Rhinolophus mehelyi*), European free-tailed bat (*Tadarida teniotis*), long-eared hedgehog (*Hemiechinus auritus*), marbled polecat (*Vormela peregusna*), European otter (*Lutra lutra*), brown bear (*Ursus arctos*), manul (*Felis manul*), the Asian wild sheep (*Ovis ammon*), and wild goat (*Capra aegagrus*). In addition, the striped hyaena (*Hyaena hyaena*), and the Caucasian birch mouse (*Sicista caucasica*) are more or less extinct in Armenia (Ref [2.4A-9]).

The IUCN Red List published in September 2007 includes 66 faunal species extant in Armenia. This includes three species native to Armenia listed as Critically Endangered, eight additional species listed as Endangered, 25 species listed as Vulnerable, one species listed as Lower Risk, Conservation Dependent, and 29 species listed as Lower Risk, Near Threatened (Ref [2.4A-31]).

The IUCN Red List does not include up to date input from the Republic of Armenia. Thus the list may be inaccurate. However, it is included here as Table 2.4A-13 to be used as a screening tool for identification of potential impact.

2.4.A.3 BIODIVERSITY

The great ecological value within Armenia is reflected in its biodiversity. Biodiversity is one measure of the health of the ecosystem. As the ecosystem becomes exploited or degraded, biodiversity declines. Much of the Caucasus has been declared to be a biodiversity hotspot. This is a designation by Conservation International. To qualify as a hotspot, a region must meet two strict criteria: it must contain at least 1,500 species of vascular plants (> 0.5 percent of the world's total) as endemics, and it has to have lost at least 70 percent of its original habitat. It is a hotspot both because of the great biodiversity and because the apparent perceived threat of loss of species.

The Caucasus has been described as follows (Ref [2.4A-32]):

> One of the most biologically rich regions on Earth, the Caucasus is among the planet's 25 most diverse and endangered hotspots. The Caucasus is one of WWF's Global 200 Ecoregions, identified as globally outstanding for biodiversity. The Caucasus has also been named a large herbivore hotspot by WWF's Large Herbivore Initiative. Eleven species of large herbivores, as well as five large carnivores, are found over a relatively small area. The 2002 IUCN Red List identifies 50 species of globally threatened animals and one plant in the Caucasus. Among the IUCN species, 18 have restricted ranges or are endemics. The Caucasus Mountains harbor a wealth of highly sought-after medicinal and decorative plants, as well as unique relic and endemic plant communities."
>
> Spanning the borders of six countries, the Caucasus hotspot is a globally significant center of cultural diversity, where a multitude of ethnic groups, languages and religions intermingle over a relatively small area. Close cooperation across borders will be required for conservation of unique and threatened ecosystems, while helping to foster peace and understanding in an ethnically diverse region.

The Ecosystem Profile developed for the Hotspot identified species threatened to the point of reducing biodiversity. The species known to Armenia are included in Table 2.4A-14. The Profile identified sites (Figure 2.4A-2) and corridors which should be protected to ensure the continued existence of the identified species. Two of the corridors extending into Armenia were in mountainous regions. The Southern Uplands Corridor however include the Ararat Valley where the site for the new unit is located. This corridor includes four sites as listed in Table 2.4A-15. The table shows the affected species. The sites can be located on Figure 2.4A-2.

The Republic of Armenia is committed to protecting biological diversity. The RoA signed to the Convention on Biological Diversity (CBD) at the Rio Summit, in 1992, and the Convention was ratified by the National Assembly on the 14th of May 1993. In becoming a Party to the Convention, Armenia accepted its commitment to biodiversity conservation and sustainable use within the country, as well as to active co-operation in tackling the biodiversity issues of regional and global relevance, including the sharing of genetic resources and biodiversity information. In accordance with its obligations under the CBD, the Government of Armenia started to develop its Biodiversity Strategy and Action Plan (BSAP) and first National Report in 1997 (Refs [2.4A-33] and [2.4A-34]).

2.4.A.4 ENVIRONMENTAL STRESSES

The main factors affecting biodiversity of Armenia are linked directly or indirectly with anthropogenic impacts. These are the following (Refs [2.4A-35] and [2.4A-36]).

1. Habitat loss and transformation

2. Bioresource overexploitation

3. Environmental pollution

4. Impact of introduced and alien species

5. Climate change

The growth of the agricultural, industrial, construction and energy sectors have led to extensive habitat change across all landscape types. Agricultural practices result in soil erosion and salination of soil accompanied by degradation of vegetation. Livestock breeding has resulted in overgrazing in alpine and subalpine meadows with a decline in wild fodder species. Urban and industrial areas have grown, forests have been logged, and over 20,000ha of marshes and wetlands have been drained. This has resulted in the destruction of natural habitats (Ref [2.4A-35]).

Exploitation of biological resources includes the use of pastures and meadows for grazing, the collection of wild plants, and excessive fishing and hunting. The current levels of use for a number of species appear to be unsustainable, and population declines have been recorded in some species (Ref [2.4A-35]).

Outputs from the industrial, energy and transport sectors have resulted in substantial levels of air, soil and water pollution in Armenia. The legacy of Soviet industry is clear in heavy metal levels still recorded in soils today. Such levels of pollution have direct impacts on the health of species and integrity of ecosystems (Ref [2.4A-35]).

A number of species of foreign origin have been introduced to the natural ecosystems of Armenia. The effects of introduced species through competition with native species, is not clear and their broader effects on biodiversity are unknown (Ref [2.4A-35]).

The impact of climate change on biodiversity remains unclear but a temperature rise of 2-3°C is predicted, which would result in increased desertification, and possibly to species extinction (Ref [2.4A-35]).

Table 2.4A-1, Fauna and Flora Associated with Steppe Ecosystems (Ref [2.4A-5])

Group	Comments	Examples of distinctive species
Fungi		*Pleurotus eryngii, Agaricus, Macrolepiota, Coprinus*
Higher plants		*Stipa lessingiana, S. pulcherrima, S. capillata, Festuca sulcata, F. ovina, Bothriodoa ischaemum, Agropyrum cristatum, Astragalus microcephalus, A. largus, Onobrychis cornuta, Bromopsis variegatum, Phleum phleoides, Koeleris cristata*
Invertebrates	Invertebrates diversity is low, but several rare and threatened species occur	*Bradyporus dilatatus, Montana armeniaca, Eumerus sogdianus, Bruchidius armeniacus, Cryptocephalus moravi*
Amphibians		*Bufo viridis, Rana ridibunda, R. macrocnemics*
Reptiles		*Lacerta armeniaca, L. dahli, L. valentini, L. nairensis, L. strigata, L. agilis, L. caucasica, L. apodus, Ophisiops elegans, Vipera erivanensis, V. raddei, Coronella austriaca, Eryx jaculus, Telescopus fallax, Natrix natrix, N. tessellate*
Birds	More than 30 species recorded	Mainly passerines and falcons
Mammals		Fox, wolf, coypu, marten, greater horseshoe bat, wild goat, Armenian mouflon, brown bear

Table 2.4A-2, Fauna and Flora Associated with Forest Ecosystems (Ref [2.4A-6])

Group	Comments	Examples of distinctive species
Fungi	Many fungi supported in such habitats, including 757 species of cap mushrooms; 314 species are found in mixed deciduous forests and 266 have been identified in thorn forests	
Invertebrates	High diversity of invertebrates, including a quarter of beetle species recorded in the country; invertebrates of northern forests typically resemble those of Caucasian and European regions, whilst those of the south resemble Mediterranean and Iranian faunas.	*Ciddaria firmata, Bupalus piniarus, Ancylochira araratica, Salpingus castaneus, Hypoplhlocus pini.*
Mammals		Wild goat, wild boar, Persian squirrel, European mole, wood mouse, forest dormouse

Table 2.4A-3, Fauna and Flora Associated with Meadow Ecosystems. [Ref 2.4A-7]

Group	Comments	Examples of distinctive species
Fungi	Cap mushrooms well represented (discomycetes and gasteromycetes)	*Helvella, Morchella, Peziza, Calvatia, Geastreem, Bovista*
Higher plants		*Festuca varia, Poa longifolia, P. alpina, Phleum alpinum, Trifolium, Onobrychis transcaucasica, Dactylis glomerata, Festuca gigantea, Linum hypericigolium, Sibbaldia parviflora, Myosotis alpestris, Alchemilla, Carex*
Invertebrates	Distinctive invertebrate fauna with many national and regional (Caucasian) endemics	*Carobus stjeruvalli, C. tamsi, Dorcadion* spp., *Deltomerns khnzorian, Trechus armenus, T. dzermuensis,* as well as *Bombus* spp., *Terymus auretus, Triobia armenica*
Amphibians		*Rana macrocnemis, R. ridibunda, Bufo viridis*
Reptiles		*Vipera erivanensis, V. darevsky, Lacerta valentini, Coronella austriaca*
Birds	Between 10 and 15 species recorded; many Red data Book species	Caspian snowcock *(Tetraogallus caspiusi)*, choughs *(Pyrrhocorax graculus, P. pyrrhocoraxi)*, Lammergeier *(Gypaetus barbatus)*, accentors *(Prunella ocularis, P. collaris)*, wallcreeper *(Tichodroma muraria)*, snowfinch *(Montifringilla nivalis)*
Mammals	A total of 17 recorded mammals species	Rodents, including mice and voles.

Table 2.4A-4, Approximate Number of Plant Species in Armenia (Ref [2.4A-8]).

Group	Number of Species (approximate)
Algae	388
Fungi	4166
Lichens	2600
Mosses	430
Vascular Plants	3555

Table 2.4A-5, Numbers of Species of Vascular Plants in Armenia by Plant Group (Ref [2.4A-10]).

Group		Number of species
Peat-mosses		2
Horse-tails		6
Ferns		38
Gymnosperms		9
	Ephedraceae	(2)
	Taxaceae	(1)
	Pinaceae	(1)
	Cupressaceae	(5)
Angiosperms		c. 3500
	Monocotyledons	(800)
	Dicotyledons	(2700)
Total		**c. 3555**

Table 2.4A-6, Endemic and Relict Plant Species of Armenia (Ref [2.4A-11]).

Family	No. of endemic species	Family	No. of endemic species
Asteraceae	26	Rubiaceae	2
Rosaceae	24	Campanulaceae	1
Scrophulariaceae	8	Caprifoliaceae	1
Fabaceae	7	Dipsacaceae	1
Brassicaceae	6	Euphoriaceae	1
Caryophyllaceae	5	Geraniaceae	1
Poaceae	5	Hypericaceae	1
Boraginaceae	4	Liliaceae	1
Apiaceae	3	Linaceae	1
Grossulariaceae	2	Malvaceae	1
Limoniaceae	2	Polygalaceae	1
Orobanchaceae	2		

Table 2.4A-7, Distribution of endemic species according to Armenian floristic regions and altitude zones (Ref [2.4A-12]).

Region	Altitude					Total
	Low	Mid	High	Sub-alpine	Alpine	
Upper Akhurian						
Shirak	4	18	14	2	-	19
Aragats	-	4	5	4	4	8
Lori	1	5	4	2	-	6
Ijevan	4	16	14	7	3	20
Aparan	2	12	12	7	1	15
Sevan	2	16	20	8	2	22
Geghama	-	13	13	10	7	20
Yerevan	13	27	18	7	-	36
Daralagiaz	8	29	22	11	-	38
Zangezour	6	16	13	8	4	24
Meghri	2	14	13	6	3	17
Total	**19**	**55**	**43**	**23**	**10**	**-**

Table 2.4A-8, Number of plant species listed in the Red Data Book of Armenia, by Taxonomic Group and Protection Status (Ref [2.4A-18]).

Taxonomic Group	Number of Species in Taxonomic Group					
	Extinct	Threatened	Rare	Declining	Indeterminate	Total
Ferns	1	5	2	0	0	8
Gymnosperms	0	1	1	2	0	4
Angiosperms	29	132	151	55	8	375
Monocotyledons	11	34	38	27	4	114
Dicotyledons	18	98	113	28	4	261
Total	30	138	154	57	8	387

Table 2.4A-9, Number of plant species of different conservation status listed by floristic regions. Status categories include extinct (EX), endangered (EN), rare (R), declining (D) and indeterminate (IN) (Ref [2.4A-19]).

Floristic region	Total	Status according to the Red Data Book				
		Ex	En	R	D	IN
Upper Akhurian	24	2	3	1	8	-
Shirak	44	-	9	15	20	-
Aragats	28	1	1	11	15	-
Lori	48	4	5	17	21	1
Ijevan	75	7	15	24	26	3
Aparan	34	2	7	8	17	-
Sevan	55	5	8	15	26	1
Geghami	24	-	4	7	13	-
Yerevan	140	12	56	39	32	1
Daralagyaz	93	5	26	37	25	-
Zangezour	94	-	20	46	25	3
Meghri	110	2	30	48	29	1
Total	**387**	**36**	**130**	**154**	**59**	**8**
No. of these in the FSU RDB	62	5	28	23	6	-

Table 2.4A-10, Number of Animal Species, Including Endemic Species, by Taxonomic Group (Ref [2.4A-25]).

Taxonomic Group	Number of Species	Number of Endemic Species
Invertebrates	**17,000**	**316**
Mollusca	155	-
Arthropoda	5,830	-
Others	11,015	-
Vertebrates	**532**	**23**
Fish	39	9*
Amphibians	81	1
Reptiles	53	7
Birds	349	0
Mammals	83	6
Total	**17,532**	**339**

Table 2.4A-11, Number of vertebrate species listed in the Red Book of Armenia (Ref [2.4A-28])

Group	No. in Armenian Red Book	No. of species				
		Extinct	Threatened	Rare	Declining	Insufficient Data
Fish	2	-	2	1	-	-
Amphibians	1	-	-	-	1	-
Reptiles	11	-	6	4	1	-
Birds	67	-	20	34	13	-
Mammals	18	2	3	6	6	3
Totals	**99**	**2**	**31**	**45**	**21**	**3**

Table 2.4A-12, Species of Amphibians, Reptiles and Mammals recorded in the Red Data Books (RDB) of Armenia and the Former Soviet Union (FSU), and also in the International Red List of Threatened Animals (RL). (Ref [2.4A-30]).

Species/Sub-species	English name	Armenian RDB	FSU RDB	International RL
Amphibians				
Pelobates syriacus	Syrian spadefoot toad	+	+	-
Reptiles				
Testudo graeca	Mediterranean spur-thighed tortoise	+	+	+
Phrynocephalus persicus	Toadhead agama	+	+	-
Eremias arguta	Racerunner	+	-	-
Eumeces schnederi	Skink	+	-	-
Mabuya aurata	Golden grass mabuya	+	-	-
Ablepharus chernovi	Skink	+	+	-
Lacerta parva	Dwarf lizard	+	+	-
Elaphe hohenackeri	Transcaucasian rat snake	+	+	-
Rhynchocalamus melanocephalus	Palestine kukri snake	+	-	-
Telescopus fallax	European tiger snake	+	-	-
Vipera raddei	Russian viper	+	+	-
Mammals				
Hemiechinus auritus	Long-eared hedgehog	+	-	-
Rhinolophus euryale	Mediterranean horseshoe bat	+	+	-
Rhinolophus mehelyi	Mehely's horseshoe bat	+	-	+
Myotis nattereri	Natterer's bat	+	-	-
Barbastella leucomelas	Eastern barbastelle	+	-	-
Miniopterus schreibersi	Schreiber's long-fingered bat	+	+	-
Tadarida teniotis	European free-tailed bat	+	+	-
Hyaena lryaena	Striped hyaena	+	-	-
Sicista caucasica	Caucasian birch mouse	+	-	-
Meriones meridianus	Mid-day gerbil	+	-	-
Ursus arctos syriacus	Brown bear	+	+	-
Vormela peregusna	Marbled polecat	+	+	-
Lutra lutra meridionalis	European otter	+	+	-
Felis silvestris caucasica	Wild cat	+	-	-
Panthera pardus tullianus	Leopard	+	+	-
Felis manul	Manul	+	+	+
Capra aegagrus aegagrus	Wild goat	+	+	+
Ovis orientalis gmelinii	Armenian mouflon	+	+	+

Table 2.4A-13, IUCN Red List Endangered Fauna of Armenia [2.4A-31]

	Critically Endangered	
1	Sicista armenica	ARMENIAN BIRCH MOUSE (Eng)
2	Vanellus gregarius	SOCIABLE LAPWING (Eng)
3	Vipera darevskii	
	Endangered	
1	Acipenser nudiventris	BASTARD STURGEON (Eng) FRINGEBARBEL STURGEON (Eng) SHIP STURGEON (Eng) SPINY STURGEON (Eng) THORN STURGEON (Eng) ESTURGEON À BARBILLONS FRANGÉS (Fre) ESTURIÓN BARBA DE FLECOS (Spa)
2	Falco cherrug	SAKER FALCON (Eng)
3	Meriones dahli	DAHL'S JIRD (Eng)
4	Myotis schaubi	SCHAUB'S MYOTIS (Eng)
5	Neophron percnopterus	EGYPTIAN VULTURE (Eng)
6	Oxyura leucocephala	WHITE-HEADED DUCK (Eng) ÉRISMATURE À TÊTE BLANCHE (Fre) MALVASÍA (Spa)
7	Vipera kaznakovi	CAUCASIAN VIPER (Eng)
8	Vipera ursinii	MEADOW VIPER (Eng) ORSINI'S VIPER (Eng) VIPÈRE D'ORSINI (Fre) VIPÈRE DES STEPPES (Fre)
	Vulnerable	
1	Anser erythropus	LESSER WHITE-FRONTED GOOSE (Eng) OIE NAINE (Fre)
2	Aquila clanga	GREATER SPOTTED EAGLE (Eng) AIGLE CRIARD (Fre) AGUILA MOTEADA (Spa)

3	Aquila heliaca	EASTERN IMPERIAL EAGLE (Eng) AIGLE IMPÉRIAL (Fre) AGUILA IMPERIAL ORIENTAL (Spa) AGUILA IMPERIAL (Spa)
4	Barbastella barbastellus	WESTERN BARBASTELLE (Eng)
5	Capra aegagrus	WILD GOAT (Eng)
6	Cerambyx cerdo	CERAMBYX LONGICORN (Eng)
7	Chlamydotis undulata	HOUBARA BUSTARD (Eng) HOUBARA ONDULÉ (Fre) OUTARDE HOUBARA (Fre) AVUTARDA HUBARA (Spa) HUBARA (Spa)
8	Falco naumanni	LESSER KESTREL (Eng) FAUCON CRÉCERELLETTE (Fre) CERNÍCALO PRIMILLA (Spa)
9	Gazella subgutturosa	GOITERED GAZELLE (Eng) GAZELLA À GOÎTRE (Fre) GACELA DE BOCIO (Spa)
10	Marmaronetta angustirostris	MARBLED TEAL (Eng) SARCELLE MARBRÉE (Fre)
11	Myotis emarginatus	GEOFFROY'S BAT (Eng)
12	Onychogomphus assimilis	
13	Otis tarda	GREAT BUSTARD (Eng) GRANDE OUTARDE (Fre) OUTARDE BARBUE (Fre) AVUTARDA EUROASIÁTICA (Spa) AVUTARDA (Spa)
14	Ovis ammon,	ARGALI (Eng, Fre) MOUFLON D'ASIE (Fre) MOUFLON D'EURASIE (Fre) MOUFLON VRAI (Fre) MUFLÓN ARGAL (Spa)
15	Ovis orientalis	MOUFLON (Eng) URIAL (Eng)
16	Parnassius apollo	APOLLO BUTTERFLY (Eng) APOLLO (Eng)

		MOUNTAIN APOLLO (Eng) APOLO (Spa) MARIPOSA APOLLO (Spa)
17	Pelecanus crispus	DALMATIAN PELICAN (Eng) PÉLICAN DALMATE (Fre) PÉLICAN FRISÉ (Fre) PELÍCANO CEÑUDO (Spa) PELÍCANO RIZADO (Spa)
18	Rhinolophus euryale	MEDITERRANEAN HORSESHOE BAT (Eng)
19	Rhinolophus mehelyi	MEHELY'S HORSESHOE BAT (Eng)
20	Rosalia alpina	ROSALIA LONGICORN (Eng)
21	Saga pedo	PREDATORY BUSH CRICKET (Eng)
22	Sambucus tigranii	
23	Testudo graeca	COMMON TORTOISE (Eng) GREEK TORTOISE (Eng) MOORISH TORTOISE (Eng) SPUR-THIGHED TORTOISE (Eng) TORTUE MAURESQUE (Fre) TORTUGA MORA (Spa)
24	Testudo horsfieldi	AFGHAN TORTOISE (Eng) CENTRAL ASIAN TORTOISE (Eng) FOUR-TOED TORTOISE (Eng) HORSFIELD'S TORTOISE (Eng) STEPPE TORTOISE (Eng) TORTUE D'HORSFIELD (Fre) TORTUE DES STEPPES (Fre) TORTUGA TERRESTRE AFGANA (Spa)
25	Zerynthia caucasica	
	Lower Risk Conservation Dependent	
1	Vertigo angustior	NARROW-MOUTHED WHORL SNAIL (Eng)
	Lower Risk Near Threatened	
1	Aegypius monachus	CINEREOUS VULTURE (Eng) VAUTOUR MOINE (Fre) BUITRE NEGRO (Spa)

2	Archon apollinaris	
3	Aythya nyroca	FERRUGINOUS DUCK (Eng) FULIGULE NYROCA (Fre) PORRÓN PARDO (Spa)
4	Chionomys nivalis	EUROPEAN SNOW VOLE (Eng) SNOW VOLE (Eng)
5	Circus macrourus	PALLID HARRIER (Eng) BUSARD PÂLE (Fre) AGUILUCHO PAPIALBO (Sp a)
6	Coracias garrulus	EUROPEAN ROLLER (Eng)
7	Crex crex	CORNCRAKE (Eng) RÂLE DES GENÊTS (Fre)
8	Emys orbicularis	EUROPEAN POND TURTLE (Eng) CISTUDE D'EUROPE (Fre)
9	Falco vespertinus	RED-FOOTED FALCON (Eng)
10	Ficedula semitorquata	SEMICOLLARED FLYCATCHER (Eng)
11	Gallinago media,	GREAT SNIPE (Eng)
12	Glareola nordmanni	BLACK-WINGED PRATINCOLE (Eng)
13	Hirudo medicinalis	MEDICINAL LEECH (Eng) SANGSUE MÉDICINALE (Fre) SANGSUE OFFICINALE (Fre)
14	Hyaena hyaena	STRIPED HYAENA (Eng) HYÈNE RAYÉE (Fre)
15	Libellula pontica	
16	Limosa limosa	BLACK-TAILED GODWIT (Eng)
17	Lutra lutra	COMMON OTTER (Eng) EURASIAN OTTER (Eng) EUROPEAN OTTER (Eng) EUROPEAN RIVER OTTER (Eng) OLD WORLD OTTER (Eng) LOUTRE COMMUNE (Fre)

		LOUTRE D'EUROPE (Fre) LOUTRE DE RIVIÈRE (Fre) NUTRIA COMÚN (Spa)
18	Lycaena dispar	LARGE COPPER (Eng)
19	Lynx lynx	EURASIAN LYNX (Eng) LYNX (Fre) LINCE (Spa)
20	Maculinea arion	LARGE BLUE (Eng)
21	Maculinea nausithous	DUSKY LARGE BLUE (Eng)
22	Marmota caudata	LONG-TAILED MARMOT (Eng) MARMOTA DE COLA LARGA (Spa)
23	Micromys minutus	EURASIAN HARVEST MOUSE (Eng) HARVEST MOUSE (Eng)
24	Nyctalus leisleri	LESSER NOCTULE (Eng)
25	Otocolobus manul	PALLAS'S CAT (Eng) CHAT MANUL (Fre) GATO DE PALLAS (Spa) GATO MANUL (Spa)
26	Rhinolophus ferrumequinum	GREATER HORSESHOE BAT (Eng)
27	Sciurus anomalus	CAUCASIAN SQUIRREL (Eng) PERSIAN SQUIRREL (Eng)
28	Tetrax tetrax	LITTLE BUSTARD (Eng) OUTARDE CANEPETIÈRE (Fre) SISÓN (Spa)
29	Zelkova carpinifolia	

Table 2.4A-14, Species Outcome for the Caucasus Hotspot (Ref [2.4A-1]).

	Scientific name	Common name	IUCN status			Distribution by country					
			Vulnerable	Endangered	Critically endangered	Armenia	Azerbaijan	Georgia	Iran	Russia	Turkey
	Mammals		**12**	**4**	**2**	**11**	**11**	**11**	**10**	**14**	**9**
1	*Barbastella barbastellus*	Western barbastelle	+			+	+	+		+	+
2	*Myotis emarginatus*	Geoffroy's bat	+			+	+	+	+	+	+
3	*Miotis schaubi*	Schaub's bat		+		+			+		
4	*Myotis bechsteini*	Bechstein's bat	+				+	+	+	+	+
5	*Rhinolophus euryale*	Mediterranean horseshoe bat	+			+	+	+	+	+	+
6	*Rhinolophus hipposideros*	Lesser horseshoe bat	+			+	+	+	+	+	+
7	*Rhinolophus mehelyi*	Mehely's horseshoe bat	+			+	+	+	+	+	+
8	*Lutra lutra*	Common otter	+			+	+	+	+	+	+
9	*Mustela lutreola*	European mink		+				+		+	
10	*Phoca caspica*	Caspian seal	+				+		+	+	
11	*Capra aegagrus*	Wild (bezoar) goat	+			+	+	+	+	+	+
12	*Capra caucasica*	West Caucasian tour		+				+		+	
13	*Capra cylindricornis*	East Caucasian tour	+				+	+		+	
14	*Ovis ammon*	Armenian mouflon	+			+	+		+		+
15	*Saiga tatarica*	Saiga antelope			+					+	
16	*Sicista armenica*	Birch mouse			+	+					
17	*Spalax giganteus*	Giant mole rat	+							+	
18	*Meriones dahli*	Dahl's jird		+		+					
	Birds		**9**	**1**	**1**	**4**	**8**	**3**	**11**	**11**	**10**
19	*Aquita heliaca*	Imperial eagle	+			+	+	+	+	+	+
20	*Aquita clanga*	Greater spotted eagle	+						+	+	+
21	*Falco naumanii*	Lesser kestrel	+			+	+	+	+	+	+
22	*Vanellus gregaris*	Sociable lapwing	+						+	+	+
23	*Crex crex*	Corncrake	+			+	+	+	+	+	+
24	*Grus leucogeranus*	Siberian crane			+		+		+	+	
25	*Otis tarda*	Great bustard	+						+	+	+
26	*Marmaronneta angustirostris*	Marbled duck	+			+	+		+	+	+
27	*Anser erythropus*	Lesser white-fronted goose	+				+		+	+	+
28	*Branta rufficolis*	Red-breasted goose	+				+		+	+	+
29	*Oxyura leucocephala*	White-headed duck		+			+		+	+	+
	Reptiles		**4**	**4**	**2**	**3**	**3**	**5**	**4**	**5**	**6**
30	*Testudo graeca*	Common tortoise	+			+	+	+	+	+	+
31	*Lacerta clarkorum*	Turkish lizard		+				+			+
32	*Natrix megalocephala*	Large-headed water snake	+							+	

33	*Vipera darevskii*	Darevsky's viper			+	+		+			
34	*Vipera kaznakovi*	Caucasian viper		+		+	+	+		+	
35	*Vipera ursinii*	Meadow viper		+					+	+	+
36	*Vipera dinniki*	Dinnik's viper	+				+	+		+	
37	*Vipera pontika*	Pontic viper			+						+
38	*Vipera wagneri*	Wagner's viper		+					+		+
39	*Vipera latifii*	Latifi's viper	+						+		
	Amphibians		**4**				**2**	**3**	**1**	**2**	**3**
40	*Mertensiella caucasica*	Caucasian salamander	+					+			+
*41	*Batrachuperus persicus*	Persian brook salamander	+						+		
42	*Bufo verrucosissimus*	Caucasian toad	+				+	+		+	+
43	*Pelodytes caucasicus*	Caucasian parsley frog	+				+	+		+	+
	Fish		**1**	**5**	**1**		**6**	**6**	**5**	**6**	**4**
44	*Acipenser gueldenstaedtii*	Russian sturgeon		+			+	+		+	
45	*Acipenser persicus*	Persian sturgeon		+			+	+	+	+	+
46	*Acipenser nudiventris*	Bastard sturgeon		+			+	+	+	+	+
47	*Acipinser ruthenus*	Sterlet	+				+		+	+	
48	*Acipinser stellatus*	Star sturgeon		+			+	+	+	+	+
49	*Acipinser sturio*	Baltic (Atlantic) sturgeon			+			+			
50	*Huso huso*	Beluga		+			+	+	+	+	+
	Plants		**1**			**1**					
51	*Sambucus tigranii*	Tigran's elder	+			+					
	Total		**31**	**14**	**6**	**19**	**30**	**28**	**31**	**38**	**32**

* The global conservation status of one of the species outcomes, the Persian brook salamander *(Batrachuperus persicus)*, has since been determined to be near threatened, rather than vulnerable as originally indicated. This species was originally included in the site outcomes based on preliminary results of the Global Amphibian Assessment. However, these results and data for the Global Amphibian Assessment have since been finalized and this species will be classified as near threatened on the 2004 IUCN Red List. As a result of this new information about the species' status, *Batrachuperus persicus* can no longer be considered a species outcome or a priority of CEPF investment. For further information, see www.globalamphibians.org.

Table 2.4A-15, Sites in Armenia in the Southern Uplands Corridor important to maintaining biodiversity in the Caucasus Hotspot.

	Corridor, country and site name*	Globally threatened species**	Area of sites (ha)	Other criteria	
				Globally significant congregation	Sites with restricted-range species
146	Goravan Sands Sanctuary	*Myotis schaubi*	3.558		+
147	Armash Fish-Farm	Marmaronetta angustirostris, Oxyura leucocephala	5.154	+	
	Southern uplands	23	1.261.008	2	11
	Armenia		**146.219**	**1**	**2**
144	Araks River	Lutra lutra, Marmaronetta angustirostris, Otis tarda, Sambucus tigranii	121.386		
145	Armash	Myotis schaubi, Meriones dahlia	16.121		+

FIGURE 2.4A –1, Distribution of Landscape Zones

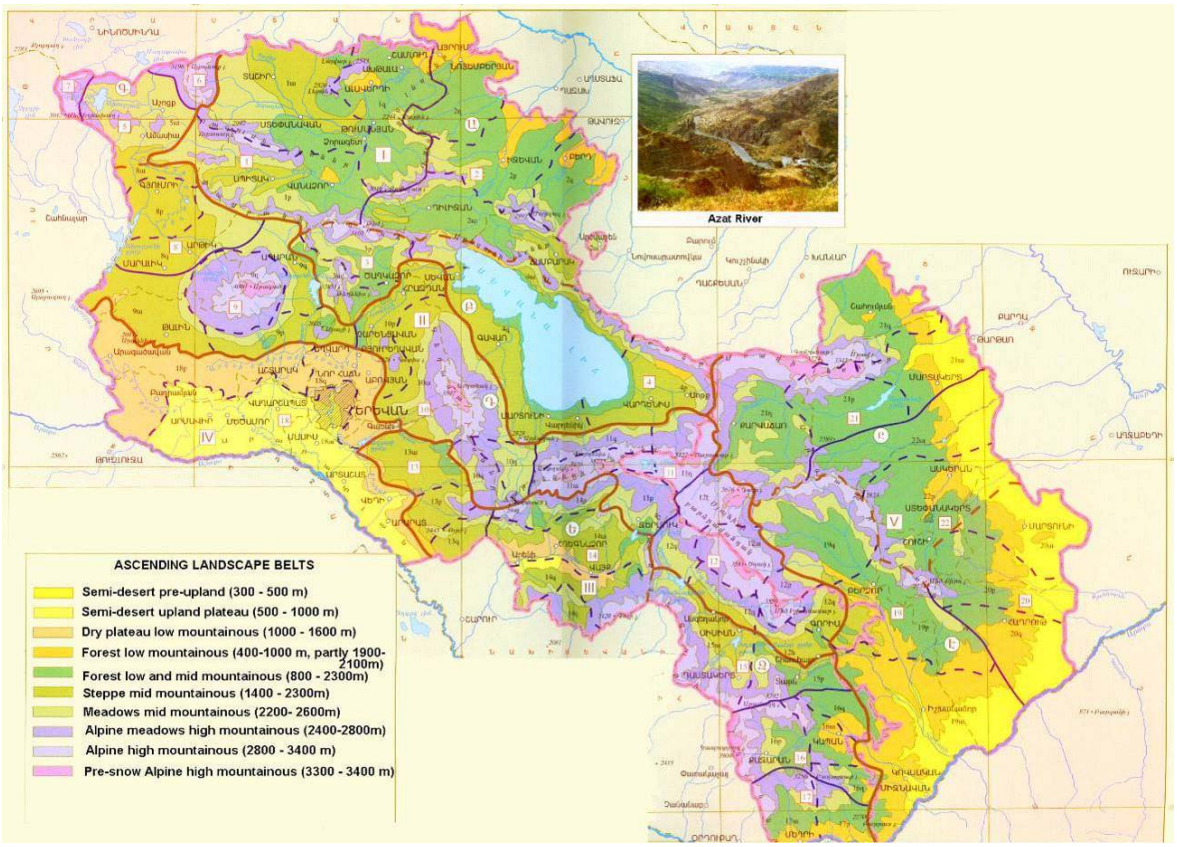
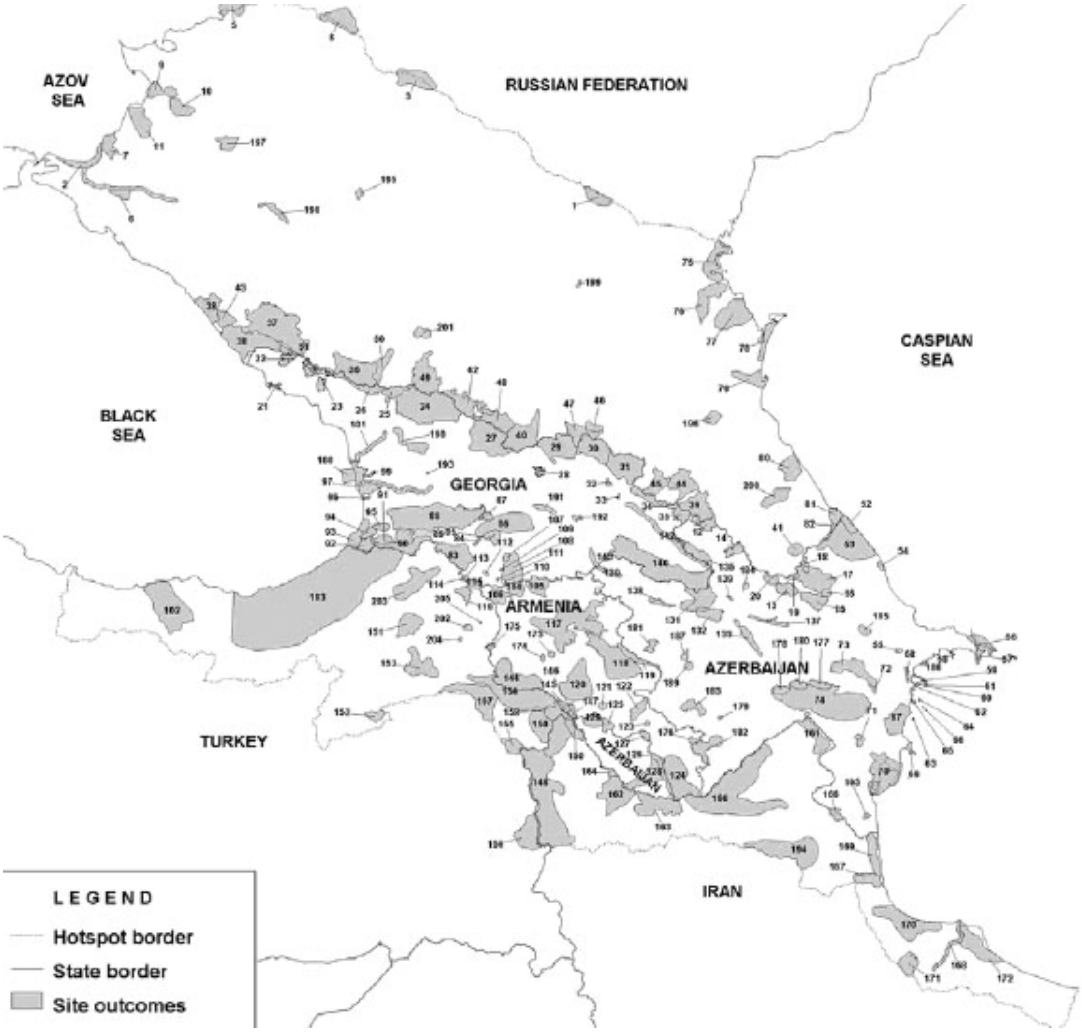


FIGURE 2.4A–2, Site outcomes of 4 of Caucasus hotspots



REFERENCES

[2.4A-1] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.13.

[2.4A-2] Republic of Armenia State Committee of Real Estate Cadastre, October 2007 *Atlas of Armenia*, plate 86

[2.4A-3] First Caucasus Environment Outlook (CEO) 2002 http://www.grid.unep.ch/product/publication/CEO-for-Internet/CEO/index.htm

[2.4A-4] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.53.

[2.4A-5] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.54.

[2.4A-6] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.56

[2.4A-7] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.55.

[2.4A-8] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.22.

[2.4A-9] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.27.

[2.4A-10] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.26.

[2.4A-11] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.36.

[2.4A-12] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.38.

[2.4A-13] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.37

[2.4A-14] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.44.

[2.4A-15] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,*Yerevan, p.49.

[2.4A-16] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.34.

[2.4A-17] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.38.

[2.4A-18] Ministry of Nature Protection of the Republic of Armenia, 2003 *National Report on the State of the Environment in Armenia in 2002*" This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.36.

[2.4A-19] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.39.

[2.4A-20] The Republic of Government February 2, 2006, *Decree No 98 On Approval of the List of Animals of the RoA Red Book of Animals and the List of Plants of the RoA Red Book of Plants*.

[2.4A-21] Government Of The Republic Of Armenia, August 3, 2006, *On Approval Of The Program Of Activities Aimed To Study And Conservation Of Representatives Of Flora And Fauna Included Into The Red Book Of The Republic Of Armenia,* Resolution No. 1075 –N

[2.4A-22] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 32.

[2.4A-23] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.40.

[2.4A-24] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.41.

[2.4A-25] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.45.

[2.4A-26] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.50.

[2.4A-27] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.52.

[2.4A-28] Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.40.

[2.4A-29] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.41.

[2.4A-30] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.42.

[2.4A-31] The International Union for the Conservation of Nature and Natural Resources (IUCN), October 2007, *The IUCN Red List of Threatened Species,* Gland, Switzerland, October, 2007. Information on their Red List is only available from them on the internet at: http://www.iucnredlist.org/info/programme

[2.4A-32] Critical Ecosystem Partnership Fund (CEPF), *Ecosystem Profile, Caucasus Biodiversity Hotspot, Final Version,* July 31, 2003 (Updated: September 2004), p.4.

[2.4A-33] Republic of Armenia, Ministry of Nature Protection, *Biodiversity of Armenia,* an internet report based on material and data supplied by the Ministry of Nature Protection of Armenia. The content of the report is a sole responsibility of the ministry, on the web at: http://enrin.grida.no/biodiv/biodiv/national/armenia/index.htm.

[2.4A-34] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 32.

[2.4A-35] Republic of Armenia Ministry for Nature Protection, 1999, *Biodiversity Strategy and Action Plan*, Yerevan, p. 33.

[2.4A-36] Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment in Armenia in 2002*," This Report was prepared in cooperation with the United Nations Economic Commission for Europe, Yerevan, p.40.

[2.4A-37] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.52.

[2.4A-38] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* Yerevan, p.53.

[2.4A-39] Republic Of Armenia, Ministry Of Nature Protection, 2006, *Ministerial Report 2003–2005*, Yerevan, p.74

[2.4A-40] Karén Jenderedjian, 2004, *Wetlands In Armenia – Their Values And Threats And Their Contribution To Sustainable Development And Poverty Alleviation,* Standing Committee, Ministry of the Nature Conservation, 5th European Regional Meeting on the implementation and effectiveness of the Ramsar Convention, 4-8 December 2004, Yerevan, Armenia. This an be found on the web at: http://www.ramsar.org/mtg/mtg_reg_europe2004_docs05.pdf

[2.4A-41] Alisma lanceolatum, from the Armeniapedia on the web at: http://www.armeniapedia.org/index.php?title=Alisma_lanceolatum&redirect=no

[2.4A-42] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007.

[2.4A-43] "Birds in Armenia, Birds, Lists, Regions," Birding Armenia, Tour Armenia, on the web at http://www.tacentral.com/nature/birding.asp#1enia

[2.4A-44] "Birding…..Armenia," Fat Birder, on the web at: http://www.fatbirder.com/links_geo/middle_east/armenia.html

[2.4A-45] "Birds in Armenia, National Birds List," on the web at: http://www.armeniabirding.info/index.html

[2.4A-46] M. S. Adamian and D. Klem, Jr. 1997, *A Field Guide to Birds of Armenia*, published by the American University of Armenia Project.

[2.4A- 47] Gabrielyan, B.K., December 2001, *An Annotated Checklist of Freshwater Fishes of Armenia,* Fishbyte, Fisheries Section of the Network of Tropical Aquaculture and Fisheries Professionals (NTAFP), Naga, The ICLARM Quarterly (Vol. 24, Nos. 3 & 4), pp. 23-29.

[2.4A-48] Republic of Armenia, Ministry of Nature Protection, March 1999, *First National Report to The Convention on Biological Diversity,* , Yerevan, p.92.

[2.4A-49] Gabrielyan, B.K., October, 2007, *Personal Communication*, at a meeting with the Scientech and PA staff on October 17, 2007

[2.4A-50] Nazik Khanjyan, 2004, *Specially Protected Nature Areas Of Armenia,* Ministry Of Nature Protection Of The Republic Of Armenia, Yerevan, p.44.

2.5 SOCIOECONOMICS

This section provides basic data for evaluation of socioeconomic impacts of the project. Subsection 2.5.1 covers demographics of the population within 50 km of the site. Subsection 2.5.2 provides characteristics of the Armenian communities within the 50 km zone around the plant, including industries, housing, and transportation. Subsection 2.5.3 gives a summary description of the urban communities and marzes of Armenia encompassed in the 50 km zone. Subsection 2.5.4 discusses governmental structures, taxing districts, and land use planning. Subsection 2.5.5 summarizes emergency planning, police and fire services in the region. Subsection 2.5.6 discusses historic, cultural, and recreational resources in the region, including a summary of registered historic sites.

2.5.1 Demographics

The location of the plant and the 16 km and 50 km zones are illustrated in Figure 2.5-1. This figure also reflects the unit location in relation to major cities and national and marz (region) borders.

Population figures discussed below are taken from publications by the National Statistical Service of Armenia. Definitions for different population data are as follows:

- *De Jure population* - the number of population of the given territory covering permanent residents including those present and those registered but temporarily absent during the census.
- *De facto population* – the number of population of the given territory, covering permanent residents including those present and those temporarily residing in the area during the census.
- *Temporarily absent population* – those individuals who were registered as residents but were absent less than 12 months from the place of their main (permanent) residence as of the census time.
- *Temporarily present population* – those individuals who weren't registered residents and were present in the given territory less than 12 months as of the census time.

The *de facto* population would be the most appropriate population for consideration of impacts; however, most demographic statistics are reported for the *de jure* population. Basic census data for both the *de facto* and *de jure* population are presented in the tables for each settlement within the 50 km zone; however, population projections and most demographic statistics are based on *de jure* population and, except where noted otherwise, population numbers are *de jure* figures.

The census report defines a *temporarily present*, or transient, population, but no census data are published for this population category. Census data are provided for the identified Armenian communities within 50 km, with demographic breakdowns by gender and age groupings. Where data are not available for rural communities, the data are reported on a marz-wide (region-wide) basis and, where available, for those urban communities in the zone.

Current population estimates for non-census years are produced on the basis of the results of the last population census, plus annual number of births and arrivals in a given territory, minus deaths and departures from the given territory. Ref. [2.5-1] The last census was conducted in October 2001. Ref. [2.5-2]

2.5.1.1 POPULATION IN THE 16 KM ZONE[6]

Figure 2.5-2 is a map showing settlements within 16 km of the proposed Unit.

Table 2.5-1 provides population data and distance to the new Unit for settlements in the 16 km zone, broken down by settlements. There is no resident population within the ANPP owned area.

Distance to ANPP Unit 3 was calculated using ArcGIS ® software[7] and GIS data assembled by PA Consulting for the USAID Armenia Water Management Program (Ref. [2.5-3]) using the longitude and latitude identified in Chapter 2.1. 2001 *de facto* and *de jure* population are from the 2001 Census. Ref. [2.5-4] The population density data are also from the 2001 Census. Ref. [2.5-5] Data for *temporarily present* population and population data for 2006 for villages were provided by the National Statistical Service. Ref. [2.5-6]

Recent (2006) population data were extracted from data used by the National Statistical Service of Armenia to generate "Marzes (Regions) of the Republic of Armenia in Figures 2001-2005" updated through 2006. Ref. [2.5-7]

Efforts to obtain transient population data have been unsuccessful, as statistics for visitors to resorts, museums and cultural sites are not collected centrally. The most important and identifiable transient population within the 16 km zone is that portion of the ANPP staff that travels from Yerevan – approximately 320 people. Another important transient population arises from visitors to the Echmaidzin cathedral and grounds. Assuming that every international visitor to Armenia also visits Echmaidzin, a transient population can be estimated as follows:

- The Department of Tourism of the Ministry of Trade and Economic Development reports that during January-December 2007, the number of international tourists to Armenia amounted to 510,287. Compared to the same period of 2006, this represents an annual growth rate of 133.5%. Ref. [2.5-8]

- Assuming that all of these tourists visit Echmaidzin and that the majority of these visitors arrive during the six months from May to October, this results in an estimated daily attendance of 2,800.

- If the growth rate seen in 2006 to 2007 continues at a steady rate (without compounding), this results in an estimated 10,000 visitors per day to Echmaidzin during the summer months of 2015. A more realistic value is probably 5,000 to

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[6] The current ANPP Emergency Plan defines a 5 km (preventive protection measures – PPM) zone and a 5 km – 10 km (urgent protective measures planning – UPMP) zone.

[7] ArcGIS is a system for authoring, serving, and using geographic information. It is an integrated collection of GIS software products – see http://www.esri.com/software/arcgis/index.html.

6,000 visitors per day, as the increase cannot be expected to continue at a constant rate.

Table 2.5-2 provides projections of the population within the 16 km zone – without changes in NPP staffing – beginning with 2013, the expected year for peak construction staffing, and at 10 year intervals beginning in 2015, the year for plant startup activities (projected Commercial Operation on 1/1/2016). Projections through 2035 are based on forecasts developed by the National Statistical Service of Armenia for the United Nations Population Fund. Ref. [2.5-9]. The forecasts were made using a program of the "Mortpak" software package developed and recommended for application by the UN. Figure 2.5-3 illustrates the results of that forecast for two different scenarios: Low or pessimistic; and High or optimistic.

In addition, a Reference value is shown, based on population inferred in the most recent Poverty Reduction Strategy Paper (Ref. [2.5-10]).

- The Low scenario assumes migration rates consistent with recent years and a decreasing birthrate relative to that observed in 2000-2005.
- The High scenario assumes migration rates consistent with recent years and an increasing birthrate relative to that observed in 2000-2005.
- The Reference values shown in Figure 2.5-3 are calculated by dividing the total gross domestic product (GDP) in USD by the per-capita GDP to calculate an inferred population for 2005, 2010, and 2015. A value is calculated for 2020 by linear interpolation between the values given for 2018 and 2021. Values for 2025, 2030 and 2035 are calculated by linear extrapolation using the slope of the line between 2020 and 2015.
- High and Reference values for 2045 and 2055 are linear extrapolations using the slope between values for 2025 and 2035.

To obtain population projections for the 16 km zone, the forecasted Republic-wide population figures illustrated in Figure 2.5-3 were indexed to 2005 and the indices were used to forecast the population figures given in Table 2.5-2; this assumes that the population trends in these communities, unrelated to NPP activities, follow the Republic-wide trend, which probably over-predicts the population in rural communities because there has been a significant migration from rural to urban areas of Armenia since the 1990's.

Table 2.5-3 forecasts the population in urban centers of the 16 km Zone, accounting for changes in the staffing at ANPP, with input assumptions as shown in Table 2.5-4, which reflects: 1) current ANPP staffing and residences; 2) on-site staffing for construction; 3) on-site resources for new unit staffing and startup activities in 2015; and 3) reductions in staffing for ANPP Units 1 and 2 in 2025 and beyond. For this purpose, the estimates for Unit 3 and their residential distribution among urban centers is assumed to be consistent with that for the current ANPP staffing. Table 2.5-4 is based, in part, on information in US DOE Report NP2010 (Ref. [2.5-11]), pending completion of an ongoing study by IAEA and the Ministry of Energy of the Republic of Armenia to define anticipated resource needs for construction and operation of a new NPP unit in Armenia – expected to be available in December 2008. The number of construction personnel predicted in NP2010 are

increased by 20% to estimate the workforce needed to construct ANPP Unit 3. The estimated Owner's O&M Staff is based on 110% of that for the VVER-1000, model AES-91 (Ref. [2.5-12]). The ANPP O&M Staff reductions due to decommissioning of Units 1 and 2 are based on the numbers of ANPP (former) staff involved in decommissioning as shown in the ANPP Decommissioning Strategy (Ref. [2.5-13]).

2.5.1.1.1 Special Populations within the 16 km Zone

In order to define the limiting individuals for radiation exposure due to releases from ANPP Unit 3, a current survey is needed to identify the following:

- Individuals (or families with infant children) who receive their drinking water from sources within 10 km of the site;
- Individuals who consume fruits and vegetables primarily grown within 10 km of the site;
- Individuals (or families with infant children) who consume milk and dairy products primarily from cows or goats raised within 10 km of the site;
- Individuals who consume fish or other aquatic life caught primarily within 10 km of the site;
- Individuals who consume meat from animals raised within 10 km of the site; and
- The location of milk-producing animals and farms raising poultry or animals for meat production within 10 km of the site.

In order to assess the impacts on low income population within the 16 km zone, statistics are needed from the Family Poverty Database System on numbers of individuals and families qualifying as poor within the 16 km zone.

2.5.1.2 POPULATION WITHIN THE 50 KM ZONE[8]

Figure 2.5-4 provides a map showing settlements within 50 km of Unit 3.

2.5.1.2.1 Population of Armenia within the 50 km Zone

Table 2.5-5 provides population and demographic data for Armenian urban communities within the 50 km zone (including those within the 16 km Zone). Table 2.5-6 provides population and demographic data for rural communities within the 16 km and 50 km Zones.[9] These tables also identify distances from the settlements to the new unit reactor.

Distance to ANPP Unit 3 was calculated using GIS data, using the longitude and latitude identified in section 2.1. 2001 *de facto* and *de jure* population are from the 2001 Census. Ref. [2.5-4] The population density data are also from the 2001 Census. Ref. [2.5-5] 2006 urban population and demographic data were extracted from data used by the

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[8] The current ANPP Emergency Plan defines a long-term protective actions planning (LTPAP) zone encompassing those marzes and communities expected to be involved in relocation of population (either to be evacuated or to receive evacuees) and does not directly coincide with a specific, constant distance from the site.

[9] Census data for demographic breakdown is published only for large villages; thus, Table 2.5-6 only includes demographic data for large villages.

National Statistical Service Republic of Armenia to generate "Marzes (Regions) of the Republic of Armenia in Figures 2001-2005" updated through 2006. Ref. [2.5-7] Data for *temporarily present* population and population data for 2006 for villages were provided by the National Statistical Service. Ref. [2.5-6]

Efforts to obtain transient population data have been unsuccessful, as statistics for visitors to resorts, museums and cultural sites are not collected centrally. The most important and identifiable transient population within the 50 km zone arises from international visitors arriving for tourism. As discussed in Subsection 2.5.1.1, the Department of Tourism of the Ministry of Trade and Economic Development reports that during January-December 2007, the number of international tourists to Armenia amounted to 510,287. Compared to the same period of 2006, this represents an annual growth rate of 133.5%. Ref. [2.5-8] Assuming this growth rate continues at a steady rate (without compounding), a projection for 2015 is 1.9 million international visitors to Armenia. A more realistic prediction would be 1.0 to 1.5 million visitors, since steady growth at the high rate observed in the period 2006-2007 probably will not continue indefinitely.

Table 2.5-7 provides population projections for Armenian urban communities and marzes in the 50 km Zone, including changes due to construction and NPP staffing. Projections were developed in the same manner as that described above for Table 2.5-2. The forecast value of the Yerevan urban areas was adjusted to account for changes in ANPP staffing as reflected in Table 2.5-4, assuming the ANPP staff residential distribution to be consistent with that for the current ANPP staffing. (This may under-predict the Yerevan population because of the migration of population from rural to urban areas since 1990.)

Table 2.5-8 provides population projections for Armenian rural communities in the 50 km Zone. Projections were developed in the same manner as that described for Table 2.5-2. It was assumed that no significant number of NPP construction or O&M staff will reside in rural areas, so projections do not include changes in NPP staffing.

2.5.1.2.2 Population of Turkey within the 50 km Zone

The Turkish provinces of Kars and Igdir border Armenia within the 50 km Zone. In 2000, the population density in Kars province was 32 people/km^2 and in Igdir province it was 47 people/ km^2. Ref. [2.5-14] The area enclosed within the 50 km Zone is approximately 2,200 km^2. Using a conservative value[10] of 47 persons per square km yields an estimated 2000 Turkish population within the Zone of 103,400.

The one major population center in the Turkish part of the 50 km Zone is the city of Igdir at a distance of approximately 30 km from the site and with a 2000 population of 59,880. Ref. [2.5-15]

Annual population growth in Igdir province was 3.843% for cities and 0% in villages. Kars province villages experienced a negative growth rate between 1990 and 2000 (there are no Kars province cities within the 50 km zone). Ref. [2.5-16] If the percent growth rate was constant, this would result in a 2005 population of 62,180 for the city of Igdir.

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[10] Since the only use of Turkish population data is to assess the potential numbers of people impacted by accidents involving radioactive materials, a higher than actual population is conservative.

2.5.1.2.3 Population in compass sectors and segments of the 50 km Zone

Table 2.5-9 gives the total estimated 2055 population for sixteen compass sectors and nine distance segments. For areas of Armenia, this represents a summation of the populations of the communities centered in the sector/segment.

For areas in Turkey, populations were estimated using the figures cited in the previous section for population densities of Igdir and Kars provinces, escalated by the same factor used for Armenia population, resulting in 55 people/km^2 and 38 people/km^2, respectively. The population of Igdir city was escalated also, resulting in an estimated population of 70,759 which was split between segments SSW 20-30 and SSW 30-40 since Igdir center is at 30 km SSW from the site. Areas near Mount Ararat that appear to be uninhabited based on satellite images are assigned zero population. The resulting population estimate for Turkish territory within the 50 km zone is 146,667, which is conservative compared with the estimate given in the previous section.

2.5.1.3 DEMOGRAPHICS OF THE REPUBLIC OF ARMENIA WITHIN THE 50 KM ZONE

Table 2.5-5 provides basic demographic data (population breakdown by gender and age) for Armenian urban centers within the 50 km zone.

Table 2.5-10 provides the income, poverty, and education demographics data for each marz within 50 km of the site, including:

- income distribution (% of population by wealth quintile) Ref. [2.5-17];
- poverty level (% of population that are poor and very poor) Ref. [2.5-18];
- education level (% of males and females - no education, primary, middle, high school, specialized secondary, and higher; median years of schooling for males and females) Ref. [2.5-19].

2.5.1.4 ETHIC GROUPINGS IN REPUBLIC OF ARMENIA AND WITHIN THE 50 KM ZONE

The vast majority (97.89%) of the population of the Republic of Armenia is identified as Armenian. The largest minority is Yezed (40,620, 1.26% of total RA), followed by Russians (14,660, 0.46% of total RA) and Assyrians (3,409, 0.11% of total RA). Other identified ethnic groups, Greeks, Ukrainians and Kurds each make up 0.05 % or less of the RA population. The Yezed, Assyrian, and Kurdish ethnic populations tend to be located in rural areas (over 80% of each group), whereas other nationalities, Russians, Greeks, and Ukrainians are primarily located in urban areas (73 to 85% of each group).

Table 2.5-11 provides data on ethnic populations for each marz in the 50 km Zone. Ref. [2.5-20] In Armavir marz, where the greatest impact of construction workforce and activities is likely, the Yezed group is the largest minority population, most of whom are in rural communities. One can expect that the number of other nationalities in the urban areas of Armavir marz and Yerevan City may increase due to an influx of foreign skilled workers and experts during the construction period.

Figure 2.5-5 illustrates concentration of ethnic groups within Armenia. This map, titled “Ethno-linguistic distribution in the South Caucasus, 2004” by Phillipe Rekacewicz, Le Monde Diplomatique, Paris, identifies a large region of southwestern Armavir marz, along the Araks river, as having a Kurdish population. It shows smaller pockets of Kurds in Ararat, Aragatsotn and Shirak marzes. (This map does not explicitly reflect the Yezed ethnic group, but most likely considers the Yezeds and Kurds to be the same ethno-

linguistic group since their language is the same; the main difference between them is the nature of their religion.)

2.5.2 Community Characteristics

For the purposes of this data, the relevant region is limited to that area necessary to include social and economic base data for (1) the marz in which the unit will be located (Armavir marz) and (2) those specific portions of surrounding marzes and urbanized areas (generally, up to 50 km from the station site) from which the construction and operations work forces would be principally drawn, or that would receive stresses to community services by a change of residence of construction workers or new operating staff. Other social and economic impacts can generally be presumed to fall within the same area covered by this definition of the region.

It should be noted that although data in most tables referenced in this section are reported on a marz-wide basis, only Armavir marz and Yerevan City are totally within the 50 km zone. Aragatsotn marz is mostly encompassed by the 50 km zone, but only small portions of Kotayk, Ararat and Shirak marzes are within the 50 km zone. Since agriculture is primarily located in the rural areas and most industry (except mining) is in urban areas, one could make judgments on the relative shares of agriculture and industry within the 50 km zone by examining Figure 2.5-1 and the relationship of the 50 km region with marz boundaries and locations of cities.

2.5.2.1 INDUSTRY, AGRICULTURE, BUSINESSES AND EMPLOYMENT IN THE 50 KM ZONE

Table 2.5-12 summarizes the industry productivity and agricultural volumes (Ref. [2.5-21]) for the marzes within the 50 km region that represents the area from which the construction/operations work force would be principally drawn, or that would receive stresses to community services by a change of residence of construction workers or operations staff.[11] Table 2.5-13 provides additional detail on the types of industry and their relative volumes within the marzes of the 50 km zone. Ref. [2.5-21] Table 2.5-14 gives a breakdown of numbers of businesses by type within urban centers and marzes in the 50 km Zone. Ref. [2.5-22]

Table 2.5-15 provides data on employment by sectors (Ref. [2.5-23]) within the marzes of the 50 km zone, including average nominal wages/salaries[12] and distribution by employment status (Ref. [2.5-24]).

Economically active population includes all employed and unemployed population, who constitute the labor market (related to labor force supply for production of goods and services). *Economically non-active* population covers working age students in daytime courses and not participating in production; persons engaged in housekeeping, taking

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[11] Agricultural volumes in Table 2.5-12 and industrial volumes in Table 2.5-13 are stated in both Armenian Drams (AMD) and in U.S. Dollars (USD). The volume in USD is calculated using the official exchange rate effective at the end of December 2005, which differs significantly from the current exchange rate.

[12] Average wages/salaries in Table 2.5-15 are stated in both Armenian Drams (AMD) and in U.S. Dollars (USD). The values in USD are calculated using the official exchange rate effective at the end of December 2005, which differs significantly from the current exchange rate.

care of children or sick relatives, and also persons who do not work for various reasons and do not look for a job. Ref. [2.5-25]

2.5.2.2 HOUSING AND REAL ESTATE IN THE 50 KM ZONE

Table 2.5-16 provides housing statistics for the marzes of the 50 km Zone, including the number of purchase/sales transactions for housing. Ref. [2.5-26]

The total floor space (*living space, or living area*) of dwellings consists of actual living spaces and *subsidiary spaces*. The floor space of dwellings and hostels as well as non-residential premises having apartments include space occupied by dining-rooms, bed rooms, rooms for children and other living spaces inside the apartments. The living space of hostels includes only the space occupied by bedrooms and rooms for day-time stay. *Subsidiary spaces* include kitchen, corridors, toilets, bathrooms, cloak rooms, storage, and built-in closets in the dwelling. The floor spaces of halls, vestibules, staircases, common corridors, as well as the floor spaces of non-residential premises close to dwellings are not included in the total actual living space. Ref. [2.5-27]

2.5.2.3 HEALTHCARE AND EDUCATIONAL INSTITUTIONS IN THE 50 KM ZONE

The Republic of Armenia has a developed network of educational establishments, from pre-school through higher education, funded from the state budget. There are a number of non-state funded schools in Yerevan. The Republic has a public health system with established hospitals and polyclinics funded from the state budget. In addition, private medical and dental clinics have been established in recent years, primarily in urban areas. Table 2.5-17 provides statistics on healthcare and educational facilities in the marzes of the 50 km Zone, including numbers of institutions, numbers of hospital beds, numbers of students, student/instructor ratios (Ref. [2.5-28]), etc. Table 2.5-18 provides capacity and usage factors for general education schools (Ref. [2.5-29]), pre-schools (Ref. [2.5-30]), and hospitals (Ref. [2.5-31]).

2.5.2.4 WATER SUPPLIES AND SANITATION IN THE 50 KM ZONE

As discussed in section 3.3, a new potable water supply will be developed for the new unit to replace that currently supplying ANPP. (The Metsamor Master Plan (Ref. [2.5-33]) indicates that Metsamor Town has its own water supply.)

As discussed below (and in detail in section 3.6.2), the waste water treatment plant originally intended to service ANPP, as well as Armavir and Metsamor towns and Norapat village, is not functional and should be replaced or refurbished.

Table 2.5-19 summarizes data on water supplies and sanitation facilities of households (Ref. [2.5-32]) in the Republic of Armenia. These data are indicative of the standard of living for the region. The table provides statistics for the marzes of the 50 km Zone. The table also provides data on water consumption and discharges. Ref. [2.5-34]

Armavir Town, Metsamor Town, and Norapat village were served by collectors and a sewage pumping station that fed into a wastewater treatment plant and effluent pipeline/canal to the Sevjur River. These were put into operation in 1980. The collectors received wastewater from household and industrial customers including ANPP. The pumping station and wastewater treatment plant were abandoned in 1989 due to energy shortages. As of 2004, the main collector discharges into a drainage canal and then to the Sevjur without treatment. The main collector and pumping station are in need of rehabilitation. A design proposal was developed in 2004 for a new wastewater treatment plant with an anaerobic lagoon and a facultative lagoon to serve these communities. The

proposed project included a first phase (two lagoons) with a proposed second phase to add a BIOLAK treatment facility. Ref. [2.5-35] The waste water treatment project was proposed to the German government for funding, but no action has been taken on the project because the local utility, Nor Akunk Closed Joint Stock Company, could not be assured that they would recover operational costs through tariffs.

The Armavir/Metsamor/Norapat sewage system currently receives sanitary sewage by gravity flow collectors from the ANPP site. Ref. [2.5-36] The abandoned waste water treatment plant was designed under Soviet standards to process 24,000 m^3/day. The pumping station had two pumps with a third, backup pump. As of 2004, the pumping station was not operable. Ref. [2.5-37] In 1995, a design was developed for a new sanitary sewer system for the ANPP site, including a biological treatment system to be located in the southwestern part of the ANPP's allocated territory. Due to financial difficulties, however, the construction of this biological treatment system was suspended. Ref. [2.5-36]

(Note: the 2006 Environmental Passport – Ref. [2.5-38] – includes a justification for a new sanitary treatment plant to be located on the ANPP site, but no design details or schedule for completion of that facility are provided. In addition, the Metsamor Master Plan (Ref. [2.5-40]) acknowledges the problems with the wastewater treatment for Metsamor Town and recommends reconstruction and operation of a treatment station to serve Metsamor and Armavir towns, but with no schedule or indication that the reconstruction will take place.)

As described in EBID Section 3.6.2, a new sanitary sewage waste water treatment facility will be completed to serve the ANPP site. This may be by completion of the facility previously started, or a newly designed facility. (Note: if completion of the suspended treatment facility construction or new construction of a sanitary sewage treatment facility is not covered by the environmental assessment for ANPP Unit 3, approval of the treatment facility will require a separate environmental assessment.)

As suggested in EBID Subsection 4.4.2.3.2, the waste water treatment plant for Armavir, Metsamor and Norapat should be rehabilitated and sized to accommodate the expected populations of these communities, accounting for the population increases due construction workers and new operating staff for Unit 3.

2.5.2.5 TRANSPORTATION IN THE REGION

Key highways and railroads are illustrated in Figure 2.5-6. Table 2.5-20 provides transportation statistics for freight and passenger transport within the marzes of the 50 km Zone. Ref. [2.5-39]

The 2006 Least Cost Generation Plan (Ref. [2.5-41]) states:

> "The lack of transportation infrastructure in Armenia is a large concern and needs to be addressed …."
>
> "Before a new nuclear plant can be built to replace ANPP, major upgrades to the transportation routes through Georgia or other neighboring countries and/or restoration of rail access through Azerbaijan should be evaluated. Much of the equipment and building materials needed to build a new nuclear plant are too large and/or too heavy for transport over the existing railroads, bridges, and tunnels of the 'northern route' through Georgia. The only existing useable transportation route is the railroad through Azerbaijan."

and:

"There are some possibilities to bring large pieces of equipment in large airplanes, but the Zvartnots airport may require some rehabilitation before it can accommodate large planes. Once the equipment arrives at Zvartnots, the ability to use the transportation infrastructure within Armenia still needs to be examined."

2.5.2.5.1 Highways

The Yerevan-Armavir-Turkish Border Highway, National Highway M-5, goes between Yerevan to the east of ANPP to Armavir Town to the west, passing within 4 km of the site.

There are two vehicular roads to the ANPP site: 1) the original highway, 6 km long, links the plant site with the town of Metsamor; and 2) a second access road, 4 km long, linking the plant site with the Yerevan-Armavir Highway (along the utility-line corridor). Ref. [2.5-42]

The Metsamor Master Plan lists the original access road as being 9.8 km in length and designated H-16. The Metsamor Master Plan also indicates that there are plans to construct a new road connecting ANPP with the Yerevan-Gyumri highway, M-1 near the villages of Aruch and Udjan. Ref. [2.5-37a]

The primary routes for transportation of goods and equipment is via Georgia. Main highway routes connecting the region with Georgia are as follows (Ref. [2.5-43]):

- Highway M-1, Yerevan-Gyumri-Georgian Border highway, connects Yerevan to the Georgia border, through Aragatsotn and Shirak marzes, via the town of Gyumri. M-1 transits Aragatsotn marz north of the site and is 173.7 km in length.

- Highway M-3, Margara-Vanadzor-Tashir-Georgian border highway, passes through Armavir marz to the east of the site. This primarily north-south highway is 168.7 km in length and passes through Aragatsotn and Lori marzes past Vanadzor town to the Georgia border, intersecting with highways M-1 and M-5 in the plant vicinity. The tunnel through the Pushkin canyon along route M-3 (km 135.16 – km 136.96) has a length of 1.8 km and a height of 4.5 m.

- Highway M-6, Vanadzor-Alaverdi-Georgian border highway, goes from Vanadzor town in Lori marz north to the Georgia border and is 91.2 km long. There are three tunnels along M-6 with the maximum height of 4.0 m (km 25.46 - km 25.57, km 31.20 - km 31.47, and km 31.91 - km 32.09).

These roads are constructed as motorcar highways according to the requirements of the construction standards IV-11.05.02-99 of the RoA, and are at least of the third technical class (the minimum width of earthworks is 12.0 m, and of the asphalt pavement is 7.0 m). The capacity of bridges on these routes is 60 t. Transportation of heavy and dimensioned loads is implemented according to the RoA Law "On Road Charges" – see Section 1.2 of this report for discussion of this Law.

In addition to routes directly from Georgia, the following are potential routes for material from outside Armenia[13]:

- M-5, discussed above, goes to the closed border with Turkey in Armavir marz, west of ANPP;
- M-2, the Yerevan-Yeraskh-Goris-Meghri-Iranian border highway, travels 373.8 km southeast through Ararat, Vayots Dzor, and Syunik marzes to the border with Iran;
- A more direct and less mountainous route to Iran connects to M-2 near Yeraskn at the Ararat marz border with Nakhidjevan (Azerbaijan), going through the cities of Sharkur and Djugha (Djulfa) before crossing into Iran;
- M-4, the Yerevan-Sevan-Ijevan-Azerbaijani border highway, travels 137.7 km north-northeast through Kotayk, Gegharkunik and Tavush marzes to the [closed] border with Azerbaijan – an alternate route to Georgia;
- M-7, the Spitak-Gyumri-Turkish border highway, goes 50.2 km from Spitak in Lori marz, west through Gyumri in Shirak marz to the closed border with Turkey.

The RA road network consists of roads of *interstate importance* (1561 km), roads of *state importance* (1800 km), and roads of *local importance* (4342 km). Ref. [2.5-47] The roads of interest or impact considered in this report are generally those of *interstate* and *state importance*, with the only *local* roads being those in the immediate vicinity of the site.

The GoA has set strategic goals for roads through 2015, to include (Ref. [2.5-47]):

- Maintenance and improvement of main highways targeted to reduce transportation costs, increase interstate transit trucking, improve the state defense and economic growth. This will be done by: formation of an efficient system for road maintenance; improvement of traffic flow on interstate highways; and renovation of state highways.
- Improvement of socioeconomic life of population of regions through renovation of the road network of local importance.
- Improvement of traffic safety of highways of general use by identifying dangerous sections of roads, removal of causes, and installation of road signs and direction marking.

Specific targets for 2006-2008, include:

- Fundamental renovation and maintenance of Interstate Roads – Interstate roads consist of 16 highways on which 47% of total passenger operations and 60% of total trucking of the Republic of Armenia is implemented.

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[13] Highways designated in GoA Resolution No. 475, routes illustrated on map by G. Beglaryan (Ref. [2.5-45]).

- Increase of traffic intensity and heavy trucks, as well as completion of internal renovation of several highways necessitate renovation of worn out layer of pavement of several sections of renovated highways.

2.5.2.5.2 Railroads

Armenian Railway (AR) is an 843 km network of rail lines that links the main cities of Armenia, and connects Armenia with the neighboring countries of Georgia, Azerbaijan, and Turkey. Currently the interchanges with Azerbaijan and Turkey are closed and Armenia only interchanges rail traffic with Georgia. Before the dissolution of the Soviet Union, AR was part of the Trans Caucasus Railway and operated as part of this larger network. At that time it carried 30 million tons of freight per year and five million passengers. Currently, it carries between 2-3 million tons and 700,000 passengers. Ref. [2.5-48]

The Yerevan-Tbilisi railway runs near the site. This railway passes from the Georgia border in the north, south and west through Lori marz, south through the western portions of Shirak and Aragatsotn marzes, then east through Armavir marz to Yerevan. Ref. [2.5-45]

A rail-access spur links the plant site (Arshaluis station) with the Armavir station of the Yerevan-Tbilisi railway. The Arshaluis station has four railroad tracks with a useful length of 400 m. Ref. [2.5-51] Rail spurs currently go into ANPP Units 1 and 2. If needed for delivery of construction materials and major components, a rail spur to the site of the new unit would need to be no more than a few hundred meters in length, totally within the ANPP territory.

Passenger trains, using railcars donated by the Armenian Railway system, run daily from Armavir Town, through Metsamor Town to the site.

In addition to the rail connection with Georgia, there is a rail line from Hrazdan in Kotayk marz through Dilidjan and Idjevan in Tavush marz to the [closed] Azerbaijan border. Ref. [2.5-45] The rail line segment east of Dilijan is closed because of a landslide, therefore there is no service to the Azeri border. Ref. [2.5-46]

During the last 20 years Armenian Railway has underinvested in infrastructure and rolling stock. These assets are now worn out and must be replaced over the next five to ten years. The Government of Armenia has asked the World Bank to support urgent rehabilitation of the railway through preparation of an IBRD Railways Restructuring Project. The Railways Restructuring Project, to be considered for funding in 2008, is proposed to address (Ref. [2.5-48]):

- Strategic Bridges. The main railway line to be included in the concession contains eight bridges between Gyumri and the Georgian border that are in urgent need of repair.

- Track. On the mainline between Gyumri and the Georgian border, some 76 km of track needs rehabilitation.

- Employee Redundancy. A restructuring study for the railway indicates that a concessionaire might reduce the railway's staff significantly. A redundancy package would be needed to assist these employees to transition to retirement or other work.

The Government of Armenia conducted a tender for privatization of the AR. In January 2008 the RA Ministry of Transport and Communication announced that the Russian Railways Company (RZD) won the concession to run the AR system for the next 30 years with rights of renewal for another 20 years. RZD is planning to invest 570 million USD, of which 230 million USD will be invested in the first five years. Ref. [2.5-49]

The rail line with Georgia is the only one connecting Armenia with the outside world. Based on this circumstance, Georgia offered discounts to Armenia compared to other states, with transit cargo discounts as high as 50%. On 26 January 2008, the Director General of the Georgian Railways informed Armenia of the decision to rescind the current discounts for Armenia-bound cargo (17% for liquid cargo and 22% for dry cargo), effective 1 March 2008. This decision was because the discounts were given to AR, not RZD. Ref. [2.5-50]

2.5.2.5.3 Airports

Republic-wide, 9,300 tonne of freight were shipped by air transport in 2006. Ref. [2.5-52]

The Zvartnots International Airport is 21.8 km from ANPP. Cargo from Zvartnots would travel on Highway M-5 to the site. A new air cargo terminal, financed by the World Bank, was opened in 1998. Improvement actions in recent years resulted in new cargo terminal with capacity for 100,000 tonne per year. Ref. [2.5-53] Zvartnot's single runway is 3,849 m long.

Armenia's second largest airport is Shirak Airport outside Gyumri City in Shirak marz. It has a single asphalt runway, 3,220 m in length. Ref. [2.5-54]

2.5.3 Marzes and Urban Centers of Armenia within the 50 km Zone

The 50 km Zone encompasses territory within 5 marzes (regions) of the Republic of Armenia and the City of Yerevan. The following sections describe each of the marzes and urban areas within 50 km of the site, in decreasing order of potential impact from the construction activities.

2.5.3.1 ARMAVIR MARZ, REF. [2.5-55]

The area most impacted by construction and operation of the new unit will be the marz (region) of Armavir. Armavir marz is notable for its developed agriculture. In the sphere of animal husbandry farming of cattle and sheep and goats, pigs and poultry is mainly developed and in horticulture - fruit-growing and plant-growing. Cereal grains are mainly processed. Industry in this area is specialized in operation of mines and production of electricity (e.g., ANPP), food products, soft drinks, beverages, and building materials.

There are three urban communities in Armavir marz:

- Armavir town, situated approximately 9.2 km from the site with a 2005 population of 32,300, is an industrial center and administrative capital of the marz. Approximately 14 % of the current ANPP staff resides in Armavir City and surrounding villages, traveling to the site primarily by rail. Armavir town is the preferred location for settlement of temporary construction personnel.

- Metsamor town, located approximately 4.6 km from the site with a 2005 population of 10,200 is the "satellite city" built to house staff and support services for ANPP. Approximately 60 % of the current ANPP staff resides there. It is expected that a similar percentage of staff for the new unit will reside here as well.

- Vagharshapat town, approximately 13 km from the site with a 2005 population of 56,700 is the site of Echmiadsin, the seat (Mother See) of the Armenian Orthodox (Apostolic) Church which represents the primary activity of the city. Less than 1% of the current ANPP staff resides in Vagharshapat town, but approximately 6% of the staff resides in nearby villages.

The balance of the Armavir marz population resides in rural villages that are not expected to be impacted significantly by the construction activities, nor construction labor force. Approximately 13 % of the current ANPP staff resides in villages near Armavir, Metsamor, and Vagharshapat towns; it is expected that a similar percentage of the operational staffing for the new unit will reside in rural communities of Armavir marz. Ref. [2.5-56]

2.5.3.2 YEREVAN CITY, REF. [2.5-57]

Yerevan, the capital city of the Republic of Armenia, is situated 32 km from the ANPP with a 2006 population of 1,103,800. It consists of twelve defined communities and includes a territory of 227 km^2. Yerevan is the residence of the president of the Republic of Armenia. RA National Assembly and the Government, all the ministries and principal departments, public and other organizations, different unions, foundations, commissions, legal-juridical bodies, an overwhelming majority of banks and exchanges, a large part of mass media are situated in the capital. The offices of representatives of international (intergovernmental, interstate, embassies, consulates, etc.) and other organizations in the Republic of Armenia are functioning in the capital.

Yerevan is the largest economic center of the Republic. Manufacturing is the main, principal industry, with over 80% of the RA Construction industry in 2005 (see additional statistics in Table 2.5-12). The main industries are manufacture of food products, including alcoholic beverages, and chemical and metallurgy industries.

Yerevan has over 600 educational establishments, including more than 60 establishments of higher education and over 35 establishments providing secondary specialized education (see additional detail in Table 2.5-16). The city has over 7,000 hospital beds and more than 3,000 outpatient clinics (see more detail in Table 2.5-16).

Approximately 18.1 % of the ANPP staff resides in Yerevan and it is expected that a similar percentage of the new staff will also reside there.

The Republic of Armenia's international airport, Zvartnots, is on the outskirts of Yerevan, at a distance of 21.8 km from the site.

2.5.3.3 ARAGATSOTN MARZ, REF. [2.5-58]

Aragatsotn marz is situated immediately to the north of Armavir marz and the ANPP site. Approximately three-fourths of the marz is contained within the 50 km zone. The highest peak of Armenia, Mount Aragats, is in Aragatsotn marz. Three motor highways of republican importance – the Yerevan-Ashtarak-Talin-Gyumri (M-1), the Yerevan-Ashtarak-Spitak (M-3), and the Yerevan-Armavir-Karakert-Gyumri (M-9) highways run through the territory of the marz. The territory of the marz intersects the principal Armenian railway as well, which passes across the western end of the marz, so it hasn't significant influence on economic development of the marz. Nevertheless, this railway is likely to be the primary route for transport of major components for the new NPP Unit, likely to come by rail via Georgia.

Industry of Aragatsotn marz is specialized in manufacture of food products and beverages, precious articles and operation of mines of building materials. Freight and passenger transportation in the marz are implemented by road transport. Agriculture is mainly specialized in plant growing (grain, potatoes, perennial grass, and forage crops) and cattle breeding.

There are three Urban centers of the Aragatsotn marz in the 50 km zone:

Marz center Ashtarak (population at the end of 2005 of 20,700 people) is situated on the bank of Kasakh river, at a distance of 22.6 km to the northeast from ANPP. The town is the junction of Yerevan-Gyumri and Yerevan-Spitak roads. Ashtarak town developed as a satellite town of Yerevan. It is administrative and political, economic, scientific, educational and cultural center of the marz. The main branch of economy here is food products and beverage production.

Aparan town (at the end of 2005, comprised 6,600 people) is the second town in the marz by its largeness and importance. It is situated on the bank of Kasakh river at a distance of 49 km from ANPP. The main branch of the Aparan economy is food production.

Talin town (population at the end of 2005 of 5,700 people) is located on the southwestern slope of Mount Aragats at a distance of 32.3 km from ANPP. The base of its economy is precious articles production.

The majority of the Aragatsotn marz population resides in rural villages that are not expected to be impacted significantly by the construction or construction labor force.

2.5.3.4 KOTAYK MARZ, REF. [2.5-59]

Kotayk marz is located to the north and east of ANPP with approximately one-quarter of its territory within the 50 km zone. It has five urban communities and 42 rural communities within 50 km of the site. More than half of the marz's population is in its urban areas.

The Yerevan-Hrazdan-Sevan (M-4) motor-road and the Yerevan-Hrazdan-Ijevan railway, which are of great importance to the republic pass through the central part of the marz territory. Kotayk marz is comparatively developed and has multi-branch economy. The main branch of economy is industry. The marz has an exclusive role, particularly, in the energy field. There are two large organizations of electricity production.

The other main trend of the marz's industry is manufacturing, in which the following branches are most developed:

a) food and beverages production (meat and meat products processing and canning, fruits and vegetables processing and canning, milk products, flour, beverages production);

b) non-metal mineral other production (glass and glass products production, cement production);

c) metallurgy and metal products production (steel and iron casting);

d) furniture industry, production of finished articles not included in other categories (jeweler and adjacent products (diamond) production).

The main branch of agriculture in Kotayk marz is poultry farming.

Urban centers of the marz within the 50 km zone are:

Charentsavan town (24,600 inhabitants in the end of the year 2005) is situated in 49.7 km from ANPP on the left bank of Hrazdan River. In 1953 after completion of hydro-electric station construction, several large industrial enterprises were established and Charentsavan became one of the most important industrial centers of the republic. The main trend of town industry is manufacturing, in which metallurgy and finished metal products production (steel and iron casting) comprise its prevailing part.

Abovyan town (in 2005 – 45,000 inhabitants) is situated 42.1 km distance from ANPP and only 16 km from Yerevan. It is one of the fastest growing towns and big industrial centers of the republic. The main industry is manufacturing, in which beer production takes prevailing place.

Byureghavan town (8,300 inhabitants in the end of 2005) is located 41.5 km from ANPP. It is an industrial town, in which the production of non metal mineral and other products (glass packing, porcelain and glazed earthenware industries) takes predominate place.

Yeghvard (Eghvard) town (12,000 inhabitants in 2005) is situated at the south foot of Aray Mountain, distance from ANPP is 33 km and from Yerevan is 18 km. The main industry here is manufacturing, in which the production of food and beverages (distilled alcoholic beverages (cognac), milk products, flour production) and production of leather articles and shoes predominate. Agriculture plays a key role in the economic life of the town as well, in which grain farming is the main trend.

The main industry of Nor-Hachn town (10,200 inhabitants in 2005, 40 km from ANPP) is manufacturing, in which the production of furniture and jewelry (diamond) production prevails.

2.5.3.5 ARARAT MARZ, REF. [2.5-60]

Ararat marz is situated to the southeast of Armavir marz and ANPP. Approximately 30% of its territory is within 50 km of the site. It has two urban and 70 rural communities in the 50 km zone. More than 70% of the marz population is rural.

Yerevan-Yeraskh-Gharabagh (M-2) highway and Yerevan-Yeraskh railway of republican importance run through the territory.

The marz's economy is based on agriculture, mainly specialized in wine-grapes, fruit and vegetables. The leading industries are manufacture of food products including beverages and manufacture of non-metallic mineral products (cement, lime carbonate, asbestos cement products, cutting and processing of stone).

Ararat marz has two urban centers within the 50 km Zone:

Artashat town (in the end of year 2005 comprised 25,100 inhabitants) is the center of the marz. The town is situated in 41.4 km distance from ANPP. It is 10 km to the northwest of the historical Armenian town of Artashat. Manufacturing is the main industry of the town, in which includes manufacture of food products and beverages (processing and canning of fruit and vegetables, manufacture of distilled alcoholic beverages and flour) as well as manufacture of non-metallic mineral products (household-domestic articles from porcelain-faience, clothing materials from natural stones). Agriculture is of great importance in the economic life of the town as well.

Masis town (at the end of 2005 comprised 21,800 inhabitants) is situated on the left bank of Hrazdan River, 28.1 km distance from ANPP. It is a big railway and goods transporting station, which is of interregional importance and supplies Yerevan. Manufacturing is the main industry, including wood and wood products (wood sawing and planing, unassembled wooden flooring including manufacture of parquet) chemicals and chemical products (paints, varnishes and similar coatings, printing ink and mastics) and tobacco products.

2.5.3.6 SHIRAK MARZ, REF. [2.5-61]

Shirak marz is situated to the north and west of the site. Approximately 10% of the marz is within 50 km of the site. One of its three urban and seven of its 193 rural communities are within 50 km of ANPP. The main railway and automobile highway connecting Armenia with Georgia pass through the marz's territory. The railway and motor-road networks of Armenia and Turkey are connected here.

The leading industries of Shirak marz are production of food, including beverages and production of other non-metal mineral products. Grain farming and cattle-breeding are the main branches of agriculture. Freight and passenger transportation in the marz are implemented by road transport, railway and air transport (the airport is situated in the marz that provides air connection with CIS countries and is the facility to receive air traffic diverted from Zvartnots).

Shirak marz has one urban center in the 50 km Zone: Maralik town, 2006 population of 5,800 and 49.8 km from the site.

2.5.4 Political Structure, Taxing Districts, and Land Use Planning Organizations

2.5.4.1 POLITICAL STRUCTURE

Armenia is a republican government with an elected President and unicameral National Assembly (Parliament). The Prime Minister is appointed by the President and confirmed by a majority of the National Assembly. The Prime Minister appoints the Cabinet of Ministers. Ref. [2.5-62]

Armenia is divided into ten administrative divisions, or marzes (provinces, singular marz), plus the City of Yerevan. Public administration in the marzes of the RoA is regulated the Presidential Decree on Public Administration in the Marzes of the Republic of Armenia and other legal acts. The Marzpets (Marz Governors), or in Yerevan the Mayor implement the government's regional policies in marzes in the following areas: finance, urban development, housing and utilities, transport and road construction, agriculture and land use, education, healthcare, social security, culture and sports, nature and environmental protection, commerce, public catering, and services. The Marzpets implement regional policies in the aforementioned sectors by means of Marzpetarans, as well as organizations subordinate to their respective marzes. Ref. [2.5-63]

The *Law on Local Self-Government* (Ref. [2.5-64]) established genuine local governments (hamainkner or communities). There are urban and rural communities. Communities have locally elected leaders with specified powers and duties, making possible greater efficiency, accountability, and transparency. Communities are headed by an elected council and an elected chief (mayor or deputy mayor in cities). In addition to regular activities, such as budgeting and finance, communities must provide a variety of communal and cultural services, including: land use planning and control; business regulation; and the operation and maintenance of utilities, roads, and publicly-owned

buildings. Some social services, such as health and primary and secondary education, remain the responsibility of the central government and the marz. Ref. [2.5-65]

The Marzpets coordinate the activities of regional services of republican executive authorities in the areas of internal affairs and national security, defense, communication, energy, taxes, emergency situations, civil defense and others. Ref. [2.5-63]

2.5.4.2 TAXATION DISTRICTS

Armenia assesses several kinds of taxes, including those applicable to ANPP: the enterprise profit tax; the Value Added Tax; the property tax; and the land tax. All taxes are paid to the state budget, except for property tax and land tax, which are paid to community budgets.

According to the *Law on Local Self-Government*, the Head of Community (Chief of Community) carries out collection and supervision of property tax, land tax, rentals for community and State lands located within the administrative boundaries of the community, as well as local duties and fees. Ref. [2.5-64]

The property tax payments by the ANPP go to local budget of Metsamor Town.

2.5.4.3 LAND USE PLANNING

According to the *Law on Local Self-Government*, the Chief of Community is responsible to compile the draft of the master plan of community urban development, as well as the community lands zoning and use schemes, which upon agreement with the respective authorized state body through the Regional Governor (Marzpet), are submitted to the Community Council for approval. In accordance with the draft zoning of the community, the Head of Community must compile and approve the detailed plan of the individual areas and urban development complexes of the community, and submit them to the Community Council for approval. Ref. [2.5-64]

ANPP is within the administrative boundary of Metsamor Town. Metsamor Town has a master plan approved by the GoA resolution № 1592 dated as of December 27, 2007. (Ref. [2.5-66]). This plan covers the administrative boundaries of Metsamor. Other ANPP facilities, such as the pumping station on the Sevjur, are outside of Metsamor administrative boundaries, and therefore subject to administration by Chiefs of other communities who have yet to establish plans for approval. Changes in land use or zoning are administered by the Chief of Community, but applications are made to the Armavir Marzpet (see Section 1.2 of this Environmental Background Information Document for more detail).

2.5.5 Emergency Planning, Police, Fire, and Rescue Organizations

2.5.5.1 EMERGENCY PLANNING

Government of Armenia Resolution № 194 dated January 17, 2008, “On Making Amendments in the ROA Government Decree № 2328, dated December 22, 2005” [14] (Ref.

[14] Decree № 2328, dated December 22, 2005 approved the National Plan for the Protection of the Population in the Event of a Nuclear and (or) Radiation Accident at the Armenian Nuclear Power Plant (External Emergency Plan for the Armenian Nuclear Power Plant)”.

[2.5-67]) sets out responsibilities for response to an emergency at ANPP. It is expected that the plan in effect will serve as the model for a revised plan to deal with the new unit.

The Emergency Plan involves many governmental organizations, including:

- the Armenian Rescue Service at the Ministry of Emergency Situations
- the Ministry of Nature Protection
- the Defense Ministry
- the Ministry of Transport and Communications
- the Ministry of Energy
- the Ministry of Foreign Affairs
- the Ministry of Agriculture
- the Ministry of Health
- the State Water Committee at the Ministry of Territorial Administration
- the National Security Service
- the State Customs Committee
- the Police of the Republic of Armenia
- the administration of the marzes of Aragatsotn, Armavir, Kotayk, and Shirak
- the ANRA at the Ministry of Nature Protection
- the public television and radio stations of Armenia.

In addition, the local self-government administrations of Armavir, Metsamor and Vagharshapat Towns, 36 villages of Armavir marz, three towns and eight villages of Aragatsotn marz, two towns in Kotayk marz, and one town in Shirak marz are involved. Local hospitals, polyclinics, rescue service offices, police stations, railway stations, and Armentel telephone company are also included.

The various responsibilities for each organization are identified in the Emergency Plan. In the event of a general accident at the ANPP, for population protection measures the following forces and resources are engaged:

a) radiological monitoring – the Armenian Rescue Service and RA State Nuclear Inspectorate;

b) decontamination of humans and territory and equipment – the Armenian Rescue Service, State Water Resources Management Committee, and the Radiation, Chemical and Bacteriological Defense Forces of the Army;

c) first medical aid and shipment of exposed – specialized medical teams from the Metsamor hospital, of the Ministry of Health;

d) diagnostics of the patients exposed to radiation, and medical testing – the Orthopedic, Burns and Radiology Center of the Ministry of Health;

e) the treatment of the patients exposed to radiation – the Grigor Lusavorich Medical Center of the Ministry of Health;

f) fire fighting activities – from the fire brigades of the territorial divisions of the Armenian Rescue Service, 2 joint fire units (at least 66 people) with 10 units of AB-40 equipment;

g) sealing off the Urgent Protective Measures Planning zone – relevant units of the internal troops of the Police of the Republic of Armenia;

h) organization of patrol service – the police departments of Armavir and Metsamor;

i) evacuation – the Ministry of Transport and Communication, mobilizing at least 699 minibuses and 30 passenger cars for evacuation;

j) notification and warning of the population – the Ministry of Transport and Communication; and

k) information about the accident – the Ministry of Transport and Communication, and the Armenian Rescue Service.

2.5.5.2 POLICE

As noted in the previous section, the police departments in the emergency planning zone are incorporated into the current ANPP emergency plan. It is expected that these same police units will remain part of the Emergency Plan and that their capabilities will be maintained at a sufficient level commensurate with their assigned responsibilities.

2.5.5.3 FIRE FIGHTING AND RESCUE

As noted above, fire brigades of the territorial divisions of the Armenian Rescue Service with 2 joint fire units (at least 66 people) and 10 units of AB-40 equipment are incorporated into the current ANPP emergency plan. It is expected that these same fire and rescue units will remain part of the Emergency Plan and that their capabilities will be maintained at a sufficient level commensurate with their assigned responsibilities.

2.5.6 Historic, Cultural and Recreational Resources in the Region

2.5.6.1 HISTORIC PROPERTIES WITHIN 10 KM OF SITE

The new unit will be sited where land clearing was done in the 1980's in preparation for construction of the units 3 and 4 planned at that time. There are no historic properties within the bounds of the ANPP site. Not only has the site already been disturbed, no new access corridors will be needed since those serving the site were intended to support four operating units. Some renovation or upgrade of transmission lines, roads, rail lines, and water supply systems may be necessary, but are expected to use existing rights of way and corridors. (As discussed in Section 3.7, a new corridor may be needed for new transmission lines from the site; however, the new lines may use an existing transmission line corridor.)

Figure 2.5-7 identifies the locations of archeological and cultural sites registered within 10 km of the site, as identified by the Ministry of Culture of the Republic of Armenia. Ref. [2.5-68] In consultation with the Ministry of Culture [15], they stated that there had been numerous investigations of cultural sites in the vicinity of ANPP and they raised no concerns regarding potential construction in the area.

The city of Armavir has a monument to the victims of World War II and a 1995 "Home of Culture". The village of Hovtamej, 9.8 km from the site, has a 19th century church. The village of Merdzavan contains a tower and a cemetery from the first/second millennium B.C. The village of Miasnikian contains three settlements and two graveyards dating to

[15] Now titled merely "Ministry of Culture".

the second to first millennium B.C. and another settlement and graveyard dating to the third/second millennium B.C. The village of Mrgashat, 9 km from the site, includes the remains of the "Sev Blur" Settlement ("Kara Tapa") from the third millennium B.C. and a number of Kurdish cemeteries. Mrgashat is also the site of St. Astvatsatsin Church built about 1900 and a monument to victims of World War II. The village of Mrgastan, 11.9 from the site, has the nineteenth century St. Hovhannes Church.

The village of Taronik, 7 km from ANPP, not only has a number of sites with historic importance but also contains pumping stations supplying water to the site from the Metsamor/Sevjur river and a groundwater collector reservoir. ANPP staff has suggested that the groundwater collection reservoir may need to be dredged to remove silt, but otherwise should have sufficient capacity for the new unit (see further discussion in sections 2.3 and 3.3 of this report). The pumping stations will be subject to upgrade to ensure a sufficient water supply for the new unit.

Taronik village encompasses a water collector system built in 1730-1732 and a mid-eighteenth century water mill. The village is also the site of the historic Metsamor settlement that existed from the fourth to the first millennium B.C., including a citadel (third to first millennium B.C), a palace complex (end of second millennium, beginning of first millennium B.C.), a temple complex (second/first millennium B.C.), an ore-mining facility and foundry complex (end of second millennium, beginning of first millennium B.C.), an observatory (third millennium B.C.), and a graveyard (second/first millennium B.C.). The Metsamor Museum is also here and includes a "dragon stone" from the second millennium B.C.

2.5.6.2 OTHER HISTORIC PROPERTIES IN THE REGION

Cultural and historic monuments within the 16 km, as recorded in the State List of Historical and Cultural Monuments (Ref. [2.5-69]) are provided in Table 2.5-21. Significant properties are summarized, as follows[16]:

2.5.6.2.1 Properties in Armavir Marz

The ruins of the Zvartnots Cathedral are located in the village of the same name near the international airport, about halfway from Yerevan to Echmaidzin to the east of the site. The Zvartnots Cathedral, dedicated to St George, was built between 643 and 652 and destroyed by an earthquake in 930. It is designated an UNESCO Heritage Site. Ref. [2.5-70]

Vagharshapat Town has numerous historical sites, many related to Echmiadzin seat of the Armenian Apostolic Church, including churches, monasteries, cemeteries, patriarchal residences, stone crosses and monuments dating from the fourth century to modern times.

Aknashen Village is the site of settlements from the sixth to fifth millennium and the second to first millennium, and a graveyard from the fourth to third millennium B.C.

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[16] Except where noted otherwise as coming from other references, most information in this section is taken from Ref. [2.5-69].

Near Aghavnatun village are: settlements from fourth to third millennium and second to first millennium; a citadel, tower, and graveyards from the second to the first millennium; a stone cross from the eleventh century; and a charnel house from the 14th century.

Amberd Village contains a settlement and graveyard from the third to first millennium B.C., the church of Tovmas Araquial from the twelfth century A.D. and a stone cross from 1594.

Aygeshat Village, Echmaidzin District, contains a settlement, graveyard and tower from the second to first millennium B.C. The seventh century Church of Targmanchats and a cemetery from the tenth to eighteen century are also in this village.

Near Aratashen village lies a settlement dating from the sixth to fifth millennium B.C.

Near village Aragats are a citadel, tower, graveyard and two settlements from the second to first millennium B.C.

The settlement Mozrablur Arevik, dating from the third millennium B.C., lies near Armavir village.

Artimet village has a number of stone crosses dating from the twelfth through the seventeenth centuries.

Near village Griboiedov is the Kghziak Blur settlement from the fourth to third millennium B.C. including an ancient irrigation system.

Dasht Village is nearby a citadel, settlement, and two graveyards from the second to first millennium B.C.

Lernamerdz Village contains rock paintings and a settlement from the third millennium, a citadel from the third to first millennium, and a tower and graveyard from the second to first millennium B.C.

Near Khoronk village is a settlement dating to the first century B.C.

In and near village Tsaghkalanj are: a graveyard from third to first millennium; two settlements and graveyards from the second to first millennium B.C.; and a church from the seventh century A.D.

Haikavan Village contains the original Armavir settlement and a citadel from the fourth to first millennium, a cave dwelling complex from third to first millennium, and a graveyard from the first millennium B.C.

The village of Hoktember has the Armenian National Ethnography Museum and a memorial to the Sardarapat battle that occurred in 1918 between Russian/Armenian forces and invading army units of the Ottoman Empire (Ref. [2.5-71]).

Near Shahumyan village are a settlement and reservoir from the eighth to seventh century B.C.

Though a nature preserve, the Vordan Karmir Reservation is of historical significance. It is situated between Argavand, Arazap and Sovetakan villages (12 to 15 km to the south of the site). It is the last area where endemic cochineal (Porphyrophora hamelii) occurs. Written sources about Ararat cochineal or vordan karmir (“vordan karmir” is “red worm” in Armenian) have been known since the 5th century AD. The natural dye carmine extracted from Ararat cochineal known as Armenian “krmizi” (“wine-colored” in Armenian) was

superior in its beauty and stability to carmine produced later from Mexican and Polish cochineal. In the past, threads dyed with cochineal carmine were used to weave clothes of Armenian kings. Royal letters and messages from the Catholicos (Patriarch of All Armenians) were written in ink extracted from cochineal. Cochineal dye was also used in medieval manuscripts, miniature paintings and church decorations, as in the Saint Echmiadzin Cathedral. Cochineal dyes reached Europe from Armenia and became a desirable and rare dye for both religious and secular (Rembrandt, Aivazovski, Bashinjaghian and others) fine art. Ref. [2.5-75] No construction activities related to the new unit at ANPP are expected to impact the Vordan Karmir Reservation.

2.5.6.2.2 Properties in Aragatsotn Marz

The village of Aragatsotn contains a number of historic monuments of national importance, including settlements, a citadel, towers and cemeteries from the second to first millennium B.C. There is also a citadel from the 17th to 18th century A.D. here.

Oshakan church, in the town of the same name near Ashtarak Town, is where Mesrop Mashtots, inventor of the Armenian Alphabet in 405 AD is buried. Ref. [2.5-72]

The Aruchavank church of St Grigor in Aruch village, north of ANPP, is one of the architectural marvels in Armenian art. According to the architectural evidence the church in Aruch was built by Prince Grigor Mamikonian in the 660s. Ref. [2.5-73] This is part of the St. Grigor monastery complex built between the fifth and seventh centuries. In addition, Aruch contains: a citadel, graveyards, and a charnel house from the third to first millennium B.C.; a citadel, a stronghold, a castle, palace, a caravansary, and charnel house from the fifth to seventeenth centuries A.D.; monastery complex of St. Astvatsatsin from the 19th century; and numerous stone crosses and obelisks dating from the fifth to the thirteenth centuries.

Kosh village contains citadels, towers, and graveyards from the third and second millennium B.C. The village contains three monasteries, St. Gevorg built in 1891, St. Grigor Lusavorich from the 13-14th century, and St. Stephanos from seventh to seventeenth centuries. Associated with the monasteries and several graveyards, numerous stone crosses dating from the twelfth through sixteenth centuries exist here.

Shamiram village has towers and graveyards from the second millennium B.C., a castle and stronghold from the first millennium B.C., and a standing stone monument (menhir) from second to first millennium B.C.

The village of Voskehat includes: a cave dwelling from the second millennium B.C.; towers, a settlement and graveyard from second to first millennium B.C.; and a stone cross from the tenth to eleventh century.

Voskevaz village contains: a citadel complex and a cave dwelling complex from the third millennium B.C.; cave dwelling and dragon stone from the second millennium B.C.; a castle from the seventeenth to 18th century;

Near Ujan village are several citadels and towers dating from the third millennium B.C. to the thirteenth century A.D.

The monastery complexes of Hovhannavank and Saghmosavank are five kilometers apart and situated in the villages of the same names of the Ashtarak district northeast of ANPP. Their silhouettes dominate the adjacent villages and rise sharp against the background of the mountains crowned by Mount Aragats. The main temples of the monasteries were erected by Prince Vache Vachutyan - the Church of Zion in Saghmosavank (1215) and

the Church of Karapet in Hovhannavank (1216-1221) overlooking the gorge of the Kazakh river. Ref. [2.5-74]

2.5.6.3 CULTURAL FACILITIES IN THE REGION

Table 2.5-21 provides data on libraries (Ref. [2.5-76]), state specialized (dramatic) theaters (Ref. [2.5-77]), museums (Ref. [2.5-80]), and concerts (Ref. [2.5-78]) in the marzes of the 50 km zone. Libraries are distributed throughout the marzes, including rural areas. However, dramatic theaters, museums, and concerts are concentrated in Yerevan, as might be expected since it is the largest urban center in the Republic.

As mentioned above, the seat or Mother See, of the Armenian Apostolic Church is Echmaidzin within the city of Vagharshapat to the east of the site. The patriarch, or Catholicos, of the Armenian Church resides in Echmaidzin. Hripsime, one of the most beautiful and oldest churches (built around 618 AD) (Ref. [2.5-79]) in Armenia is in Echmaidzin. The Cathedral and Churches of Echmaidzin are designated UNESCO World Heritage Sites.

2.5.6.4 RECREATIONAL FACILITIES IN THE REGION

Armenia has a number of sanatoriums, or spas, from the Soviet area, many of which are in the mountainous areas to the north and east of the site and near Lake Sevan. These resort areas offer rest and relaxation in scenic areas. These include the following within 50 km of the site (Ref. [2.5-45]):

- Antarut, Aragatsotn marz, north from Vagharshapat; and
- Arzni, Kotayk marz immediately north of Yerevan.

Information provided by the National Statistical Service indicates that in 2005 there were a total of seven sanatoriums and resort houses registered in Kotayk marz. Ref. [2.5-31]

Visits to the area indicate that a number of local residents use the area near the Sevjur River for fishing; it was not determined if this was for recreation or subsistence.

The Town of Metsamor has a large Sports Complex for its citizens. Ref. [2.5-80]

Table 2.5-1, Population within 16 km Zone

Table 2.5-1, Population in the 16 km Zone		Distance to NPP, km	2001 Census De Facto Population	2001 Census De Jure Population	2006 Census Temporarily Present	2006 Residential Population
Settlement	Marz					
Urban Centers w/in 16 km	TOTAL		88,866	98,292		99,200
Armavir t.	Armavir	9.2	28,733	32,034		32,300
Metsamor t.	Armavir	4.6	8,853	9,870		10,200
Vaharshapat t. (Eshmiadzin)	Armavir	13.0	51,280	56,388		56,700
Rural Settlements w/in 16 km	TOTAL		90,529	96,361	3,018	105,045
Aragatsotn	Aragatsotn	9.3	705	804	-	1,109
Aruch (Aruj)	Aragatsotn	13.1	943	1,016	-	1,029
Dprevank	Aragasotn	13.0	52	58	13	102
Kosh	Aragatsotn	13.5	2,600	2,756	89	2,665
Nor Amanos	Aragatsotn	8.8	540	672	52	654
Nor Edesia (Nor Yedesia)	Aragatsotn	5.0	786	982	40	1,156
Partizak	Aragasotn	13.4	249	274	33	271
Shamiram	Aragatsotn	11.2	609	945	9	1,573
Ujan	Aragatsotn	14.0	2,510	2,758	-	2,961
Voskehat	Aragatsotn	15.4	2,197	2,448	20	1,078
Aghavnatun	Armavir	10.7	2,934	3,158	37	3,387
Aknalich (Aknalij)	Armavir	4.0	2,673	2,864	210	3,313
Aknashen	Armavir	15.2	1,372	1,404	144	1,642
Amberd	Armavir	12.9	1,276	1,363	22	1,726
Apaga	Armavir	13.1	1,646	1,679	18	1,906
Aragats	Armavir	8.8	2,973	3,013	58	3,269
Aratashen	Armavir	9.2	2,688	2,823	25	2,769
Arazap	Armavir	15.3	1,383	1,402	22	1,739
Arevik	Armavir	10.0	2,473	2,525	-	2,621
Argavand	Armavir	14.0	2,062	2,191	82	2,303
Armavir v. (Maisyan)	Armavir	7.0	2,772	2,910	50	3,509
Arshaluys	Armavir	6.3	3,836	4,162	-	4,217
Artashar	Armavir	8.5	962	966	15	1,365
Artimet	Armavir	11.0	1,512	1,638	61	2,063
Aygeshat (Armavir reg.)	Armavir	13.5	1,618	1,754	105	1,631
Aygeshat (Echmaidzin reg.)	Armavir	13.8	1,368	1,480	28	1,813
Bambakashat	Armavir	13.4	3,111	3,212	150	3,373
Dasht	Armavir	14.3	752	723	105	1,019
Djrarat (Irarat)	Armavir	15.3	2,627	2,808	32	3,043
Djrarat Poultry (Jrarpi)	Armavir	12.9	1,088	1,165	65	1,685
Doghs	Armavir	12.0	1,195	1,267	-	1,415
Dzerzhinsky (Aygevan)	Armavir	15.2	1,512	1,573	126	1,467
Eghegnut (Yeghegnut)	Armavir	9.9	1,759	1,876	76	1,860
Ferik	Armavir	5.7	267	399	21	276
Griboyedov	Armavir	13.2	1,893	2,003	26	1,952
Haykavan	Armavir	13.0	1,210	1,328	-	1,200
Haytagh	Armavir	7.6	2,441	2,565	55	2,903
Hoktember (Sardarapat)	Armavir	12.3	5,387	5,727	18	5,569
Hovtamech	Armavir	9.8	1,025	1,068	210	1,369
Jrashen (Djrashen)	Armavir	15.1	699	727	79	803
Khandjyan	Armavir	14.2	1,796	1,880	-	1,984
Khoronk	Armavir	9.9	2,164	2,274	51	2,611
Lenughi	Armavir	16.0	1,510	1,583	170	1,502
Lernamerdz (Lernamerds)	Armavir	13.6	395	405	40	451
Lukashin	Armavir	11.8	2,213	2,346	262	2,628
Lusagyugh	Armavir	14.8	840	930	17	1,155
Mrgashat	Armavir	9.0	4,997	5,297	-	6,151
Mrgastan	Armavir	11.9	944	960	70	1,590
Norapat	Armavir	10.0	2,675	2,780	90	2,768
Noravan	Armavir	9.4	930	962	172	1,283
Samaghar (Geghakert)	Armavir	8.8	2,360	2,458	50	3,117
Shahumian (Shahumyan)	Armavir	13.7	939	1,119	33	1,557
Shahumyan Poultry	Armavir	14.4	929	951	40	1,228
Sovetakan (Alashkert)	Armavir	11.1	1,625	1,714	12	1,750
Tandzut (Tansut)	Armavir	13.4	1,829	1,914	79	1,771
Taronik	Armavir	7.0	1,888	2,017	10	2,044
Tsaghkalunj (Tsaghkalanj/Tsakhk	Armavir	7.6	1,225	1,323	105	1,418
Tsaghkunk	Armavir	10.8	1,097	1,141	135	1,295
Tsiatsan	Armavir	10.6	1,058	1,110	83	1,277
Vardanashen (Vardashen)	Armavir	14.9	907	913	-	1,172
Voskehat	Armavir	16.0	2,197	2,448	235	3,635
Yeraskhahun	Armavir	13.5	1,356	1,461	267	2,270
Zartonk	Armavir	8.0	1,831	1,883	23	2,174
Zhdanov	Armavir	5.0	1,523	1,653	-	1,523
Sipanik (see Note)	Ararat	14.2	394	437	75	928

Note: v. Sipanik is listed in government documents as being in Ararat marz, yet the GIS data used for these measurements shows it within 16 km of the site.

Table 2.5-2, Projected Population for 16 km Zone

Table 2.5-2, Projected Population in the 16 km Zone	Low Projection 2013	High Projection w/o new unit NPP workers				
		2015	2025	2035	2045	2055
Urban Centers w/in 16 km	98,120	104,483	107,888	110,922	113,955	116,988
Armavir t.	31,948	34,020	35,129	36,117	37,104	38,092
Metsamor t.	10,089	10,743	11,093	11,405	11,717	12,029
Vaharshapat t. (Eshmiadzin)	56,083	59,720	61,666	63,400	65,134	66,867
Rural Settlements w/in 16 km	100,817	110,643	114,245	117,457	120,671	123,881
Aragatsotn	1,097	1,168	1,206	1,240	1,274	1,308
Aruch (Aruj)	1,018	1,084	1,119	1,151	1,182	1,214
Dprevank	101	107	111	114	117	120
Kosh	2,636	2,807	2,898	2,980	3,061	3,143
Nor Amanos	647	689	711	731	751	771
Nor Edesia (Nor Yedesia)	1,143	1,218	1,257	1,293	1,328	1,363
Partizak	268	285	295	303	311	320
Shamiram	1,556	1,657	1,711	1,759	1,807	1,855
Ujan	2,929	3,119	3,220	3,311	3,401	3,492
Voskehat	1,066	1,135	1,172	1,205	1,238	1,271
Aghavnatun	3,350	3,567	3,684	3,787	3,891	3,994
Aknalich (Aknalij)	3,277	3,489	3,603	3,704	3,806	3,907
Aknashen	1,624	1,729	1,786	1,836	1,886	1,936
Amberd	1,707	1,818	1,877	1,930	1,983	2,036
Apaga	1,885	2,008	2,073	2,131	2,190	2,248
Aragats	3,233	3,443	3,555	3,655	3,755	3,855
Aratashen	2,739	2,916	3,012	3,096	3,181	3,266
Arazap	1,720	1,832	1,891	1,944	1,998	2,051
Arevik	2,592	2,761	2,851	2,931	3,011	3,091
Argavand	2,278	2,426	2,505	2,575	2,646	2,716
Armavir v. (Maisyan)	3,471	3,696	3,816	3,924	4,031	4,138
Arshaluys	4,171	4,442	4,586	4,715	4,844	4,973
Artashar	1,350	1,438	1,485	1,526	1,568	1,610
Artimet	2,041	2,173	2,244	2,307	2,370	2,433
Aygeshat (Armavir reg.)	1,613	1,718	1,774	1,824	1,874	1,923
Aygeshat (Echmaidzin reg.)	1,793	1,910	1,972	2,027	2,083	2,138
Bambakashat	3,336	3,553	3,668	3,772	3,875	3,978
Dasht	1,008	1,073	1,108	1,139	1,171	1,202
Djrarat (Irarat)	3,010	3,205	3,310	3,403	3,496	3,589
Djrarat Poultry (Jrarpi)	1,667	1,775	1,833	1,884	1,936	1,987
Doghs	1,400	1,490	1,539	1,582	1,625	1,669
Dzerzhinsky (Aygevan)	1,451	1,545	1,595	1,640	1,685	1,730
Eghegnut (Yeghegnut)	1,840	1,959	2,023	2,080	2,137	2,194
Ferik	273	291	300	309	317	325
Griboyedov	1,931	2,056	2,123	2,183	2,242	2,302
Haykavan	1,187	1,264	1,305	1,342	1378	1415
Haytagh	2,871	3,058	3,157	3,246	3,335	3,424
Hoktember (Sardarapat)	5,508	5,866	6,057	6,227	6,397	6,568
Hovtamech	1,354	1,442	1,489	1,531	1,573	1,614
Jrashen (Djrashen)	794	846	873	898	922	947
Khandjyan	1,962	2,090	2,158	2,218	2,279	2,340
Khoronk	2,583	2,750	2,840	2,920	2,999	3,079
Lenughi	1,486	1,582	1,634	1,679	1,725	1,771
Lernamerdz (Lernamerds)	446	475	491	504	518	532
Lukashin	2,599	2,768	2,858	2,939	3,019	3,099
Lusagyugh	1,142	1,217	1,256	1,291	1,327	1,362
Mrgashat	6,084	6,479	6,690	6,878	7,066	7,254
Mrgastan	1,573	1,675	1,729	1,778	1,827	1,875
Norapat	2,738	2,915	3,010	3,095	3,180	3,264
Noravan	1,269	1,351	1,395	1,435	1,474	1,513
Samaghar (Geghakert)	3,083	3,283	3,390	3,485	3,581	3,676
Shahumian (Shahumyan)	1,540	1,640	1,693	1,741	1,789	1,836
Shahumyan Poultry	1,215	1,293	1,336	1,373	1,411	1,448
Sovetakan (Alashkert)	1,731	1,843	1,903	1,957	2,010	2,064
Tandzut (Tansut)	1,752	1,865	1,926	1,980	2,034	2,089
Taronik	2,022	2,153	2,223	2,286	2,348	2,411
Tsaghkalunj	1,403	1,494	1,542	1,586	1,629	1,672
Tsaghkunk	1,281	1,364	1,408	1,448	1,488	1,527
Tsiatsan	1,263	1,345	1,389	1,428	1,467	1,506
Vardanashen (Vardashen)	1,159	1,234	1,275	1,310	1,346	1,382
Voskehat	3,595	3,829	3,953	4,065	4,176	4,287
Yeraskhahun	2,245	2,391	2,469	2,538	2,608	2,677
Zartonk	2,150	2,290	2,364	2,431	2,497	2,564
Zhdanov	1,506	1,604	1,656	1,703	1,750	1,796
Sipanik (see Note)	918	977	1,009	1,038	1,066	1,094

Note: v. Sipanik is listed in government documents as being in Ararat marz, yet the GIS data used for these measurements shows it within 16 km of the site.

Table 2.5-3, Projected Urban Populations with Changes in NPP Staffing

Table 2.5-3, Projected Urban Populations with Changes in NPP Staffing	Low Projection + Construction 2013	High Projection with change in NPP workers				
		2015	2025	2035	2045	2055
Urban Centers w/in 16 km	100,398	104,804	107,696	110,689	113,829	116,984
Armavir	33,556	34,127	35,078	36,054	37,026	38,000
Metsamor	10,757	10,850	11,030	11,327	11,625	12,073
Vaharshapat (Eshmiadzin)	56,085	59,827	61,588	63,308	65,178	66,911
	Percent Change due to NPP workers					
Urban Centers w/in 16 km	2.32%	0.31%	-0.18%	-0.21%	-0.11%	0.00%
Armavir	5.03%	0.31%	-0.15%	-0.17%	-0.21%	-0.24%
Metsamor	6.62%	1.00%	-0.57%	-0.68%	-0.79%	0.37%
Vaharshapat (Eshmiadzin)	0.00%	0.18%	-0.13%	-0.15%	0.07%	0.07%

Table 2.5-4, ANPP Staffing and Residences

Current O&M Staff and Residences - ANPP Units 1&2	Total	w/in 16 km zone	Armavir	Metsamor	Vagharshapat	Yerevan	Rural, Armavir Marz
Current O&M Staff - ANPP	1,743	1,427	139	1,051	18	316	219
Percentage	100%	82%	8.0%	60.3%	1.0%	18.1%	12.6%
Peak Construction Labor (2013)	**NP2010**	**Use**	**Armavir**	**Metsamor**	**Vagharshapat**	**Yerevan**	**Other**
Construction Craft Labor	1600	1920	1152	384		384	
Construction Craft Supervision	80	96	58	19		19	
Construction Site Indirect Labor	160	192	115	38		38	
Construction Quality Control Inspectors	40	48	29	10		10	
NSSS Vendor and Subcontractor Staffs	140	168	101	34		34	
EPC Contractor's Mgrs, Engrs, & Schedulers	100	120	72	24		24	
Owner's O&M Staff (Unit 3 peak during const.)	200	240	19	145	2	44	30
Start-Up Personnel	60	72	43	14		14	
State Inspectors	20	24	19			5	
TOTAL, Peak Construction	2400	2880	1608	668	2	572	30
Additional Staff in 2015-2016	**% of peak**	**Total**	**Armavir**	**Metsamor**	**Vagharshapat**	**Yerevan**	**Rural, AM**
Construction Craft Labor	20%	384	230	77		77	
Construction Craft Supervision	20%	19	11	4		4	
Construction Site Indirect Labor	20%	38	23	8		8	
Construction Quality Control Inspectors	50%	24	14	5		5	
NSSS Vendor and Subcontractor Staffs	15%	25	15	5		5	
EPC Contractor's Mgrs, Engrs, & Schedulers	20%	24	14	5		5	
Start-Up Personnel	100%	240	144	48		48	
State Inspectors	50%	36	526			7	
Owner's O&M Staff - Unit 3		552	44	333	6	100	69
TOTAL, First year operation		1342	1021	485	6	259	69
O&M Staff Reductions	**% Red.**	**Total**	**Armavir**	**Metsamor**	**Vagharshapat**	**Yerevan**	**Rural, AM**
Units 1,2 in 2025, in decom.	-68%	-1193	-95	-719	-12	-216	-150
Units 1,2 in 2035, in decom.	-77%	-1338	-107	-807	-14	-243	-168
Units 1,2 in 2045, decom. Near done	-88%	-1533	-122	-924	-16	-278	-193
Units 1,2 in 2055	-98%	-1708	-136	-1030	-18	-310	-215

Table 2.5-5, Population and Demographic Data for Urban Communities and Marzes in 50 km Zone

Table 2.5-5, Urban/Marz Population and Demographics within 50km Zone								Demographic Data - 2001 De Jure Population					
Urban Center	Marz	Distance to NPP, km	Compass Sector	2001 Census de facto Population	2001 Census de jure Population	2001 *de jure* Population Density person/km^2	2006 Residential Population	Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Total RA					3,213,011	108.00	3,219,200						
Urban Centers w/in 16 km				88,866	98,292		99,200	16,894	24,819	5,244	16,371	27,759	7,205
Armavir t.	Armavir	9.2	WSW	28,733	32,034	4,576	32,300	5,425	7,920	1,969	5,194	8,858	2,668
Metsamor t.	Armavir	4.6	SW	8,853	9,870	8,973	10,200	1,700	2,825	274	1,663	3,063	345
Vaharshapat t. (Echmiadzin)	Armavir	13.0	E	51,280	56,388	7,049	56,700	9,769	14,074	3,001	9,514	15,838	4,192
Urban Centers 16 - 50 km	TOTAL			1,253,300	1,288,131		1,290,400	201,683	324,601	76,023	195,718	382,504	107,602
Yerevan	Yerevan	32.0	E	1,091,235	1,103,488	4,861	1,103,800	169,197	277,505	66,844	164,728	329,983	95,231
Aparan	Aragatsotn	49.0	NNE	5,711	6,614	2,646	6,600	1,175	1,779	333	1,041	1,830	456
Ashatarak	Aragatsotn	22.6	NE	18,915	20,636	2,684	21,500	3,393	5,452	1,243	3,342	5,484	1,722
Talin	Aragatsotn	32.3	NW	4,981	5,614	2,552	5,700	1,007	1,423	279	953	1,554	398
Artashat	Ararat	41.4	SE	22,567	25,066	4,178	25,100	4,519	6,043	1,332	4,137	7,082	1,953
Masis	Ararat	28.1	ESE	19,048	21,376	6,478	21,800	3,912	5,288	1,033	3,780	6,018	1,345
Abovyan	Kotayk	42.1	ENE	38,876	44,569	7,428	45,000	7,629	11,479	2,127	7,267	13,352	2,715
Byureghavan	Kotayk	41.5	ENE	7,023	8,152	5,823	8,300	1,479	2,060	339	1,436	2,359	479
Charentsavan	Kotayk	49.7	ENE	19,708	25,039	6,260	24,600	4,304	6,446	1,258	4,168	7,258	1,605
Nor Hachn	Kotayk	40.0	ENE	9,458	10,168	7,263	10,200	1,858	2,697	392	1,783	2,924	514
Yeghvard (Eghvard)	Kotayk	33.0	ENE	10,783	11,627	2,325	12,000	2,123	2,991	593	2,059	3,073	788
Maralik	Shirak	49.8	NNW	4,995	5,782	1,320	5,800	1,087	1,438	250	1,024	1,587	396
Marzes w/in 50 km	Approx % in 50 km			1,830,196	1,911,813		1,925,193						
Aragatsotn Marz	75%			114,122	124,972	50	128,869	26,923	33,582	8,102	24,926	33,336	11,432
Ararat Marz	30%			184,389	199,442	130	199,382	52,084	65,124	15,305	49,116	69,193	21,194
Armavir Marz	100%			255,861	276,233	222	279,200	52,521	67,806	14,549	49,191	71,374	20,792
Kotayk Marz	25%			166,704	187,111	130	191,063	50,018	68,646	14,276	47,402	73,480	18,647
Shirak Marz	10%			17,885	20,567	106	22,879	52,412	67,850	15,906	49,986	73,909	23,326
Yerevan City	100%			1,091,235	1,103,488	4,861	1,103,800	169,197	277,505	66,844	164,728	329,983	95,231

Table 2.5-6, Population and Demographic Data, Rural Communities in 50 km Zone

Table 2.5-6, Rural Population and Demographics within 50 km Zone				2001 Census De Facto Population	2001 Census De Jure Population	2006 Temporarily Present Population	2006 Residential Population	Demographic Data - 2001 De Jure Population					
Settlement	Marz	Distance to NPP, km	Compass Sector					Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Rural Settlements w/in 16 km	TOTAL			109,327	116,445	4,115	129,087						
Aragatsotn	Aragatsotn	9.3	NNE	705	804		1,109						
Aruch (Aruj)	Aragatsotn	13.1	NNW	943	1,016		1,029						
Dprevank	Aragasotn	13.0	NNW	52	58	13	102						
Kosh	Aragatsotn	13.5	N	2,600	2,756	89	2,665						
Nor Amanos	Aragatsotn	8.8	NW	540	672	52	654						
Nor Edesia (Nor Yedesia)	Aragatsotn	5.0	N	786	982	40	1,156						
Partizak	Aragasotn	13.4	NW	249	274	33	271						
Shamiram	Aragatsotn	11.2	NNW	609	945	9	1,573						
Ujan	Aragatsotn	14.0	NNE	2,510	2,758		2,961						
Voskehat	Aragatsotn	15.4	NE	2,197	2,448	20	1,078						
Aghavnatun	Armavir	10.7	ENE	2,934	3,158	37	3,387						
Aknalich (Aknalij)	Armavir	4.0	S	2,673	2,864	210	3,313						
Aknashen	Armavir	15.2	SE	1,372	1,404	144	1,642						
Amberd	Armavir	12.9	ENE	1,276	1,363	22	1,726						
Apaga	Armavir	13.1	SE	1,646	1,679	18	1,906						
Aragats	Armavir	8.8	ENE	2,973	3,013	58	3,269						
Aratashen	Armavir	9.2	SE	2,688	2,823	25	2,769						
Arazap	Armavir	15.3	S	1,383	1,402	22	1,739						
Arevik	Armavir	10.0	SSW	2,473	2,525		2,621						
Argavand	Armavir	14.0	SSW	2,062	2,191	82	2,303						
Armavir v. (Maisyan)	Armavir	7.0	WSW	2,772	2,910	50	3,509						
Arshaluys	Armavir	6.3	ESE	3,836	4,162		4,217						
Artashar	Armavir	8.5	SSE	962	966	15	1,365						
Artimet	Armavir	11.0	ESE	1,512	1,638	61	2,063						
Aygeshat (Armavir reg.)	Armavir	13.5	SSW	1,618	1,754	105	1,631						
Aygeshat (Echmaidzin reg.)	Armavir	13.8	ENE	1,368	1,480	28	1,813						
Bambakashat	Armavir	13.4	WSW	3,111	3,212	150	3,373						
Dasht	Armavir	14.3	ENE	752	723	105	1,019						
Djrarat (Irarat)	Armavir	15.3	SE	2,627	2,808	32	3,043						
Djrarat Poultry (Jrarpi)	Armavir	12.9	SE	1,088	1,165	65	1,685						
Doghs	Armavir	12.0	ENE	1,195	1,267		1,415						
Dzerzhinsky (Aygevan)	Armavir	15.2	WSW	1,512	1,573	126	1,467						
Eghegnut (Yeghegnut)	Armavir	9.9	S	1,759	1,876	76	1,860						
Ferik	Armavir	5.7	E	267	399	21	276						
Griboyedov	Armavir	13.2	SE	1,893	2,003	26	1,952						
Haykavan	Armavir	13.0	SW	1,210	1,328		1,200						
Haytagh	Armavir	7.6	E	2,441	2,565	55	2,903						
Hoktember (Sardarapat)	Armavir	12.3	WSW	5,387	5,727	18	5,569	1,086	1,400	330	1,013	1,411	487
Hovtamech	Armavir	9.8	E	1,025	1,068	210	1,369						
Jrashen (Djrashen)	Armavir	15.1	SW	699	727	79	803						
Khandjyan	Armavir	14.2	W	1,796	1,880		1,984						
Khoronk	Armavir	9.9	ESE	2,164	2,274	51	2,611						
Lenughi	Armavir	16.0	WSW	1,510	1,583	170	1,502						
Lernamerdz (Lernamerds)	Armavir	13.6	NE	395	405	40	451						
Lukashin	Armavir	11.8	W	2,213	2,346	262	2,628						
Lusagyugh	Armavir	14.8	SE	840	930	17	1,155						
Mrgashat	Armavir	9.0	SW	4,997	5,297		6,151	1,037	1,224	288	946	1,307	495
Mrgastan	Armavir	11.9	E	944	960	70	1,590						
Norapat	Armavir	10.0	WSW	2,675	2,780	90	2,768						
Noravan	Armavir	9.4	W	930	962	172	1,283						
Samaghar (Geghakert)	Armavir	8.8	E	2,360	2,458	50	3,117						
Shahumian (Shahumyan)	Armavir	13.7	ENE	939	1,119	33	1,557						
Shahumyan Poultry	Armavir	14.4	ENE	929	951	40	1,228						
Sovetakan (Alashkert)	Armavir	11.1	SW	1,625	1,714	12	1,750						
Tandzut (Tansut)	Armavir	13.4	SSW	1,829	1,914	79	1,771						
Taronik	Armavir	7.0	SE	1,888	2,017	10	2,044						
Tsaghkalunj (Tsaghkalanj/Tsakhk	Armavir	7.6	ENE	1,225	1,323	105	1,418						
Tsaghkunk	Armavir	10.8	E	1,097	1,141	135	1,295						
Tsiatsan	Armavir	10.6	E	1,058	1,110	83	1,277						
Vardanashen (Vardashen)	Armavir	14.9	SSE	907	913		1,172						
Voskehat	Armavir	16.0	ESE	2,197	2,448	235	3,635						
Yeraskhahun	Armavir	13.5	SSE	1,356	1,461	267	2,270						
Zartonk	Armavir	8.0	S	1,831	1,883	23	2,174						
Zhdanov	Armavir	5.0	WSW	1,523	1,653		1,523						
Sipanik (see Note)	Ararat	14.2	ESE	394	437	75	928						

Note: v. Sipanik is listed in government documents as being in Ararat marz, yet the GIS data used for these measurements shows it within 16 km of the site.

Table 2.5-6, Cont'd

Table 2.5-6, Rural Population and Demographics within 50 km Zone				2001 Census De Facto Population	2001 Census De Jure Population	2006 Temporarily Present Population	2006 Residential Population	Demographic Data - 2001 De Jure Population					
Settlement	Marz	Distance to NPP, km	Compass Sector					Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Rural Settlements 16 - 50 km	Marz			684,870	739,369	34,982	774,383						
Aragatsotn Marz, Rural 16-50 km				73,324	79,395	2,056	82,471	21,348	24,928	6,247	19,590	24,468	8,856
Agarak (Ashtarak dist.)	Aragasotn	18.0	NE	1,586	1,655	0	1,599						
Agarak (Talin dist. Agarakavan)	Aragasotn	17.7	NNW	962	1,069	4	935						
Aghdzk	Aragasotn	17.4	NNE	1,655	1,801	121	1,850						
Akunq	Aragasotn	34.0	NW	633	672	40	605						
Antarut	Aragasotn	22.2	NNE	205	225	0	228						
Apnagyugh	Aragasotn	36.0	NE	482	490	41	707						
Ara	Aragasotn	36.5	NNE	364	368	0	615						
Aragats (Aparan dist.)	Aragasotn	38.9	NNE	2,727	3,040	278	3,536						
Aragats (Talin dist. Aragatsavan)	Aragasotn	44.0	WNW	5,129	5,383	60	5,643	1,071	1,315	294	978	1,299	426
Areg (Tatul)	Aragasotn	36.7	NW	738	819	56	891						
Artashavan	Aragasotn	31.0	NE	606	624	67	670						
Arteni	Aragasotn	45.0	WNW	3,108	3,386	27	3,412						
Ashnak	Aragasotn	25.1	NW	1,139	1,226	46	1,136						
Avan community	Aragasotn	17.5	N	813	915	44	798						
Avtona (Metsadzor)	Aragasotn	23.7	NNW	94	159	0	101						
Barog (Barozh, Arevut)	Aragasotn	35.1	NW	158	167	4	141						
Baysz (Otevan)	Aragasotn	21.5	NNW	156	182	0	222						
Bazmaghbyur	Aragasotn	23.1	NE	894	950	0	971						
Byurakan	Aragasotn	21.0	NNE	3,930	4,312	2	4,417						
Dashtadem	Aragasotn	30.0	NW	520	613	71	549						
Davtashen	Aragasotn	25.8	NW	699	752	35	685						
Dian	Aragasotn	20.4	NNW	111	151	11	129						
Djrambar	Aragasotn	41.7	NE	120	215	0	157						
Dzoraglukh	Aragasotn	37.7	NNW	379	366	18	325						
Garnahovit	Aragasotn	38.7	NNW	423	440	0	482						
Geghadzor	Aragasotn	49.7	N	947	1099	69	1,212						
Getap	Aragasotn	50.0	WNW	159	183	24	174						
Ghabaghtapa (Ddmasar)	Aragasotn	32.8	NW	151	161	0	125						
Ghazaravan	Aragasotn	24.3	NE	450	477	0	450						
Gyalto (Kanch)	Aragasotn	41.7	WNW	111	160	0	129						
Hakko	Aragasotn	44.6	WNW	136	229	0	157						
Hartavan	Aragasotn	40.0	NNE	768	913	6	1,038						
Hatsashen	Aragasotn	41.8	NW	278	304	0	286						
Irind	Aragasotn	27.6	NNW	769	840	0	859						
Kakavadzor	Aragasotn	20.5	NNW	919	1,012	62	1,168						
Karbi	Aragasotn	26.3	NE	3,547	3,624	0	3,796						
Karin	Aragasotn	20.0	ENE	307	334		307						
Karmrashen	Aragasotn	32.6	NNW	582	634	37	538						
Katnaghbyur	Aragasotn	27.8	NW	1,222	1,347	5	1,311						
Lernarot	Aragasotn	19.1	N	329	343	0	415						
Lusaghbyur	Aragasotn	32.2	NE	0	0	0	0						
Lusakn	Aragasotn	28.3	WNW	149	198		182						
Mastara	Aragasotn	37.7	NW	2,233	2,581	54	2,065						
Mughni	Aragasotn	24.7	NE	770	839		770						
Mulki (Mulqi, Kayq)	Aragasotn	48.6	NNE	497	554	24	699						
Nerqin Bazmaberd	Aragasotn	20.3	NNW	1,334	1,408	115	1,493						
Nerkin Sasunashen	Aragasotn	23.2	NNW	942	999	53	938						
Nigatun	Aragasotn	34.0	NE	0	0		0						
Nigavan	Aragasotn	50.0	NNW	671	707		694						
Nor Artik	Aragasotn	48.9	NW	542	562		562						
Norashen(Aparan dist., Shoghakn)	Aragasotn	42.8	NE	162	136	0	131						
Ohanavan	Aragasotn	27.8	NE	2,239	2,254	184	2,383						
Orgov	Aragasotn	21.0	NNE	458	511	27	554						
Oshakan	Aragasotn	18.1	ENE	4,803	5,106	0	5,134	936	1,196	355	832	1,260	527
Parpi	Aragasotn	22.1	NE	1,900	2,083	0	2,355						
Quchak (Kuchak)	Aragasotn	43.3	NNE	1,878	1,993	12	2,478						
Saghmosavan	Aragasotn	31.1	NE	194	198	41	235						
Sasunik	Aragasotn	18.8	N	1,973	2,239	110	2,283						
Shenavan	Aragasotn	39.5	NNE	1,599	1,699	15	1,899						
Shgharshik	Aragasotn	29.8	NNW	515	536	0	535						
Sorik	Aragasotn	44.5	NW	123	182	0	126						
Suser	Aragasotn	47.4	NW	309	346	8	398						
Tegher	Aragasotn	20.0	NNE	90	90	0	239						
Tsaghkasar	Aragasotn	38.2	NNW	87	112	2	117						
Tsaghkashen	Aragasotn	40.2	NNE	551	600	15	765						
Tsamaqasar	Aragasotn	45.4	NW	409	469	0	450						
Ushi	Aragasotn	27.1	NE	1,285	1,328	0	1,430						
Vardenis	Aragasotn	48.6	NNE	591	604	23	753						
Vardenut	Aragasotn	37.4	NNE	854	852	40	927						
Verin Bazmaberd	Aragasotn	22.8	NNW	429	472	5	493						
Verin Sasunashen	Aragasotn	24.7	NNW	337	363	0	348						
Verin Sasunik	Aragasotn	17.3	N	49	81	0	146						
Vosketas	Aragasotn	34.0	NNW	494	526	0	534						
Voskevaz	Aragasotn	17.0	NE	3,817	4,204	0	4,299						
Yeghipatrush	Aragasotn	48.2	NE	714	739	0	863						
Yeghnik	Aragasotn	30.5	NW	367	452	31	566						
Yerndjatap	Aragasotn	41.0	NE	487	490	144	669						
Zarindja	Aragasotn	45.1	NW	595	646	0	629						
Zovasar	Aragasotn	36.7	NNW	571	596	25	560						

Table 2.5-6, Cont'd

Table 2.5-6, Rural Population and Demographics within 50 km Zone, (Cont'd.)								Demographic Data - 2001 De Jure Population					
Settlement	Marz	Distance to NPP, km	Compass Sector	2001 Census De Facto Population	2001 Census De Jure Population	2006 Temporarily Present Population	2006 Residential Population	Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Ararat Marz, Rural 16-50 km				142,774	153,000	8,736	152,482	36,948	45,704	11,569	34,736	47,214	15,960
Abovyan	Ararat	34.7	ESE	1,389	1,457	55	1,389						
Araksavan	Ararat	34.2	SE	721	819	62	882						
Arbat	Ararat	22.5	ESE	1,898	1,993	216	1,911						
Arevabuyr	Ararat	32.2	ESE	1,049	1,117	107	1,175						
Arevshat	Ararat	20.0	ESE	2,104	2,225	78	2,352						
Argavand	Ararat	24.2	E	1,715	1,734	185	1,705						
Artashat v.	Ararat	41.5	SE	3,960	4,193		3,960						
Aygepat	Ararat	45.9	ESE	1,359	1,451	64	3,183						
Aygestan	Ararat	40.6	ESE	2,449	2,642	72	1,533						
Aygezard	Ararat	46.3	ESE	3,215	3,458	64	4,272						
Ayntap	Ararat	29.0	ESE	7,352	7,712	71	2,395	1,402	1,854	470	1,354	2,001	631
Azatashen	Ararat	23.5	ESE	572	606	129	669						
Azatavan	Ararat	38.0	SE	2,907	3,117	169	3,055						
Baghramyan	Ararat	37.8	SE	1,702	1,875	30	1,954						
Bardzrashen	Ararat	38.7	ESE	1,282	1,411	66	1,602						
Berdik	Ararat	41.9	ESE	812	917	0	1,011						
Berqanush	Ararat	39.4	SE	1,694	1,808	37	1,957						
Burastan	Ararat	36.7	SE	2,013	2,206	140	1,983						
Byuravan	Ararat	36.8	ESE	1,237	1,336	9	1,433						
Dalar	Ararat	39.8	SE	2,522	2,844	66	2,540						
Darakert	Ararat	24.5	ESE	2,342	2,493	126	2,526						
Darbnik	Ararat	21.6	ESE	937	1,071	226	1,339						
Dashtavan	Ararat	22.9	ESE	1,775	2,013	245	2,238						
Deghdzut	Ararat	38.6	ESE	919	989	72	952						
Dimitrov	Ararat	35.3	ESE	1,221	1,353	109	1,184						
Ditak	Ararat	35.3	ESE	670	691	18	721						
Dvin	Ararat	41.9	ESE	2,815	2,997	92	2,700						
Geghanist	Ararat	25.0	E	2,427	2,471	287	2,464						
Getapnya	Ararat	25.0	E	1,200	1,292	231	1,341						
Getazat	Ararat	39.3	ESE	1,961	2,059	121	1,931						
Ghukasavan	Ararat	23.8	ESE	2,128	2,168	213	2,360						
Hayanist	Ararat	20.7	ESE	2,046	2,144	120	2,140						
Hnaberd	Ararat	41.9	ESE	636	654	74	711						
Hovtashat	Ararat	19.1	ESE	3,497	3,674	77	3,513						
Hovtashen	Ararat	31.5	SE	1,142	1,202	39	1,098						
Jrahovit (Djrahovit)	Ararat	32.0	ESE	1,040	1,144	67	1,214						
Jrashen (Djrashen)	Ararat	34.5	ESE	1,708	1,792	79	1,795						
Kanachut	Ararat	39.3	ESE	1,191	1,262	138	1,403						
Khachpar	Ararat	23.0	ESE	1,610	1,887	451	1,840						
Landjazat	Ararat	39.0	ESE	1,440	1,460	0	1,286						
Marmarashen	Ararat	31.1	ESE	2,967	3,112	187	3,356						
Masis v.	Ararat	36.6	SE	1,434	1,656	38	1,489						
Mkhchyan	Ararat	34.3	ESE	4,531	5,022	13	5,039	921	1,259	294	902	1,235	411
Mrganush	Ararat	39.2	ESE	1,039	1,100	79	1,276						
Mrgavan	Ararat	40.6	SE	1,725	1,872	61	1,957						
Mrgavet	Ararat	33.6	ESE	2,146	2,226	40	2,322						
Narek	Ararat	45.2	ESE	1,075	1,138	51	1,253						
Nizami	Ararat	24.4	ESE	1,068	1,257	154	1,604						
Nor Kharberd	Ararat	30.7	ESE	5,772	6,186	715	6,304	1,220	1,500	324	1,155	1,551	436
Nor Kyurin	Ararat	30.3	ESE	845	967	368	1,228						
Norabats	Ararat	25.8	ESE	1,987	2,193	300	2,338						
Noramarg	Ararat	28.8	SE	1,824	2,003	638	2,149						
Norashen	Ararat	43.3	ESE	3,071	3,265	30	3,463						
Nshavan	Ararat	36.6	ESE	1,930	1,978	93	1,843						
Nubarashen	Ararat	36.0	ESE	8,920	9,212		8,920						
Pokr Vedi	Ararat	49.7	SE	2,931	3,091	0	3,174						
Qaghtsrashen (Kaghtsrashen)	Ararat	46.5	ESE	2,987	3,094	201	3,136						
Ranchpar	Ararat	25.8	SE	996	1,103	267	1,485						
Sayat-Nova	Ararat	24.6	ESE	1,739	1,992	250	2,200						
Shahumyan	Ararat	45.3	SE	3,933	4,162	37	4,184						
Sis	Ararat	24.2	ESE	1,143	1,331	192	1,837						
Taperakan	Ararat	48.0	SE	3,437	3,708	0	3,739						
Vardashen	Ararat	37.5	ESE	445	471	51	604						
Verin Artashat	Ararat	43.0	ESE	3,960	4,193	301	4,709						
Verin Dvin	Ararat	42.2	ESE	1,866	2,175	0	2,183						
Vostan	Ararat	42.6	SE	2,946	3,125	80	3,043						
Zorak	Ararat	23.3	ESE	1,400	1,631	185	1,930						

Table 2.5-6, Cont'd

Table 2.5-6, Rural Population and Demographics within 50 km Zone (Cont'd)								Demographic Data - 2001 De Jure Population					
Settlement	Marz	Distance to NPP, km	Compass Sector	2001 Census De Facto Population	2001 Census De Jure Population	2006 Temporarily Present Population	2006 Residential Population	Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Armavir Marz, Rural 16-50 km				69,253	74,646	3,243	85,432	35,627	42,987	9,305	32,820	43,615	13,587
Amasia	Armavir	18.6	SW	905	958	0	989						
Araks (Armavir dist.)	Armavir	18.5	WSW	1,521	1,607	146	1,839						
Araks (Echmiadzin dist.)	Armavir	19.4	SE	1,452	1,582	70	1,804						
Arevadasht	Armavir	19.6	WSW	326	375	50	351						
Arevashat	Armavir	19.9	ESE	1,413	1,508	109	2,113						
Argina	Armavir	36.1	WNW	518	547	10	509						
Artamet	Armavir	22.6	WSW	133	212		160						
Aygek	Armavir	20.5	E	1,103	1,178	0	1,434						
Bagaran	Armavir	41.3	W	609	652	40	567						
Baghramyan(Baghramyan dist.)	Armavir	29.4	W	663	903	31	1,116						
Baghramyan(Echmiadzin dist.)	Armavir	19.4	E	2,363	2,675	92	3,052						
Berkashat	Armavir	25.2	SW	521	544	42	405						
Dalarik	Armavir	23.2	WNW	3,102	3,580	110	4,190						
Gay (Gai)	Armavir	17.5	SE	3,333	3,470	196	3,624						
Getashen	Armavir	22.9	SW	2,129	2,205	26	2,128						
Hatsik	Armavir	16.5	W	2,372	2,567	276	2,054						
Haykashen	Armavir	18.5	SE	1,148	1,197	84	1,491						
Hushakert	Armavir	21.0	WSW	850	877	48	971						
Janfida (Djanfida)	Armavir	18.0	SSW	3,008	3,088	0	3,051						
Karakert	Armavir	28.6	WNW	3,438	3,826	146	4,696						
Koghbavan	Armavir	32.7	W	83	114	15	110						
Lernagog	Armavir	24.8	WNW	1,676	2,171	86	2,205						
Margara	Armavir	16.4	S	1,370	1,422	50	1,409						
Merdzavan	Armavir	21.8	E	2,722	2,938	104	3,094						
Metsamor v.	Armavir	17.2	SE	1,089	1,123	20	1,164						
Musaler	Armavir	20.3	E	2,340	2,534	180	2,845						
Myasnikyan	Armavir	19.4	W	3,483	3,798	100	4,322						
Nalbandyan	Armavir	18.3	SW	4,048	4,502	60	5,257						
Nor Armavir	Armavir	16.5	SW	1,609	1,703	8	2,109						
Nor Artages	Armavir	17.0	SW	1,398	1,581	0	1,490						
Nor Kesaria	Armavir	24.4	WSW	1,288	1,318	73	1,426						
Norakert	Armavir	17.4	E	2,503	2,645	26	3,198						
Parakar	Armavir	22.2	E	4,816	5,041	550	8,827	913	1,222	306	891	1,307	402
Pshatavan	Armavir	17.0	SSW	2,175	2,217	50	2,672						
Ptghunk	Armavir	17.2	E	1,355	1,454	189	1,887						
Shenavan	Armavir	22.7	SW	1,770	1,768	31	1,790						
Shenik	Armavir	32.0	W	815	852	63	899						
Tairov	Armavir	22.9	E	2,091	2,170		2,091						
Talvorik	Armavir	21.4	WSW	190	204	40	241						
Vanand	Armavir	29.3	WSW	823	845	106	1,011						
Yervandashat	Armavir	40.8	W	702	695	16	841						

Table 2.5-6, Rural Population and Demographics within 50 km Zone (Cont'd)								Demographic Data - 2001 De Jure Population					
Settlement	Marz	Distance to NPP, km	Compass Sector	2001 Census De Facto Population	2001 Census De Jure Population	2006 Temporarily Present Population	2006 Residential Population	Male 0 - 19 yrs	Male 20 - 59 yrs	Male 60 yrs +	Female 0 - 19 yrs	Female 20 - 59 yrs	Female 60 yrs +
Kotayk Marz, Rural 16-50 km				80,856	87,556	4,181	90,963	23,051	28,471	6,959	21,664	29,177	9,166
Akunk (Akunq)	Kotayk	47.2	E	1,800	1,914	12	2,012						
Alapars	Kotayk	49.7	ENE	2,354	2,527	154	2,372						
Aragyugh	Kotayk	42.0	NE	1,006	1,025	75	1,354						
Aramus	Kotayk	45.0	E	3,237	3,320	120	3,737						
Argel (Lusakert)	Kotayk	45.0	ENE	2,546	2,894	69	2,930						
Arindj	Kotayk	37.0	E	5,219	5,413	200	5,040						
Arzakan	Kotayk	49.5	NE	2,679	2,881	0	2,728						
Arzni	Kotayk	40.7	ENE	2,515	2,774	136	2,456						
Balahovit	Kotayk	40.3	E	3,004	3,426	150	3,291						
Buzhakan	Kotayk	44.7	NE	1,690	1,724	44	1,808						
Djraber	Kotayk	46.8	ENE	423	451	98	612						
Dzoraghbyur	Kotayk	43.0	E	2,026	2,133	165	2,180						
Geghadir	Kotayk	43.4	E	652	676	34	724						
Geghashen	Kotayk	49.8	E	3,693	4,020	75	3,991						
Getamech	Kotayk	39.2	ENE	659	712	55	668						
Hatsavan	Kotayk	43.6	E	541	563	42	613						
Jrvezh (Djrvezh)	Kotayk	38.0	E	5,397	6,273	83	6,334						
Kamaris	Kotayk	47.3	E	2,079	2,195	110	2,480						
Kanakeravan	Kotayk	34.2	E	2,971	3,365	198	3,704						
Kaputan	Kotayk	49.7	ENE	1,261	1,312	102	1,413						
Karashamb	Kotayk	44.8	ENE	669	676	20	737						
Karenis	Kotayk	46.0	ENE	767	813	40	888						
Kasakh	Kotayk	27.2	ENE	4,278	4,755	356	5,015						
Katnaghbyur	Kotayk	46.3	E	554	577	0	610						
Kotayk	Kotayk	45.3	ENE	1,521	1,627	203	2,038						
Mayakovskiy	Kotayk	43.0	E	1,740	1,830	115	1,653						
Mrgashen	Kotayk	36.2	ENE	1,635	1,774	212	2,312						
Nor Artamet	Kotayk	39.2	ENE	871	1,038	57	1,195						
Nor Geghi	Kotayk	40.4	ENE	4,932	5,184	281	5,642						
Nor Gyugh	Kotayk	44.8	E	1,473	1,560	91	1,404						
Nor Yerznka	Kotayk	26.9	ENE	1,470	1,627	100	1,574						
Nurnus	Kotayk	44.3	ENE	529	572	58	534						
Proshyan	Kotayk	24.6	ENE	4,364	4,660	224	4,764						
Ptghni	Kotayk	38.5	ENE	1,240	1,357	43	1,341						
Saralandj	Kotayk	40.5	NE	325	332	53	375						
Teghenik	Kotayk	45.7	NE	516	559	32	640						
Verin Ptghni	Kotayk	37.4	E	782	887	80	969						
Voghchaberd	Kotayk	43.1	E	918	957	95	1,104						
Zoravan	Kotayk	38.0	ENE	1,175	1,312	43	1,564						
Zovk	Kotayk	47.3	E	828	897	68	968						
Zovuni	Kotayk	31.6	E	4,517	4,964	88	5,189						
Shirak Marz, Rural 16-50 km				12,890	14,785	303	17,079	22,101	25,700	5,988	20,698	26,005	8,637
Dzitanqov (Dzithankov)	Shirak	45.8	NW	1,170	1,332	42	1,574						
Dzorakap	Shirak	48.5	NNW	942	1,039	31	1,067						
Harich	Shirak	49.0	NNW	991	1,123	17	1,435						
Karaberd (Qaraberd)	Shirak	48.3	NNW	991	1,090	0	1,306						
Lanjik	Shirak	43.6	NNW	737	924	20	1,036						
Lernakert	Shirak	45.8	NNW	1,315	1,449	20	1,504						
Nahapetavan	Shirak	48.8	NNW	709	817	21	1,115						
Pemzashen	Shirak	48.0	NNW	2,454	2,862	113	3,517						
Saralandj	Shirak	50.0	NNW	1,021	1,115	13	1,195						
Sarnaghbyur	Shirak	43.0	NNW	2,560	3,034	26	3,330						

Table 2.5-7, Projected Urban/Marz Population for Communities within 50 km Zone

Table 2.5-7, Urban/Marz Population Projection with NPP Worker Changes	Low Projection w/Const. Labor 2013	High Projection with Changes in NPP Workers				
		2015	2025	2035	2045	2055
Total RA	3,184,154	3,390,646	3,501,171	3,599,604	3,698,036	3,796,469
Urban Centers w/in 16 km	100,398	104,804	107,696	110,689	113,829	116,984
Armavir t.	33,556	34,127	35,078	36,054	37,026	38,000
Metsamor t.	10,757	10,850	11,030	11,327	11,625	12,073
Vagharshapat t. (Echmiadzin)	56,085	59,827	61,588	63,308	65,178	66,911
Urban Centers 16 - 50 km	1,276,924	1,359,382	1,403,210	1,442,641	1,482,061	1,521,484
Yerevan	1,092,355	1,162,844	1,200,266	1,233,990	1,267,705	1,301,424
Aparan	6,528	6,951	7,178	7,380	7,582	7,784
Ashatarak	21,266	22,645	23,383	24,041	24,698	25,355
Talin	5,638	6,004	6,199	6,374	6,548	6,722
Artashat	24,827	26,437	27,299	28,066	28,833	29,601
Masis	21,563	22,961	23,709	24,376	25,043	25,709
Abovyan	44,510	47,397	48,942	50,318	51,693	53,069
Byureghavan	8,210	8,742	9,027	9,281	9,535	9,788
Charentsavan	24,332	25,910	26,755	27,507	28,259	29,011
Nor Hachn	10,089	10,743	11,093	11,405	11,717	12,029
Yeghvard (Eghvard)	11,869	12,639	13,051	13,418	13,785	14,152
Maralik	5,737	6,109	6,308	6,485	6,663	6,840
Marzes w/in 50 km						
Aragatsotn Marz	127,469	135,733	140,153	144,099	148,038	151,971
Ararat Marz	197,210	210,002	216,842	222,936	229,039	235,132
Armavir Marz	276,160	294,069	303,655	312,192	320,729	329,266
Kotayk Marz	188,980	201,237	207,801	213,641	219,483	225,321
Shirak Marz	22,631	24,097	24,884	25,582	26,282	26,981
Yerevan City	1,092,355	1,162,844	1,200,266	1,233,990	1,267,705	1,301,424

Table 2.5-8, Projected Rural Population for Communities within 50 km Zone

Table 2.5-8, Rural Population Projection	Low Projection 2013	High Projection				
		2015	2025	2035	2045	2055
Rural Settlements w/in 16 km	127,680	135,965	140,391	144,341	148,290	152,234
Aragatsotn	1,097	1,168	1,206	1,240	1,274	1,308
Aruch (Aruj)	1,018	1,084	1,119	1,151	1,182	1,214
Dprevank	101	107	111	114	117	120
Kosh	2,636	2,807	2,898	2,980	3,061	3,143
Nor Amanos	647	689	711	731	751	771
Nor Edesia (Nor Yedesia)	1,143	1,218	1,257	1,293	1,328	1,363
Partizak	268	285	295	303	311	320
Shamiram	1,556	1,657	1,711	1,759	1,807	1,855
Ujan	2,929	3,119	3,220	3,311	3,401	3,492
Voskehat	1,066	1,135	1,172	1,205	1,238	1,271
Aghavnatun	3,350	3,567	3,684	3,787	3,891	3,994
Aknalich (Aknalij)	3,277	3,489	3,603	3,704	3,806	3,907
Aknashen	1,624	1,729	1,786	1,836	1,886	1,936
Amberd	1,707	1,818	1,877	1,930	1,983	2,036
Apaga	1,885	2,008	2,073	2,131	2,190	2,248
Aragats	3,233	3,443	3,555	3,655	3,755	3,855
Aratashen	2,739	2,916	3,012	3,096	3,181	3,266
Arazap	1,720	1,832	1,891	1,944	1,998	2,051
Arevik	2,592	2,761	2,851	2,931	3,011	3,091
Argavand	2,278	2,426	2,505	2,575	2,646	2,716
Armavir v. (Maisyan)	3,471	3,696	3,816	3,924	4,031	4,138
Arshaluys	4,171	4,442	4,586	4,715	4,844	4,973
Artashar	1,350	1,438	1,485	1,526	1,568	1,610
Artimet	2,041	2,173	2,244	2,307	2,370	2,433
Aygeshat (Armavir reg.)	1,613	1,718	1,774	1,824	1,874	1,923
Aygeshat (Echmaidzin reg.)	1,793	1,910	1,972	2,027	2,083	2,138
Bambakashat	3,336	3,553	3,668	3,772	3,875	3,978
Dasht	1,008	1,073	1,108	1,139	1,171	1,202
Djrarat (Irarat)	3,010	3,205	3,310	3,403	3,496	3,589
Djrarat Poultry (Jrarpi)	1,667	1,775	1,833	1,884	1,936	1,987
Doghs	1,400	1,490	1,539	1,582	1,625	1,669
Dzerzhinsky (Aygevan)	1,451	1,545	1,595	1,640	1,685	1,730
Eghegnut (Yeghegnut)	1,840	1,959	2,023	2,080	2,137	2,194
Ferik	273	291	300	309	317	325
Griboyedov	1,931	2,056	2,123	2,183	2,242	2,302
Haykavan	1,187	1,264	1,305	1,342	1,378	1,415
Haytagh	2,871	3,058	3,157	3,246	3,335	3,424
Hoktember (Sardarapat)	5,508	5,866	6,057	6,227	6,397	6,568
Hovtamech	1,354	1,442	1,489	1,531	1,573	1,614
Jrashen (Djrashen)	794	846	873	898	922	947
Khandjyan	1,962	2,090	2,158	2,218	2,279	2,340
Khoronk	2,583	2,750	2,840	2,920	2,999	3,079
Lenughi	1,486	1,582	1,634	1,679	1,725	1,771
Lernamerdz (Lernamerds)	446	475	491	504	518	532
Lukashin	2,599	2,768	2,858	2,939	3,019	3,099
Lusagyugh	1,142	1,217	1,256	1,291	1,327	1,362
Mrgashat	6,084	6,479	6,690	6,878	7,066	7,254
Mrgastan	1,573	1,675	1,729	1,778	1,827	1,875
Norapat	2,738	2,915	3,010	3,095	3,180	3,264
Noravan	1,269	1,351	1,395	1,435	1,474	1,513
Samaghar (Geghakert)	3,083	3,283	3,390	3,485	3,581	3,676
Shahumian (Shahumyan)	1,540	1,640	1,693	1,741	1,789	1,836
Shahumyan Poultry	1,215	1,293	1,336	1,373	1,411	1,448
Sovetakan (Alashkert)	1,731	1,843	1,903	1,957	2,010	2,064
Tandzut (Tansut)	1,752	1,865	1,926	1,980	2,034	2,089
Taronik	2,022	2,153	2,223	2,286	2,348	2,411
Tsaghkalunj (Tsaghkalanj/Tsakhka	1,403	1,494	1,542	1,586	1,629	1,672
Tsaghkunk	1,281	1,364	1,408	1,448	1,488	1,527
Tsiatsan	1,263	1,345	1,389	1,428	1,467	1,506
Vardanashen (Vardashen)	1,159	1,234	1,275	1,310	1,346	1,382
Voskehat	3,595	3,829	3,953	4,065	4,176	4,287
Yeraskhahun	2,245	2,391	2,469	2,538	2,608	2,677
Zartonk	2,150	2,290	2,364	2,431	2,497	2,564
Zhdanov	1,506	1,604	1,656	1,703	1,750	1,796
Sipanik (see Note)	918	977	1,009	1,038	1,066	1,094

Note: v. Sipanik is listed in government documents as being in Ararat marz, yet the GIS data used for these measurements shows it within 16 km of the site.

Table 2.5-8,Cont'd

Table 2.5-8, Rural Population Projection	Low Projection 2013	High Projection				
		2015	2025	2035	2045	2055
Rural Settlements 16 - 50 km	423,761	451,242	465,952	479,047	492,156	505,238
Aragatsotn Marz, Rural 16-50 km	81,576	86,864	89,693	92,217	94,740	97,253
Agarak (Ashtarak dist.)	1,582	1,684	1,739	1,788	1,837	1,886
Agarak (Talin dist. Agarakavan)	925	985	1,017	1,045	1,074	1,103
Aghdzk	1,830	1,949	2,012	2,069	2,125	2,182
Akunq	598	637	658	676	695	713
Antarut	226	240	248	255	262	269
Apnagyugh	699	745	769	791	812	834
Ara	608	648	669	688	706	725
Aragats (Aparan dist.)	3,498	3,724	3,846	3,954	4,062	4,170
Aragats (Talin dist. Aragatsavan)	5,582	5,944	6,137	6,310	6,482	6,655
Areg (Tatul)	881	938	969	996	1,024	1,051
Artashavan	663	706	729	749	770	790
Arteni	3,375	3,594	3,711	3,815	3,920	4,024
Ashnak	1,124	1,197	1,236	1,270	1,305	1,340
Avan community	789	840	868	892	917	941
Avtona (Metsadzor)	100	106	110	113	116	119
Barog (Barozh, Arevut)	139	149	153	158	162	166
Baysz (Otevan)	220	234	241	248	255	262
Bazmaghbyur	960	1,023	1,056	1,086	1,115	1,145
Byurakan	4,369	4,652	4,804	4,939	5,074	5,209
Dashtadem	543	578	597	614	631	647
Davtashen	678	721	745	766	787	808
Dian	128	136	140	144	148	152
Djrambar	155	165	171	176	180	185
Dzoraglukh	321	342	353	363	373	383
Garnahovit	477	508	524	539	554	568
Geghadzor	1,199	1,277	1,318	1,355	1,392	1,429
Getap	172	183	189	195	200	205
Ghabaghtapa (Ddmasar)	124	132	136	140	144	147
Ghazaravan	445	474	489	503	517	531
Gyalto (Kanch)	128	136	140	144	148	152
Hakko	155	165	171	176	180	185
Hartavan	1,027	1,093	1,129	1,161	1,192	1,224
Hatsashen	283	301	311	320	329	337
Irind	850	905	934	961	987	1,013
Kakavadzor	1,155	1,230	1,270	1,306	1,342	1,377
Karbi	3,755	3,998	4,128	4,245	4,361	4,477
Karin	304	323	334	343	353	362
Karmrashen	532	567	585	602	618	634
Katnaghbyur	1,297	1,381	1,426	1,466	1,506	1,546
Lernarot	410	437	451	464	477	489
Lusaghbyur	0	0	0	0	0	0
Lusakn	180	192	198	204	209	215
Mastara	2,043	2,175	2,246	2,309	2,372	2,435
Mughni	762	811	837	861	885	908
Mulki (Mulqi, Kayq)	691	736	760	782	803	824
Nerqin Bazmaberd	1,477	1,573	1,624	1,669	1,715	1,761
Nerkin Sasunashen	928	988	1,020	1,049	1,078	1,106
Nigatun	0	0	0	0	0	0
Nigavan	686	731	755	776	797	818
Nor Artik	556	592	611	628	646	663
Norashen(Aparan dist., Shoghakn)	130	138	142	146	150	154
Ohanavan	2,357	2,510	2,592	2,665	2,737	2,810
Orgov	548	584	603	619	636	653
Oshakan	5,078	5,407	5,584	5,741	5,898	6,055
Parpi	2,329	2,480	2,561	2,633	2,705	2,777
Quchak (Kuchak)	2,451	2,610	2,695	2,771	2,847	2,922
Saghmosavan	232	248	256	263	270	277
Sasunik	2,258	2,405	2,483	2,553	2,623	2,692
Shenavan	1,878	2,000	2,065	2,123	2,181	2,240
Shgharshik	529	563	582	598	615	631
Sorik	125	133	137	141	145	149
Suser	394	419	433	445	457	469
Tegher	236	252	260	267	275	282
Tsaghkasar	116	123	127	131	134	138
Tsaghkashen	757	806	832	855	879	902
Tsamaqasar	445	474	489	503	517	531
Ushi	1,414	1,506	1,555	1,599	1,643	1,686
Vardenis	745	793	819	842	865	888
Vardenut	917	976	1,008	1,037	1,065	1,093
Verin Bazmaberd	488	519	536	551	566	581
Verin Sasunashen	344	367	378	389	400	410
Verin Sasunik	144	154	159	163	168	172
Vosketas	528	562	581	597	613	630
Voskevaz	4,252	4,528	4,676	4,807	4,938	5,070
Yeghipatrush	854	909	939	965	991	1,018
Yeghnik	560	596	616	633	650	667
Yerndjatap	662	705	728	748	769	789
Zarindja	622	662	684	703	723	742
Zovasar	554	590	609	626	643	660

Table 2.5-8,Cont'd

Table 2.5-8, Rural Population Projection	Low Projection 2013	High Projection				
		2015	2025	2035	2045	2055
Ararat Marz, Rural 16-50 km	150,820	160,604	165,834	170,494	175,163	179,822
Abovyan	1,374	1,463	1,511	1,553	1,596	1,638
Araksavan	872	929	959	986	1,013	1,040
Arbat	1,890	2,013	2,078	2,137	2,195	2,254
Arevabuyr	1,162	1,238	1,278	1,314	1,350	1,386
Arevshat	2,326	2,477	2,558	2,630	2,702	2,774
Argavand	1,686	1,796	1,854	1,906	1,959	2,011
Artashat v.	3,917	4,171	4,307	4,428	4,549	4,670
Aygepat	3,148	3,353	3,462	3,559	3,656	3,754
Aygestan	1,516	1,615	1,667	1,714	1,761	1,808
Aygezard	4,225	4,500	4,646	4,777	4,907	5,038
Ayntap	2,369	2,523	2,605	2,678	2,751	2,824
Azatashen	662	705	728	748	769	789
Azatavan	3,022	3,218	3,323	3,416	3,509	3,603
Baghramyan	1,933	2,058	2,125	2,185	2,245	2,304
Bardzrashen	1,585	1,687	1,742	1,791	1,840	1,889
Berdik	1,000	1,065	1,100	1,130	1,161	1,192
Berqanush	1,936	2,061	2,128	2,188	2,248	2,308
Burastan	1,961	2,089	2,157	2,217	2,278	2,339
Byuravan	1,417	1,509	1,559	1,602	1,646	1,690
Dalar	2,512	2,675	2,762	2,840	2,918	2,995
Darakert	2,499	2,661	2,747	2,824	2,902	2,979
Darbnik	1,324	1,410	1,456	1,497	1,538	1,579
Dashtavan	2,214	2,357	2,434	2,502	2,571	2,639
Deghdzut	942	1,003	1,035	1,064	1,094	1,123
Dimitrov	1,171	1,247	1,288	1,324	1,360	1,396
Ditak	713	759	784	806	828	850
Dvin	2,671	2,844	2,936	3,019	3,102	3,184
Geghanist	2,437	2,595	2,680	2,755	2,831	2,906
Getapnya	1,326	1,412	1,458	1,499	1,540	1,581
Getazat	1,910	2,034	2,100	2,159	2,218	2,277
Ghukasavan	2,334	2,486	2,567	2,639	2,711	2,783
Hayanist	2,117	2,254	2,327	2,393	2,458	2,524
Hnaberd	703	749	773	795	817	838
Hovtashat	3,475	3,700	3,821	3,928	4,036	4,143
Hovtashen	1,086	1,156	1,194	1,228	1,261	1,295
Jrahovit (Djrahovit)	1,201	1,279	1,320	1,357	1,395	1,432
Jrashen (Djrashen)	1,775	1,891	1,952	2,007	2,062	2,117
Kanachut	1,388	1,478	1,526	1,569	1,612	1,655
Khachpar	1,820	1,938	2,001	2,057	2,114	2,170
Landjazat	1,272	1,354	1,399	1,438	1,477	1,517
Marmarashen	3,319	3,535	3,650	3,753	3,855	3,958
Masis v.	1,473	1,568	1,619	1,665	1,710	1,756
Mkhchyan	4,984	5,307	5,480	5,634	5,789	5,943
Mrganush	1,262	1,344	1,388	1,427	1,466	1,505
Mrgavan	1,936	2,061	2,128	2,188	2,248	2,308
Mrgavet	2,297	2,446	2,525	2,596	2,667	2,738
Narek	1,239	1,320	1,363	1,401	1,439	1,478
Nizami	1,587	1,689	1,744	1,794	1,843	1,892
Nor Kharberd	6,235	6,640	6,856	7,049	7,242	7,434
Nor Kyurin	1,215	1,293	1,336	1,373	1,411	1,448
Norabats	2,313	2,463	2,543	2,614	2,686	2,757
Noramarg	2,126	2,263	2,337	2,403	2,469	2,534
Norashen	3,425	3,647	3,766	3,872	3,978	4,084
Nshavan	1,823	1,941	2,004	2,061	2,117	2,173
Nubarashen	8,823	9,395	9,701	9,974	10,247	10,520
Pokr Vedi	3,139	3,343	3,452	3,549	3,646	3,743
Qaghtsrashen (Kaghtsrashen)	3,102	3,303	3,411	3,507	3,602	3,698
Ranchpar	1,469	1,564	1,615	1,660	1,706	1,751
Sayat-Nova	2,176	2,317	2,393	2,460	2,527	2,595
Shahumyan	4,138	4,407	4,550	4,678	4,806	4,934
Sis	1,817	1,935	1,998	2,054	2,110	2,166
Taperakan	3,698	3,938	4,067	4,181	4,295	4,409
Vardashen	597	636	657	675	694	712
Verin Artashat	4,658	4,960	5,121	5,265	5,409	5,553
Verin Dvin	2,159	2,299	2,374	2,441	2,508	2,574
Vostan	3,010	3,205	3,310	3,403	3,496	3,589
Zorak	1,909	2,033	2,099	2,158	2,217	2,276

Table 2.5-8,Cont'd

Table 2.5-8, Rural Population Projection	Low Projection 2013	High Projection				
		2015	2025	2035	2045	2055
Armavir Marz, Rural 16-50 km	84,501	89,980	92,916	95,527	98,140	100,750
Amasia	978	1,042	1,076	1,106	1,136	1,166
Araks (Armavir dist.)	1,819	1,937	2,000	2,056	2,113	2,169
Araks (Echmiadzin dist.)	1,784	1,900	1,962	2,017	2,072	2,127
Arevadasht	347	370	382	392	403	414
Arevashat	2,090	2,226	2,298	2,363	2,427	2,492
Argina	503	536	554	569	585	600
Artamet	158	169	174	179	184	189
Aygek	1,418	1,510	1,560	1,603	1,647	1,691
Bagaran	561	597	617	634	651	669
Baghramyan(Baghramyan dist.)	1,104	1,175	1,214	1,248	1,282	1,316
Baghramyan(Echmiadzin dist.)	3,019	3,215	3,319	3,413	3,506	3,599
Berkashat	401	427	440	453	465	478
Dalarik	4,144	4,413	4,557	4,685	4,813	4,941
Gay (Gai)	3,585	3,817	3,941	4,052	4,163	4,274
Getashen	2,105	2,241	2,314	2,379	2,445	2,510
Hatsik	2,032	2,163	2,234	2,297	2,360	2,422
Haykashen	1,475	1,570	1,622	1,667	1,713	1,758
Hushakert	960	1,023	1,056	1,086	1,115	1,145
Janfida (Djanfida)	3,018	3,213	3,318	3,412	3,505	3,598
Karakert	4,645	4,946	5,107	5,251	5,395	5,538
Koghbavan	109	116	120	123	126	130
Lernagog	2,181	2,322	2,398	2,466	2,533	2,600
Margara	1,394	1,484	1,532	1,575	1,619	1,662
Merdzavan	3,060	3,259	3,365	3,460	3,554	3,649
Metsamor v.	1,151	1,226	1,266	1,302	1,337	1,373
Musaler	2,814	2,997	3,094	3,181	3,268	3,355
Myasnikyan	4,275	4,552	4,701	4,833	4,965	5,097
Nalbandyan	5,200	5,537	5,717	5,878	6,039	6,200
Nor Armavir	2,086	2,221	2,294	2,358	2,423	2,487
Nor Artages	1,474	1,569	1,621	1,666	1,712	1,757
Nor Kesaria	1,410	1,502	1,551	1,595	1,638	1,682
Norakert	3,163	3,368	3,478	3,576	3,674	3,771
Parakar	8,731	9,297	9,600	9,870	10,140	10,410
Pshatavan	2,643	2,814	2,906	2,988	3,069	3,151
Ptghunk	1,866	1,987	2,052	2,110	2,168	2,225
Shenavan	1,771	1,885	1,947	2,002	2,056	2,111
Shenik	889	947	978	1,005	1,033	1,060
Tairov	2,068	2,202	2,274	2,338	2,402	2,466
Talvorik	238	254	262	269	277	284
Vanand	1,000	1,065	1,100	1,130	1,161	1,192
Yervandashat	832	886	915	940	966	992

Table 2.5-8,Cont'd

Table 2.5-8, Rural Population Projection	Low Projection 2013	High Projection				
		2015	2025	2035	2045	2055
Kotayk Marz, Rural 16-50 km	89,970	95,806	98,933	101,712	104,494	107,272
Akunk (Akunq)	1,990	2,119	2,188	2,250	2,311	2,373
Alapars	2,346	2,498	2,580	2,652	2,725	2,797
Aragyugh	1,339	1,426	1,473	1,514	1,555	1,597
Aramus	3,696	3,936	4,064	4,179	4,293	4,407
Argel (Lusakert)	2,898	3,086	3,187	3,276	3,366	3,455
Arindj	4,985	5,308	5,481	5,636	5,790	5,944
Arzakan	2,698	2,873	2,967	3,050	3,134	3,217
Arzni	2,429	2,587	2,671	2,746	2,821	2,896
Balahovit	3,255	3,466	3,579	3,680	3,781	3,881
Buzhakan	1,788	1,904	1,966	2,022	2,077	2,132
Djraber	605	645	666	684	703	722
Dzoraghbyur	2,156	2,296	2,371	2,438	2,504	2,571
Geghadir	716	763	787	810	832	854
Geghashen	3,948	4,204	4,341	4,463	4,585	4,707
Getamech	661	704	727	747	767	788
Hatsavan	606	646	667	685	704	723
Jrvezh (Djrvezh)	6,265	6,671	6,889	7,082	7,276	7,470
Kamaris	2,453	2,612	2,697	2,773	2,849	2,925
Kanakeravan	3,664	3,901	4,028	4,142	4,255	4,368
Kaputan	1,398	1,488	1,537	1,580	1,623	1,666
Karashamb	729	776	802	824	847	869
Karenis	878	935	966	993	1,020	1,047
Kasakh	4,960	5,282	5,454	5,608	5,761	5,914
Katnaghbyur	603	642	663	682	701	719
Kotayk	2,016	2,147	2,217	2,279	2,341	2,403
Mayakovskiy	1,635	1,741	1,798	1,848	1,899	1,949
Mrgashen	2,287	2,435	2,515	2,585	2,656	2,727
Nor Artamet	1,182	1,259	1,300	1,336	1,373	1,409
Nor Geghi	5,581	5,942	6,136	6,309	6,481	6,654
Nor Gyugh	1,389	1,479	1,527	1,570	1,613	1,656
Nor Yerznka	1,557	1,658	1,712	1,760	1,808	1,856
Nurnus	528	562	581	597	613	630
Proshyan	4,712	5,018	5,181	5,327	5,473	5,618
Ptghni	1,326	1,412	1,458	1,499	1,540	1,581
Saralandj	371	395	408	419	431	442
Teghenik	633	674	696	716	735	755
Verin Ptghni	958	1,021	1,054	1,084	1,113	1,143
Voghchaberd	1,092	1,163	1,201	1,234	1,268	1,302
Zoravan	1,547	1,647	1,701	1,749	1,797	1,844
Zovk	957	1,020	1,053	1,082	1,112	1,142
Zovuni	5,133	5,465	5,644	5,802	5,961	6,119
Shirak Marz, Rural	16,894	17,988	18,576	19,097	19,619	20,141
Dzitanqov (Dzithankov)	1,557	1,658	1,712	1,760	1,808	1,856
Dzorakap	1,055	1,124	1,160	1,193	1,226	1,258
Harich	1,419	1,511	1,561	1,605	1,648	1,692
Karaberd (Qaraberd)	1,292	1,376	1,420	1,460	1,500	1,540
Lanjik	1,025	1,091	1,127	1,158	1,190	1,222
Lernakert	1,488	1,584	1,636	1,682	1,728	1,774
Nahapetavan	1,103	1,174	1,213	1,247	1,281	1,315
Pemzashen	3,479	3,704	3,825	3,933	4,040	4,148
Saralandj	1,182	1,259	1,300	1,336	1,373	1,409
Sarnaghbyur	3,294	3,507	3,622	3,723	3,825	3,927

Table 2.5-9, Projected Populations by Sectors/Segments within 50km Zone in 2055

Table 2.5-9, Projected Sector Populations within 50km Zone in 2055										
	Distance from ANPP (km)									Sector Total
Compass Sector	0 - 4	4 - 5	5.1 - 7	7.1 - 10	10.1 - 15	15.1 - 20	20.1 - 30	30.1 - 40	40.1 - 50	
N	-	-	-	-	3,143	4,294	-	-	1,429	8,866
NNE	-	-	-	1,308	3,492	2,464	6,131	9,452	13,320	36,167
NE	-	-	-	-	532	8,227	39,689	1,901	10,289	60,638
ENE	-	-	-	5,527	14,323	6,417	13,388	34,530	115,007	189,192
E	-	-	325	8,714	71,819	9,595	28,069	1,326,468	29,209	1,474,199
ESE	-	-	4,973	3,079	3,527	13,696	57,936	55,401	33,201	171,813
SE	-	-	2,411	3,266	7,899	15,181	6,462	22,211	59,131	116,561
SSE	-	-	-	1,610	4,059	1,020	5,442	7,618	-	19,749
S	-	3,907	-	4,758	-	4,921	5,442	-	-	19,028
SSW	-	-	-	3,091	6,728	7,173	40,822	42,998	-	100,812
SW	-	12,073	-	7,254	3,479	12,557	9,360	3,809	-	48,532
WSW	-	1,796	4,138	41,264	10,546	6,084	5,374	4,571	6,669	80,442
W	-	-	-	1,513	5,439	7,519	1,316	1,607	8,330	25,724
WNW	-	-	-	-	-	-	13,294	600	12,888	26,782
NW	-	-	-	771	320	-	3,694	12,548	4,747	22,080
NNW	-	-	-	-	3,189	1,103	7,412	3,013	22,760	37,477
Totals	-	17,776	11,847	82,155	138,495	100,251	243,831	1,526,727	316,980	2,438,062

Area includes territory in Turkey

Area is totally in Turkey

Table 2.5-10, Income, Poverty, and Education for Marzes in 50 km Zone

Table 2.5-10, Income, Poverty and Education in the 50 km Zone		Income Levels (% by quintile)					Percent in Poverty		Education Level (% of male/female populations)													
		Lowest	2nd	3rd	4th	Highest	Poor	Very Poor	No Education		Primary (1-3)		Middle (4-8)		HS (9-10)		Specialized Sec.		Higher Ed.		Median Yrs Sch.	
									M	F	M	F	M	F	M	F	M	F	M	F	M	F
Total Marz	~ % in 50 km																					
Aragatsotn Marz	75%	54.2	26.4	8.4	8.0	3.1	35.4	5.6	2.4	1.9	10.6	5.8	22.7	20.3	28.0	37.7	26.2	26.1	10.2	8.2	9.5	9.5
Ararat Marz	30%	27.3	38.3	21.1	10.0	3.3	32.7	6.4	1.2	1.0	8.0	8.5	29.0	23.9	41.1	36.4	12.6	22.4	8.1	7.9	9.3	9.4
Armavir Marz	100%	39.9	27.1	14.2	12.9	5.9	36.0	6.6	1.9	2.5	8.6	9.5	34.5	24.2	28.4	32.7	14.8	22.7	11.9	8.3	9.1	9.4
Kotayk Marz	25%	13.2	21.4	26.8	20.6	17.9	39.3	9.2	1.5	2.1	8.7	8.0	25.4	18.8	32.2	32.8	17.3	24.3	14.9	14.0	9.4	9.6
Shirak Marz	10%	32.6	35.5	19.7	9.2	3.0	48.8	10.4	2.2	1.9	7.8	5.9	31.6	24.2	28.0	33.4	15.0	21.6	15.4	12.9	9.2	9.5
Yerevan City	100%	0.7	6.8	20.8	30.7	41.0	29.2	6.1	0.6	1.0	7.3	4.6	17.7	13.8	24.0	22.8	17.3	24.7	33.0	33.0	10.0	11.4
Republic of Armenia Wide Total Statistics							34.6	6.4	1.3	1.6	8.6	6.6	24.4	19.0	28.5	29.7	17.3	24.1	19.9	19.0	9.5	9.8
Urban		3.6	12.9	24.2	28.7	30.7			0.8	1.1	7.5	5.3	19.9	15.6	26.4	26.1	18.6	26.0	26.8	25.9	9.8	10.5
Rural		47.1	31.8	12.9	5.9	2.3			2.1	2.5	10.2	8.8	31.7	24.7	31.9	35.9	15.2	20.8	8.8	7.4	9.1	9.4

Table 2.5-11, 2001 Ethnic Populations in RA and the 50 km Zone

Table 2.5-11, 2001 Ethnic Populations in RA and the 50 km Zone		Armenians	Assyrians	Yezeds	Greeks	Russians	Ukrainians	Kurds	Others	TOTALS
RA-Wide Statistics		3,145,354	3,409	40,620	1,176	14,660	1,633	1,519	4,640	3,213,011
Urban		2,041,622	524	7,413	853	10,489	1,386	315	3,551	2,066,153
Rural		1,103,732	2,885	33,207	323	4,171	247	1,204	1,089	1,146,858
By Marz, urban and rural	~ % in 50 km									
Aragatsotn Marz	75%	130,678	0	6,405	0	179	0	846	193	138,301
Urban		32,666	0	70	0	74	0	0	54	32,864
Rural		98,012	0	6,335	0	105	0	846	139	105,437
Ararat Marz	30%	263,357	1,926	5,940	0	418	70	0	305	272,016
Urban		79,178	94	279	0	195	30	0	109	79,885
Rural		184,179	1,832	5,661	0	223	40	0	196	192,131
Armavir Marz	100%	257,362	242	17,665	0	480	0	128	356	276,233
Urban		96,864	60	966	0	0	234	16	152	98,292
Rural		160,498	182	16,699	0	246	0	112	204	177,941
Kotayk Marz	25%	266,023	950	4,097	0	684	0	229	486	272,469
Urban		152,488	95	461	0	501	0	102	334	153,981
Rural		113,535	855	3,636	0	183	0	127	152	118,488
Shirak Marz	10%	280,594	0	974	0	1,048	222	0	551	283,389
Urban		172,535	0	258	0	868	182	0	417	174,260
Rural		108,059	0	716	0	180	40	0	134	109,129
Yerevan City	100%	1,088,389	239	4,733	308	6,684	876	0	2,259	1,103,488

Source: 2001 Census, available: http://www.armstat.am/Eng/Census/cens.htm

Table 2.5-12, Industry and Agriculture in Marzes of the 50 km Zone

Table 2.5-12, Industries and Agriculture in Marzes of the 50 km Zone			Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	RA-Wide Total Statistics
			~ % in 80 km ->	75%	30%	100%	25%	10%	100%	
2005 Industrial Output by Production Centers	Mining		Mln Dram	84.5	122.6	0.8	1,092.8	273.1	1,898.2	113,328.0
			Mln USD*	0.19	0.27	0.00	2.43	0.61	4.22	251.73
			% of RA	0.1%	0.1%	0.0%	1.0%	0.2%	1.7%	
	Manu-facturing		Mln Dram	6,604.0	41,476.6	10,582.7	35,522.3	9,846.8	269,535.6	424,361.7
			Mln USD*	14.67	92.13	23.51	78.91	21.87	598.72	942.63
			% of RA	1.6%	9.8%	2.5%	8.4%	2.3%	63.5%	
	Production / Distribution of Water & Electricity		Mln Dram	1,284.2	4,678.6	17,690.7	30,545.8	3,317.9	36,255.0	114,229.9
			Mln USD*	2.85	10.39	39.30	67.85	7.37	80.53	253.74
			% of RA	1.1%	4.1%	15.5%	26.7%	2.9%	31.7%	
2005 Gross Agricultural Production	Total Agriculture		Mln Dram	2,400	64,700	74,900	45,300	49,300	5,900	493,000
			Mln USD*	5.3	143.7	166.4	100.6	109.5	13.1	1,095.09
			% of RA	0.5%	13.1%	15.2%	9.2%	10.0%	1.2%	
	Plant Growing		Mln Dram	22,500	46,800	60,400	23,000	25,600	3,500	288,000
			Mln USD*	50.0	104.0	134.2	51.1	56.9	7.8	639.73
			% of RA	7.8%	16.3%	21.0%	8.0%	8.9%	1.2%	
	Animal Husbandry		Mln Dram	13,000	17,900	14,500	22,300	23,700	2,400	205,000
			Mln USD*	28.9	39.8	32.2	49.5	52.6	5.3	455.36
			% of RA	6.3%	8.7%	7.1%	10.9%	11.6%	1.2%	
2005 Gross Agricultural Output	Gross Harvests	Grains, Leguminous Crops	Thousand Tonnes	40.8	42.9	55.3	24.4	50.1	0.7	396.2
			% of RA	10.3%	10.8%	14.0%	6.2%	12.6%	0.2%	54.1%
		Potatoes	Thousand Tonnes	40.6	24.5	52.8	12.9	56.5	1.4	564.2
			% of RA	7.2%	4.3%	9.4%	2.3%	10.0%	0.2%	33.4%
		Vegetables	Thousand Tonnes	23.3	207.9	277.8	23.4	25.5	6.2	663.8
			% of RA	3.5%	31.3%	41.8%	3.5%	3.8%	0.9%	85.0%
		Melons	Thousand Tonnes	1.9	29.0	85.3	-	0.3	0.1	117.8
			% of RA	1.6%	24.6%	72.4%	0.0%	0.3%	0.1%	99.0%
		Fruits and Berries	Thousand Tonnes	64.0	91.9	80.0	16.2	2.5	5.7	315.6
			% of RA	20.3%	29.1%	25.3%	5.1%	0.8%	1.8%	82.5%
		Vineyards	Thousand Tonnes	10.0	65.7	72.6	0.9	3.4	2.0	164.4
			% of RA	6.1%	40.0%	44.2%	0.5%	2.1%	1.2%	94.0%
	Livestock	Cows & Cattle	Thousand Head	67.6	43.1	40.7	55.7	89.0	3.4	573.3
			% of RA	11.8%	7.5%	7.1%	9.7%	15.5%	0.6%	52.2%
		Pigs	Thousand Head	3.8	8.7	9.5	11.4	11.9	2.3	89.1
			% of RA	4.3%	9.8%	10.7%	12.8%	13.4%	2.6%	53.4%
		Sheep and Goats	Thousand Head	87.6	76.6	49.7	59.9	72.6	3.4	603.3
			% of RA	14.5%	12.7%	8.2%	9.9%	12.0%	0.6%	58.0%
		Horses	Thousand Head	0.5	0.5	0.1	0.8	0.6	-	11.9
			% of RA	4.2%	4.2%	0.8%	6.7%	5.0%	0.0%	21.0%
	Animal Products	Livestock and Poultry for Slaughter	Thousand Tonnes	10.8	8.8	10.9	10.0	13.7	0.5	99.1
			% of RA	10.9%	8.9%	11.0%	10.1%	13.8%	0.5%	55.2%
		Milk	Thousand Tonnes	68.6	44.5	38.4	61.2	88.8	3.6	594.6
			% of RA	11.5%	7.5%	6.5%	10.3%	14.9%	0.6%	51.3%
		Eggs	Millions	27.4	42.9	41.0	206.6	40.3	38.6	518.2
			% of RA	5.3%	8.3%	7.9%	39.9%	7.8%	7.4%	76.6%
		Wool	Tonnes	194.6	173.0	109.0	150.7	139.1	6.1	1306
			% of RA	14.9%	13.2%	8.3%	11.5%	10.7%	0.5%	59.2%
		*Dram/USD used:	450							

Table 2.5-13, Industries of the Marzes in the 50 km Zone

Table 2.5-13, Industries of Marzes in the 50 km Zone			Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City
			~ % in 80 km ->	75%	30%	100%	25%	10%	100%
Production of Industrial Output by Types of Economic Activity, 2005	Total industry		Mln Dram	7,972.7	46,277.8	28,274.2	67,160.8	13,437.8	307,688.8
			Mln USD	17.7	102.8	62.8	149.2	29.8	683.5
	Production and distribution of electricity, gas, hot water and steam		Mln Dram	1,085.6	3,713.0	17,297.7	29,854.6	3,103.8	31,399.4
			Mln USD	2.4	8.2	38.4	66.3	6.9	69.7
	Collection, purification and distribution of water		Mln Dram	198.6	965.6	393.0	691.0	214.2	4,855.6
			Mln USD	0.4	2.1	0.9	1.5	0.5	10.8
	Mining		Mln Dram	84.5	122.7	0.8	1,092.9	273.0	1,898.2
			Mln USD	0.2	0.3	0.0	2.4	0.6	4.2
	Manufacturing	food products (including alcoholic beverage)	Mln Dram	4,041.2	20,170.5	8,953.8	16,913.4	8,139.9	102,645.4
			Mln USD	9.0	44.8	19.9	37.6	18.1	228.0
		tobacco products	Mln Dram		7,706.7				7,301.8
			Mln USD	-	17.1	-	-	-	16.2
		textiles	Mln Dram				71.7	456.0	1,295.4
			Mln USD	-	-	-	0.2	1.0	2.9
		wearing apparel, dressing and dyeing of fur	Mln Dram		30.3		453.2	15.1	1,218.1
			Mln USD	-	0.1	-	1.0	0.0	2.7
		leather, products of leather and footwear	Mln Dram				92.7		239.8
			Mln USD	-	-	-	0.2	-	0.5
		wood and products of wood	Mln Dram		255.2		31.0		423.2
			Mln USD	-	0.6	-	0.1	-	0.9
		paper and paper board	Mln Dram		326.5				
			Mln USD	-	0.7	-	-	-	-
		publishing, poly-graphic industry and printing	Mln Dram	94.3		601.6			7,487.0
			Mln USD	0.2	-	1.3	-	-	16.6
		chem-ical industry	Mln Dram	65.2	1,180.0		322.7		13,828.8
			Mln USD	0.1	2.6	-	0.7	-	30.7
		rubber and plastics products	Mln Dram	57.0	42.3	245.5			3,748.3
			Mln USD	0.1	0.1	0.5	-	-	8.3
		other non-metallic mineral products	Mln Dram	98.9	9,536.4	172.5	8,435.3	412.9	4,595.5
			Mln USD	0.2	21.2	0.4	18.7	0.9	10.2
		metal-lurgy	Mln Dram		2,031.5		1,356.2		101,494.7
			Mln USD	-	4.5	-	3.0	-	225.4
		fabricat-ed metal products	Mln Dram			323.1	1,102.0	93.4	4,975.0
			Mln USD	-	-	0.7	2.4	0.2	11.1
		machin-ery and equip-ment	Mln Dram			62.9	2,230.1	377.8	2,846.3
			Mln USD	-	-	0.1	5.0	0.8	6.3
		radio, television and commun-ication equipment	Mln Dram	68.5					
			Mln USD	0.2	-	-	-	-	-
		medical, precision and optical instru-ments, watches and clocks	Mln Dram					96.0	
			Mln USD	-	-	-	-	0.2	-
		jewellery products	Mln Dram	2,132.0			4,123.7	255.7	6,721.9
			Mln USD	4.7	-	-	9.2	0.6	14.9
		other types of activity	Mln Dram	46.9	197.1	223.3	390.3		10,714.4
			Mln USD	0.1	0.4	0.5	0.9	0.0	23.8
		Dram/USD	450						

Table 2.5-14, Businesses within Urban centers and Marzes of the 50 km Zone

Table 2.5-14, Numbers of Businesses by Type in Urban Centers and Marzes of the 50 km Zone		ACTIVITY															TOTALS
		Agriculture	Fishing	Mining and Quarrying	Manu-facturing	Electric, gas, and Water Supply	Con-struction	Trade, Repair of Vehicles & House-hold Goods	Hotels, Rest aurants	Transport, Storage and Com-unications	Financial Inter-mediation	Real Estate Operations	Public Admin and Defence	Education	Health and Social Services	Communal, Social, & Personal Services	
Urban Center	Marz																
Urban Centers w/in 16 km		48	4	9	450	6	80	3,368	54	183	6	125	3	23	36	147	4,542
Armavir	Armavir	12	1	3	162	4	36	1,285	17	72	3	41	3	10	18	48	1,715
Metsamor	Armavir	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Vaharshapat (Eshmiadzin)	Armavir	36	3	6	288	2	44	2,083	37	111	3	84	-	13	18	99	2,827
Urban Centers 16 - 50 km	TOTAL	643	61	82	7,761	102	1,416	39,536	1,357	3,578	578	3,817	49	434	562	2,577	62,553
Yerevan	Yerevan	333	30	50	6,407	84	1,225	32,530	1,175	3,161	538	3,542	40	396	470	2,178	52,159
Aparan	Aragatsotn	60	4	1	72	2	17	411	11	43	-	14	-	3	11	19	668
Ashatarak	Aragatsotn	41	1	3	111	3	33	765	21	29	5	38	1	6	9	46	1,112
Talin	Aragatsotn	83	1	15	95	1	22	416	7	27	-	22	1	3	9	8	710
Artashat	Ararat	25	3	4	128	4	23	938	21	73	5	47	2	5	7	56	1,341
Masis	Ararat	50	18	2	455	3	30	1,661	34	102	6	39	2	2	23	88	2,515
Abovian	Kotayk	34	4	6	327	3	44	1,877	72	109	23	87	3	12	25	124	2,750
Byureghavan	Kotayk	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Charentsavan	Kotayk	17	-	1	166	2	22	938	16	34	1	28	-	7	8	58	1,298
Nor Hachin	Kotayk	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Yeghvard	Kotayk	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Maralik	Shirak	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Marzes in 80 km Zone	~% in 50 km	1,808	140	173	10,819	181	2,090	57,426	1,816	4,951	619	4,376	62	535	850	3,315	89,161
Aragatsotn Marz	75%	298	8	24	416	12	95	2,427	50	168	5	81	3	12	47	89	3,735
Ararat Marz	30%	241	33	23	1,100	27	121	5,617	103	395	17	159	4	19	65	282	8,206
Armavir Marz	100%	245	41	13	810	11	150	6,034	88	349	6	166	4	26	100	226	8,269
Kotayk Marz	25%	464	19	21	1,483	31	238	6,518	325	532	37	271	7	43	97	381	10,467
Shirak Marz	10%	227	9	42	603	16	261	4,300	75	346	16	157	4	39	71	159	6,325
Yerevan City	100%	333	30	50	6,407	84	1,225	32,530	1,175	3,161	538	3,542	40	396	470	2,178	52,159

Table 2.5-15, Employment within the Marzes of the 50 km Zone

Table 2.5-15, Employment in Marzes of the 50 km Zone			Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	RA-Wide Total Statistics
			~ % in 50 km ->	100%	30%	100%	25%	10%	100%	
2005 Employment by Sectors, average annual	Total Employed		Thousands	64.4	116.2	121.9	80.0	87.6	300.0	1097.8
			% of RA	5.9%	10.6%	11.1%	7.3%	8.0%	27.3%	70.1%
	Industry		Thousands	2.0	8.5	4.6	19.2	5.0	72.5	134.6
			% of RA	1%	6.3%	3.4%	14.3%	3.7%	53.9%	83.1%
	Agriculture and Forestry		Thousands	49.8	82.0	89.7	32.4	50.1	1.6	507.6
			% of RA	10%	16.2%	17.7%	6.4%	9.9%	0.3%	60.2%
	Construction		Thousands	0.3	2.0	2.3	1.4	2.3	18.8	34.6
			% of RA	1%	5.8%	6.6%	4.0%	6.6%	54.3%	78.3%
	Services	Total Services	Thousands	12.3	23.7	25.4	27.0	30.2	207.1	421
			% of RA	3%	5.6%	6.0%	6.4%	7.2%	49.2%	77.4%
		Transport and Communications	Thousands	0.9	1.9	1.8	2.5	3.5	31.0	49.7
			% of RA	2%	3.8%	3.6%	5.0%	7.0%	62.4%	83.7%
		Trade	Thousands	2.7	7.1	8.6	8.9	8.0	47.6	108.9
			% of RA	2%	6.5%	7.9%	8.2%	7.3%	43.7%	76.1%
		Social Sphere[1]	Thousands	5.6	9.8	10.5	10.1	13.4	80.9	169.6
			% of RA	3%	5.8%	6.2%	6.0%	7.9%	47.7%	76.8%
		Government Staff	Thousands	1.5	1.9	1.5	1.5	2.3	11.9	28.2
			% of RA	5%	6.7%	5.3%	5.3%	8.2%	42.2%	73.0%
		Other	Thousands	1.6	3.0	3.0	3.9	3.1	35.7	64.6
			% of RA	2%	4.6%	4.6%	6.0%	4.8%	55.3%	77.9%
Average Nominal Monthly Wages/Salaries of Employees			Dram	39,295	46,945	50,999	55,053	41,222	57,414	47,039
			USD*	$ 87.29	$ 104.28	$ 113.28	$ 122.29	$ 91.57	$ 127.53	$ 104.49
Distribution of Labor Resources	Total Resources[2]		Thousands	92.7	166.5	177.3	164.8	204.4	666.5	2072.4
			% of RA	4.5%	8.0%	8.6%	8.0%	9.9%	32.2%	100%
	Economically Active[3]	Employed	Thousands	64.4	116.2	121.9	80.0	87.6	300.0	1097.8
			% of RA	5.9%	10.6%	11.1%	7.3%	8.0%	27.3%	100%
		Unemployed	Thousands	1.3	3.3	3.9	5.0	19.4	24.5	98
			% of RA	1.3%	3.4%	4.0%	5.1%	19.8%	25.0%	100%
	Economically Not-Active[4]		Thousands	26.9	47.0	51.5	79.8	97.4	342.1	876.6
			% of RA	3.1%	5.4%	5.9%	9.1%	11.1%	39.0%	100%

* Dram/USD used 450

[1] Healthcare, physical training and social insurance, education, culture and art
[2] Excluding small and medium-sized economic entities
[3] Number of employees in religious organizations is not distributed by Marzes
[4] Students, retired, disabled, etc.

Table 2.5-16, Housing Data for the Marzes of the 50 km Zone

Table 2.5-16, Housing Statistics in Marzes of the 50 km Zone			Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	Total RA
			~ % in 50 km ->	75%	30%	100%	25%	10%	100%	
Number of Dwellings, as of 1/1/2006			Number	1,041	110	3,599	36,895	19,708	221,948	326,464
			% of RA	0.32%	0.03%	1.10%	11.30%	6.04%	67.99%	86.78%
Housing Area, as of 1/1/2006	Housing Stock	Housing, thousand m^2	Total	4,267.6	7,284.9	6,739.9	6,294.4	7,655.0	20,463.0	74,359.5
			% of RA	5.74%	9.80%	9.06%	8.46%	10.29%	27.52%	70.88%
			Urban	1,122.6	1,404.6	2,666.4	3,315.9	3,213.0	20,463.0	42,687.1
			Rural	3,145.0	5,880.3	4,073.5	2,978.5	4,442.0	0.0	31,672.4
		Living Area per Inhabit-ant, m^2	Urban	34.1	17.4	26.9	21.5	18.7	18.5	20.7
			Rural	29.6	30.4	22.7	24.8	40.4	-	27.4
	Dormitory Stock	Dormitories, m^2	Total	7,780	14,643	41,185	12,020	28,175	123,621	293,570
			% of RA	2.65%	4.99%	14.03%	4.09%	9.60%	42.11%	77.47%
			Urban	6,480	7,453	41,185	11,742	28,175	123,621	273,672
			Rural	1,300	7,190	-	278	-	-	19,898
Housing in Urban Areas, 1/1/2006	Dwelling Houses	Houses	Units	5,937	5,899	8,961	5,973	12,742	38,423	123,159
		Area	Thousand m^2	849.6	680.8	1,780.4	1,170.9	1,514.1	6,489.3	18,034
	Apart-ments	Apartments	Units	4,787	13,402	15,031	37,470	23,977	210,036	385,797
		Area	Thousand m^2	273.0	715.5	878.6	2,113.3	1,687.1	13,850.1	24,390
Housing in Rural Areas, 1/1/2006	Dwelling Houses	Houses	Units	37,967	27,401	34,904	22,848	13,067	23,773	234,267
		Area	Thousand m^2	5,678.1	3,507.0	3,819.7	4,225.7	1,415.2	2,984.8	29,489
	Apart-ments	Apartments	Units	2,979	8,089	573	2,644	1,588	2,482	28,891
		Area	Thousand m^2	200.8	553.4	38.6	213.9	121.4	160.2	2,100
Completed Transactions (2005)	Purchase and Sale Transactions	Tenement Buildings, Units	Total	164	428	520	1,377	515	9,175	12,179
			1st Half	63	188	239	620	228	4,401	6,744
			2nd Half	101	240	281	757	287	4,774	7,489
		Detachced Houses, Units	Total	309	761	623	595	382	1,306	3,976
			1st Half	121	354	268	258	176	598	2,260
			2nd Half	188	407	355	337	206	708	2,819

Table 2.5-17, Health and Educational Facilities in the Marzes of the 50 km Zone

Table 2.5-17, Health and Educational Facilities in Marzes of the 80 km Zone			Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	Total RA
			~ % in 50 km ->	75%	30%	100%	25%	10%	100%	
Main Indicators on Public Health, 2005	Doctors[1]		Persons	231	440	414	575	576	8,366	12,307
			% of RA	1.88%	3.58%	3.36%	4.67%	4.68%	67.98%	86.1%
	Paramedical Personnel[2]		Persons	748	1,064	1,145	1,338	1,714	8,006	18,364
			% of RA	4.07%	5.79%	6.24%	7.29%	9.33%	43.60%	76.3%
	Hospital Beds		Units	468	830	632	935	1,039	7,435	14,353
			% of RA	3.26%	5.78%	4.40%	6.51%	7.24%	51.80%	79.0%
Main Indicators per 10,000 population, 2005	Doctors		# / 10,000	16.6	16.0	14.8	20.9	20.5	75.8	38.2
	Paramedical Personnel		# / 10,000	53.6	38.8	41.0	48.6	60.9	72.5	57
	Hospital Beds		# / 10,000	33.5	30.3	22.6	34.0	36.9	67.4	44.6
	Outpatient Institutions		# / 10,000	1.9	2.2	2.1	1.6	1.2	0.9	1.4
Educational Institutions 2005-2006 Academic Year	Pre-schools	Establishments	Units	25	65	52	50	45	175	623
		Children	Persons	782	3,679	3,312	3,326	3,378	21,530	47,791
		Teachers	Persons	97	419	373	463	356	2,081	5,060
		Attendants per school	Persons	31	57	64	67	75	123	77
		Children/Teacher	Child/Teacher	8.1	8.8	8.9	7.2	9.5	10.3	9.4
	General Education Schools	Number of Schools	Units	127	114	123	107	172	233	1,427
		Pupils	Persons	25,356	43,831	45,025	41,398	46,909	135,283	471,316
		Teachers	Persons	2,838	3,272	3,565	3,313	4,549	11,193	41,721
		Pupils/Teacher	Pupil/Tcher	8.9	13.4	12.6	12.5	10.3	12.1	11.3
		Teachers/School	Tchers/Sch	22.3	28.7	29.0	31.0	26.4	48.0	29.2
	Music, Art and Fine Art Schools	Number of Schools	Units	11	20	17	20	25	37	212
		Pupils	Persons	846	2,878	1,528	2,863	3,377	14,418	35,192
	State Specialized Secondary	Establishments	Units	-	4	5	6	10	27	83
		Students	Persons	-	1,288	1,863	1,109	3,073	12,355	27,837
		Teachers	Persons	-	121	250	184	461	1,652	3,741
		Students/Teacher	Student/Tchr	-	10.6	7.5	6.0	6.7	7.5	7.4
	Non-State Specialized Secondary	Establishments	Units	1	2	2	0	2	13	28
		Students	Persons	15	106	63	0	209	2,135	2,981
		Teachers	Persons	4	46	29	0	24	291	472
		Students/Teacher	Student/Tchr	3.8	2.3	2.2	0.0	8.7	7.3	6.3
	Non-State Higher Education	Establishments	Units	-	1	3	2	2	49	67
		Students	Persons	-	237	873	347	755	20,465	24,049
		Lecturers	Persons	-	40	70	47	96	2,420	3,018
		Students/Lecturer	Student/Lctrr	-	5.9	12.5	7.4	7.9	8.5	8.0
	State Higher Education	Establishments	Units	-	-	-	-	1	19	22
		Branches	Units	-	-	-	-	5	-	11
		Students	Persons	-	-	-	-	5,899	58,023	73,716
		Teaching Staff	Persons	-	-	-	-	591	8335	9,763
		Students/Staff	Student/staff	-	-	-	-	10.0	7.0	7.6

[1]Includes Dentists of Private Dentistry Clinics
[2]Includes Paramedical Personnel of Private Dentistry Clinics

Table 2.5-18, Capacity and Utilization of Schools and Hospitals

Table 2.5-18, Capacity and Utilization Factors for Schools and Hospitals of Marzes and Communities of the 50 km Zone		Pre-schools, 2006				General Education Schools, 2006				Hospitals, 2006				
		Number of Preschools	Capacities, Seats	Number of Children	% Capacity Used	Number of Schools	Capacity, seats	Seats filled	% Capacity Used	Number of Beds	Number of Accepted Patients	Average bed-days per patient	Average Annual Occupation of Bed, days	Average Annual % of Bed Occupancy
Marzes in 50 km Zone	~% in 50 km													
Yerevan City	100%	194	31,495	22,078	70%	262	188,470	136,990	72.7%	7,393	172,976	9.2	215	58.9%
Aragatsotn Marz	75%	23	1,087	1,471	135%	127	37,316	24,700	66.2%	468	5,093	5.4	59	16.2%
Ararat Marz	30%	72	6,680	3,725	55.8%	112	64,450	42,205	65.5%	805	11,625	9.4	135	37.0%
Armavir Marz	100%	49	5,030	3,369	67.0%	124	70,308	44,717	63.6%	632	10,008	6.3	100	27.4%
Kotayk Marz	25%	50	4,406	2,529	57.4%	111	69,996	41,283	59.0%	935	12,040	11.2	144	39.5%
Shirak Marz	10%	45	3,732	3,271	87.6%	177	55,325	46,459	84.0%	1,034	18,413	9.3	166	45.5%
Total RA		839	99,913	70,093	70.2%	989	434,850	277,474	63.8%	14,276	269,546	9.4	178	48.8%
Urban Center	Marz													
Urban Centers w/in 16 km														
Armavir	**Armavir**					**14**	**12,160**	**6,458**	**53.1%**	**200**	**3,618**	**5.8**	**104**	**28.5%**
Metsamor	**Armavir**					**3**	**2,498**	**1,665**	**66.7%**	**90**	**1,793**	**6.6**	**131**	**35.9%**
Vaharshapat (Echmiadzin)	**Armavir**					**18**	**12,212**	**8,790**	**72.0%**	**325**	**4,366**	**6.7**	**90**	**24.7%**
Urban Centers/Communities 16 - 50 km														
Yerevan	Yerevan					262	188,470	136,990	72.7%	7,393	172,976	9.2	215	58.9%
Ashatarak	Aragatsotn					8	4,553	3,435	75.4%	190	2,036	5.0	54	14.8%
Aparan	Aragatsotn					4	2,115	1,092	51.6%	123	1,179	6.1	58	15.9%
Talin	Aragatsotn					4	1,838	1,018	55.4%	115	1,360	5.4	64	17.5%
Artashat	Ararat					6	6,564	3,520	53.6%	285	3,967	8.0	112	30.7%
Masis	Ararat					6	3,326	2,682	80.6%	220	3,777	7.5	129	35.3%
Baghramyan	Armavir					1	1,709	1,464	85.7%	17	231	5.1	69	18.9%
Abovian (Kotayk)	Kotayk					11	10,899	7,014	64.4%	640	6,503	15.3	156	42.7%
Byureghavan	Kotayk					3	1,909	1,161	60.8%					
Nor Hachin	Kotayk					4	3,700	1,735	46.9%					
Yeghvard (Nairi)	Kotayk					4	2,726	1,932	70.9%	65	1,160	7.3	131	35.9%
Charentsavan	Kotayk					7	6,535	3,392	51.9%	60	1,334	6.1	135	37.0%
Maralik	Shirak					2	1,030	739	71.7%					

Some schools report zero capacity, values estimated

No data or data not broken down by community

Table 2.5-19, Household Water and Sanitation in the 50 km Zone

Table 2.5-19, Water and Sanitation in Marzes of the 50 km Zone				Total RA	Total RA Urban	Total RA Rural	De Jure Population
Household Drinking Water, 2005	Improved	Piped into Dwelling	Percent of Population	75.0	93.6	38.8	73.0
		Piped Into Yard/Plot		14.8	3.8	36.2	16.1
	Non-Improved	Tanker Truck		2.1	0.0	6.1	2.4
		Other Unprotected		0.2	0.1	0.4	0.3
	Other/Missing			0.6	0.5	0.7	0.5
Household Sanitation Facility, 2005	Improved	Flush/pour Flush to Piped Sewer	Percent of Population	66.7	92.1	17.3	64.1
		Flush/pour Flush to Septic Tank		0.3	0.3	0.3	0.3
		Flush/pour flush to pit latrine		3.1	1.0	7.1	3.6
		Ventilated Improved Pit Latrine		18.0	2.9	47.2	19.3
		Pit Latrine with Slab		3.0	0.6	7.5	3.1
	Not Improved	Any Facility Shared w/ other Households	Percent of Population	2.1	1.6	3.1	1.9
		Flush/pour flush not to sewer, septic tank or pit latrine		0.4	0.5	0.2	0.3
		Pit latrine without slab/open pit		6.1	0.5	17.0	7.1
		Bucket		0.1	0.2	0.1	0.1
		No facility/bush/field		0.1	0.1	0.0	0.1
		Other/missing		0.1	0.2	0.1	0.1
Water Consumption for Purpose, 2005	Household and drinking purposes		Million m^3				
	Industrial Purposes						
	Irrigation						
	Agricultural Purposes						
Waste Water Discharge, 2005	Total		Million m^3				
	Polluted	Total Polluted					
		Without Purification					
		Insufficiently Purified					
	Pure according to Standards						
	Purified according to Standards						

Marz ->		Aragatsotn Marz			Ararat Marz			Armavir Marz			Kotayk Marz			Shirak Marz			Yerevan City	Total RA		
~ % in 50 km ~>		75%			30%			100%			25%			10%			100%			
		Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Urban	Total	Urban	Rural
Household Drinking Water, 2005	Centralized	95.8	100.0	94.4	94.8	91.3	96.3	75.4	96.8	63.6	97.1	99.3	94.5	98.8	99.4	97.8	99.9	90.8	97.9	78.7
	Well/Spring	4.2		5.6	3.8	5.5	3.1	12.8	3.0	18.2	2.9	0.7	5.5	1.2	0.6	2.1		4.3	1.7	9.0
	Private System							1.0		1.5								3.1	0.0	8.5
	Collected Water				1.4	3.2	0.6	10.8	0.2	16.7						0.1		1.6	0.3	3.8
	Other																0.1	0.1	0.1	0.0
Sanitation Facilities, 2005	Flush Toilet, functional	19.5	77.6	0.8	32.0	75.6	13.1	34.5	77.7	10.6	68.2	94.0	36.7	62.6	89.5	20.9	96.9	63.9	89.8	19.0
	Flush Toilet, non-functional				2.3	6.5	0.6	1.2	2.4	0.5	0.5	0.0	1.0	0.3	0.0	0.7	0.1	0.8	0.5	1.2
	Outside Toilet	82.6	30.9	99.2	78.4	34.3	97.6	71.0	37.6	89.4	40.9	6.5	82.8	43.7	10.6	95.2	4.8	41.8	13.5	90.7
Water Consumption for Purpose, 2005	Household and drinking purposes	1.3			2.1			3.5			5.0			8.3			37.3	69.4		
	Industrial Purposes	0.1			1.7			28.4			5.7			0.4			27.3	70.4		
	Irrigation	197.5			162.5			635.0			57.2			49.8			21.3	1137.8		
	Agricultural Purposes	0.8			31.8			93.8			2.3			4.8			4.7	226.9		
Waste Water Discharge, 2005	Total	1.2			14.7			93.6			8.0			10.0			101.8	339.6		
	Total Polluted	0.8			2.7			1.0			1.5			8.8			26.1	102.2		
	Without Purification	0.7			2.7			1.0			1.5			8.8			26.0	101.9		
	Insufficiently Purified	0.1			-			-			0.0			0.0			0.1	0.3		
	Pure according to Standards	-			11.9			90.5			0.7			-			6.8	156.7		
	Purified according to Standards	0.4			0.1			2.1			5.8			1.2			68.9	80.7		

Table 2.5-20, Transportation and Roads in the Marzes of the 50 km Zone

Table 2.5-20, Transportation and Roads in Marzes of the 50 km Zone		Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	Total RA
		~ % in 50 km ->	75%	30%	100%	25%	10%	100%	
Main Indicators of Road Transport, 2005	Freight Transported	Thousand Tonnes	156.3	2,059.8	158.8	864.6	261.4	2,700.3	26,086.0
	Freight Turnover	Million Tonne-km	4.1	12.2	4.1	16.3	4.4	98.4	231.3
	Passengers Transported	Thousand People	602.8	1,705.0	2,557.5	3,598.4	1,345.2	122,910.0	139,526.6
	Passenger Turnover	Million Person-km	14.1	54.6	78.0	63.8	30.1	1,232.1	1,600.7
Total Length of Run of RA Road Transport, 2005	Trucks	Thousand Tonnes	2,146.7	4,759.8	873.3	6,266.4	1,992.4	53,023.5	89,363.3
	Passenger Buses (Microbuses)	Thousand Tonnes	921.9	2,239.7	4,172.9	7,037.7	3,617.3	175,474.4	206,917.9
	Passenger Cars	Thousand Tonnes	2,472.5	5,292.7	1,266.0	6,620.9	3,479.0	110,340.7	144,179.7
	Special Cars	Thousand Tonnes	300.4	1,014.8	104.7	901.9	606.3	14,212.0	20,758.0
Intra-Republican Road Transport, 2005	Volume of Freight Transport	Thousand Tonnes	130.8	149.0	164.3	529.4	403.0	487.6	3,667.6
	Volume of Passenger Transport	Thousand People	1,024.3	3,215.0	4,033.4	5,965.1	6,509.6	150,198.9	181,792.3
	Volume of Freight Turnover	Million Tonne-km	1.5	3.5	3.7	8.4	3.8	18.3	48.6
	Volume of Passenger Turnover	Million Person-km	22.9	65.6	81.7	107.6	141.5	1,494.1	2,131.3

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2 Aragatsotn Marz								
2.17 v. Aragatsotn								
1				Citadel	2-1 millennium B.C.	1 km to the north-west	National	On the canyon's right hill
	1.1			Tower	2-1 millennium B.C.		National	
	1.2			Graveyard	2-1 millennium B.C.		National	
2				Citadel "Kyor oghlu berd"	17-18 century	8km to the south-west	National	On the homonymous hill
3				Tower	2 millennium B.C.	1.5km to the south-west	National	Near the high voltage pole
4				Tower	2 -1 millennium B.C.	3.5km to the south-west	National	1km to the north from the stone-mining
5				Settlement	2 -1 millennium B.C.	In the north-west part	National	Edge of the village, south-east part of the citadel located on the right-side hill of canyon
6				Settlement	2 -1 millennium B.C.	3km to the south-west	National	1km to the north from the stone-mining
	6.1			Tower	2 -1 millennium B.C.		National	On the south hill
7				Settlement	2 -1 millennium B.C.	2km to the north	National	300m left from the Ashtarak-Talin highway, "Kosha saler"
	7.1			Graveyard	2 -1 millennium B.C.		National	Northern end of the settlement
2.22. v. Aruch								
1				Citadel	5 - 17 Century	inside the village	National	
	1.1			Stronghold	5 - 17 Century		National	
2				Citadel "Dzori berd"	3 millennium B.C.	1km west	National	At Shamiramdzor
	2.1			Graveyard	3 - 1 millennium B.C.		National	North-west from the citadel
3				Countryside	Middle Ages	1-1.5km to the north	Local	left from the Ashtarak-Talin highway, to the right from seraglio
4				Charnel House "Aruchi Mets"	2 millennium B.C.	1km to the north	National	To the right from Arzni-Shamiram canal
5				Charnel House	15-16 Century	3,5 km to the south	National	
6				Graveyard	End of 2 millennium B.C., Beginning of 1 millenium B.C.	to the south	National	Edge of the village
7				Castle	10 - 14 Century	1km to the north	National	Edge of the Sruch-Talin highway, 0.5 km south to the charnel house, dilapidated

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2.22. v. Aruch								
8				Monastery complex name of St. Grigor /Aruchi Katoghike/	5 - 7 Century	in the eastern part	National	Edge of the village
	8.1			Church	5 - 7 Century		National	50 m south – west from Katoghike, crumble
	8.2			Church St. Grigor (Katoghike)	7 Century		National	Chartered Grigor Mamikonyan
		8.2.1		Obelisk	5 - 7 Century		National	Inside the church, crumble
		8.2.2		Obelisk	5 - 7 Century		National	Inside the church, crumble
		8.2.3		Obelisk	7 Century		National	Inside the church, dilapidated
		8.2.4		Cross-stone (khachqar)	9 - 10 Century		National	Inside for the Katoghike, nether-right corner crumble
		8.2.5		Cross-stone (khachqar)	Year 973			on the north wall
	8.3			Palace	7 Century		National	crumble
	8.4			Cemetery	7 - 20 Century		National	round the monastery complex
		8.4.1		Obelisk	5 - 7 Century		National	The north of monastery
		8.4.2		Obelisk	7 Century		National	The north of monastery
9				Monastery name of St. "Astvatsatsin"	19 Century	inside the village	Local	dilapidated
	9.1			Cross-stone (khachqar)	13 Century		National	Under the south wall
10				Cross-stone (khachqar)	10-11 Centuries	inside the village	National	in the yard of house Rafik Harutyunyan
11				Cross-stone (khachqar)	11 Century	inside the village	National	in the place of "Vani bagher"
12				Cross-stone (khachqar)	12 Century	inside the village	National	near house of Adik Vasilyan in "Aghbri dzor", broken
13				Cross-stone (khachqar)	12 - 13 Century	inside the village	National	In fence of Levon Makaryan's house
14				Cross-stone (khachqar) "Sahmanakhach"	12 - 13 Centuries	in the eastern part	National	
15				Obelisk	7 Century	in the eastern part	National	In the active cemetery
16				Caravan-serai	13 Century	1.5 km of north	National	left from the, Yerevan- Gjumri highway

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2.61 v. Kosh								
1				Citadel "Berd"	2 millennium B.C.	1 km to the north	National	Place on "Paruiri lchak" on the top of hill
	1.1			Graveyard	2 millennium B.C.		National	located at the plateau, north part of the citadel
2				Citadel "Qarhanqi berd"	3 millennium B.C.-3 century	2km east	National	right from the Yerevan-Gyumri highway, opposite to Kosh career hill
	2.1			Settlement	1 - 3 Centuries		National	northern of the citadel
	2.2.			Graveyard	2 millennium B.C.-3 century		National	maintained in 2 parts
3				Tower	2 millennium B.C.	1km to the north	National	300 m to the north from citadel "Berd"
4				Tower	2-1 millennium B.C.	1km to the north	National	800m to the north-east from citadel "Berd"
5				Tower	2-1 millennium B.C.	1km to the north	National	in place "Paruiri lchak"
6				Tower	2-1 millennium B.C.	2km to the south-west	National	eastern of the "Qarhanqi Berd"
7				Tower	2-1 millennium B.C.	1km to the north	National	in place "Paruiri lchak" 1 km south-east from citadel "Berd"
8				Tower	2-1 millennium B.C.	1km to the north	National	in place "Paruiri lcjak" 800m north-east from citadel "Berd"
9				Settlement "Kuash"	1 millennium B.C.-17 century	To the north	National	
	9.1			Citadel "Agjka berd"	13-14 centuries		Local	south–east from settlement
	9.2			Cross-stone (khachqar)	12 - 13 centuries		National	fetch up on ground
	9.3			Cross-stone (khachqar)	13 - 13 centuries		National	prang down in ground
10				Cemetery	12-20 Centuries	To the north	Local	Edge of the village
	10.1			Monastery St. Gevorg	Year 1891		Local	
	10.2			Monastery St. Grigor Lusavorich	13-14 Centuries		Local	
	10.3			Oil-tritman	18 -19 Centuries		Local	to the right from St. Gevorg monastery
	10.4			Cross-stone (khachqar)	12 - 13 Centuries		National	20m south from the St. Gevorg monastery
	10.5			Cross-stone (khachqar)	12 - 13 Centuries		National	70m south from the St. Grigor Lusavorich monastery
	10.6			Cross-stone (khachqar)	12 - 13 Centuries		National	north-west from the St. Grirog Lusavorich monastery
	10.7			Cross-stone (khachqar)	12 - 13 Centuries		National	fetch up on the Gross Pedestal
	10.8			Cross-stone (khachqar)	12 - 13 Centuries		National	south-west from the St. Grigor Lusavorich monastery
	10.9			Cross-stone (khachqar) "Tevavor Xach"	13 Century		National	
	10.10			Cross-stone (khachqar)	14 -15 Centuries		National	20 m south from St. Gevorg in the new billed oratory
	10.11			Cross-stone (khachqar)	15 -16 Centuries		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2.61 v. Kosh								
	10.12			Cross-stone (khachqar)	15 -16 Centuries		National	west from the St. Gevorg
	10.13			Cross-stone (khachqar)	15 -16 Centuries		National	west from the St. "Grigor Lusavorich"
	10.14			Cross-stone (khachqar)	Year 1564		National	
11				Monastery St. Stephanos	7-17 Centuries	1km to the north	National	On the right to canyon's rim
	11.1			Cemetery	11 - 16 Centuries		Local	On the left to monastery
		11.1.1		Cross-stone (khachqar)	9 Century		National	10 m to the right from reservoir
		11.1.2		Cross-stone (khachqar)	12 - 13 Centuries		National	
		11.1.3		Cross-stone (khachqar)	13 Century		National	
		11.1.4		Cross-stone (khachqar)	13 Century		National	near to western fence of the monastery
		11.1.5		Cross-stone (khachqar) "Tadevosi"	Year 1224		National	
		11.1.6		Cross-stone (khachqar)	13-14 Centuries		National	
		11.1.7		Cross-stone (khachqar)	14-15 Centuries		National	
		11.1.8		Cross-stone (khachqar)	14-15 Centuries		National	
		11.1.9		Cross-stone (khachqar)	15-16 Centuries		National	
		11.1.10		Cross-stone (khachqar)	15-16 Centuries		National	
		11.1.11		Cross-stone (khachqar)	16 Century		National	
		11.1.12		Memorial "Aghabab"	15-16 Centuries		National	
	11.2			Oratory	14-15 Centuries		Local	
	11.3			Oratory "Kapuyt Khach	10 Century		Local	
	11.4			Reservoir	10 Century		National	
12				Cross-stone (Khachqar)	Year 1195	0.5 km to the north-east	Local	
13				Memorial fountain St. Vardan	19 Century	In the north-east part	Local	
14				Monument to the Victims of WW II	Year 1978	South part	Local	
15				Memorial fountain complex	13-14 Centuries	1 km to the north	Local	
16				Cave-Dwelling	Middle Ages	1.5 km to the north	Local	
17				Cave-Dwelling	Middle Ages	1.5 km to the north	Local	
2.81 v. Shamiram								
1				City place "Shamiram"	2-1 millennium B.C.	to the south-west part	National	Edge of the village on the ness
	1.1			Stronghold	1 millennium B.C.		National	On the south-east from the edge of the ness
		1.1.1		Castle	1 millennium B.C.		National	On the east edge
	1.2			Graveyard	2-1 millennium B.C.	1km north-east	National	
	1.3			Graveyard	2-1 millennium B.C.	south and south-east parts	National	Basic Graveyard to the south of gorge.
		1.3.1		Credence	2-1 millennium B.C.		National	
		1.3.2		Menhir	2-1 millennium B.C.		National	0.5 km to the north from the village

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2.81 v. Shamiram								
	1.4			Graveyard "Mets Kurganner"	Half of 2 millennium B.C.	north part	National	
		1.4.1		Charnel House "Mets Kurgan"	Half of 2 millennium B.C.		National	North from the village
	1.5			Towers complex	2 millennium B.C.	1 km to the north	National	
		1.5.1		Tower	2 millennium B.C.	2.5 km to the north	National	
		1.5.2		Tower	2 millennium B.C.	1 km to the north	National	199 m north-east from the highway Shamiram-Aruch
		1.5.3		Tower	2 millennium B.C.	1 km south-east	National	
		1.5.4		Tower	2 millennium B.C.	0.5 km south	National	
	1.6			Fence	2 -1 millennium B.C.	south-east part	National	
	1.7			Impoundment			National	
2.86 v. Voskehat								
1				Citadel (Church St. Sargis)	17-19 centuries	Eastern part	Local	
	1.2			Cross-stone (khachqar)	10-11 centuries		National	
2				Tower	2-1 millennium B.C.	1 km to the north-east	National	
3				Tower	2-1 millennium B.C.	1 km to the north-east	National	
4				Tower	2-1 millennium B.C.	1 km to the north-east	National	
5				Settlement	2 millennium B.C. – 18 centuries	0.5 km to the north-east	National	
	5.1			Cave-Dwelling	2 millennium B.C.		National	
	5.2			Former village	10-18 centuries		Local	
6				Settlement	2-1 millennium B.C.	1 km to the south-east	National	
	6.1			Graveyard	2-1 millennium B.C.		National	
7				Cave-Dwelling "Chgnavori Ajr"	12-13 centuries	1 km north-east	Local	
2.87 v. Voskevaz								
1				Citadel Complex "Akhtamir"	3 millennium B.C. – 9-19 centuries	2.5 km to the south	National	
	1.1			Settlement Akhtamir	Half of 3 millennium B.C.-3-1 centuries, 9-13 centuries		National	
	1.2.			Graveyard	2-1 millennium B.C.		National	
	1.3.			Cemetery	16-17 centuries		Local	
	1.4			Cave-Dwelling complex	3 millenium-15 century B.C.	2.5 km to the south-east	National	
2				Residential house	Year 1901	2 Abovyan str.	Local	
3				Residential house	Year 1900	2a Abovyan str.	Local	
4				Residential house	Year 1900	3 Abovyan str.	Local	
5				Residential house	Year 1901	4 Abovyan str.	Local	
6				Residential house	Year 1900	1 Arayi str.	Local	
7				Residential house	Year 1907	11 Araratyan str.	Local	
8				Residential house	18 Century	Hoktemberyan str	Local	
9				Residential house	End of 19 Century	7 hoktemberyan str.	Local	
10				Residential house	Year 1911	1, 2 Myasnikyan str.	Local	
11				Residential house	Year 1906	24 Myasnikyan str.	Local	
12				Residential house	Year 1900	Inside the village	Local	
13				Residential house	Year 1901	Inside the village	Local	
14				Residential house	Year 1910	Inside the village	Local	
15				Residential house	Year 1914	Inside the village	Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
2.87 v. Voskevaz								
16				Residential house	Year 1914	Inside the village	Local	
17				Residential house	Year 1925	Inside the village	Local	
18				Cemetery	19-20 centuries	Northern part	Local	
19				Castle	17-18 centuries	2 km to the south	National	
20				Church "Badali Jam"	4-5 centuries	2 km south-west	National	
	20.1.			Auxiliary building	4-5 centuries		National	
	20.2.			Vine press	19 century		Local	
21				Church St. Hovhannes	7-13 centuries	Inside the village	National	
22				Altar	2 millennium B.C.	2 km south-west	National	
23				Bridge	17 century	south-east part	Local	
24				Memorial fountain	Year 1962	Inside the village	Local	
25				Monument to the Victims of WW II	1981-1982	Inside the village	Local	
26				Dragon stone	2 millennium B.C.	2 km south-west	National	
27				Cave dwelling	2 millennium B.C.	1.5 km to the south	National	
2.109 v. Ujan								
1				Citadel (Zorakayan)	3-1 millennium B.C.- 15 century	2.5 km to the north	National	
	1.1			Settlement	1 millennium B.C.-1 century		National	To the north from the citadel
2				Citadel "Baroj"	9-13 century	to the north part	Local	
3				Citadel "Bqoyi Gegh"	1 millennium B.C., 10-20 century	1 km to the north	National	
	3.1.			Graveyard	2-1 millennium B.C.		National	To the east part former village
	3.2.			Former village "Bqoyi Gegh"	10-20 century		Local	
		3.2.1		Church	10-12 cent.		Local	
		3.2.2		Church	17-18 cent.		Local	
		3.2.3		Cemetery	12-16 cent.		Local	
			3.2.3.1	Obelisk	5-7 cent.		National	
4				Citadel "Motkan Berd"	3 millennium B.C.	0.5 km to the north-east	National	Called "Smbataberd"
	4.1.			Graveyard	15 century 2-1 millennium B.C.		National	To the north and north-east part of the citadel
5				Tower	2 millennium B.C.	1 km to the north	National	
6				Tower	2 millennium B.C.	0.7 km to the north-east		200 m of the citadel "Motkan Berd"
7				Tower	2 millennium B.C.	1.5 km to the north	National	800 m of the citadel "Bqoyi Gegh"
8				Castle	9-13 cent.	to the north part	Local	
9				Statue of "Zoravar Andranik"	Year 1967	inside the village	Local	
10				Monument of "Hay Haydukner"	Year 1969	inside the village	Local	
11				Oratory	10-19 century	inside the village	Local	
12				Oratory	16-17 century	0.5 km to the west	Local	
	12.1			Obelisk	5-7 century		National	
13				Cave-Dwelling Complex	13-18 century	1.5-3 km to the north	Local	
	13.1			Cave-Dwelling St. Ghazari	13-18 century		Local	
	13.2			Cave-Dwelling "Yot Drnani"	13-18 cent.		Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3. Armavir District								
3.1 t. Armavir								
1				Monument to the Victims of WW II		In the town (hereafter in m^2)	Local	City Park
2				Home of Culture	1955	M^2	Local	Part of the ensemble of the main town square. Architect: R. Alaverdyan
3.2 t. Vagharshapat								
1				Residential House	End of 19 century	Across the Abovyan-Movses Khorenatsi streets	Local	
2				Residential House	1st part of 20 century	8 Alaverdyan street	Local	
3				Residential House	1947	37 Baghramyan street	Local	
4				Residential House	1st part of 19th Century	46, Isi Le Mulino str.	Local	
5				Residential House	1950	79, Mesrop Mashtots street	Local	
6				Residential House	Beginning of 20th Century	10, Shahumyan street	Local	
7				Residential House	Beginning of 20th century	12,14 Shahumyan street	Local	
8				Residential House	Beginning of 20th century	16, Shahumyan street	Local	
9				Residential House	1880	18, Shahumyan street	Local	
10				Residential House	Beginning of 20th century	21, Shahumyan street	Local	
11				Residential House	1914	51, Shahumyan street	Local	
12				Ejmiatsin society cemetery	17-20 centuries	Inside the town	National	
	12.1			Araqel Davrijetsi cemetery	Year 1670		National	
	12.2			Cemetery of architect Murad	Year 1656		National	
13				Vagharshapat St.Grigor Monastery complex (Zvartnots)	5-7 centuries	3 km to the east	National	
	13.1			Church	Mid of 5th century		National	
	13.2			St.Grigor Lusavorich Church	Years 643-662		National	
	13.3			Bath	Mid of 7th century		National	
	13.4			Catholic palace	Years 652-662		National	
		13.4.1		Throne hall	Years 652-662		National	
	13.5			Museum of Zvartnots	1937		National	
	13.6			Obelisk	1985		National	
	13.7			Monument	7 millennium B.C.		National	
	13.8			Vine press	7 century		National	
	13.9			Refectory	7 century		National	
	13.1			Waterhole	4th to 5th centuries		National	
	13.11			High wall	7 century		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
14				Monastery complex Mair Ator St. Ejmiatsin	303 - 20th Century	Across the Movses Khorenatsi-Araratyan streets	National	
	14.1			Mair Tachar church	4-17 centuries		National	
		14.1.1		Belfry	Years 1653-1658		National	
		14.1.2		Stepanos cross-stone (khachqar)	Year 1304		National	
		14.1.3.		Cross-stone (khachqar)	9 century		National	
		14.1.4.		Cross-stone (khachqar)	9 century		National	
		14.1.5.		Deghoin Cross-stone (khachqar)	Year 1148		National	
		14.1.6.		Cross-stone (khachqar)	Year 1171		National	
		14.1.7.		Khachatur Anakht cross-stone (khachqar)	Year 1218		National	
		14.1.8.		Grigor Khaghbakyan Cross-stone (khachqar)	Year 1233		National	
		14.1.9.		Grigor and Mamqan Mamikonyan Cross-stone (khachqar)	Year 1273		National	
		14.1.10		Cross-stone (khachqar)	Year 1287		National	
		14.1.11		Tamta Cross-stone (khachqar)	Year 1297		National	
		14.1.12		Cross-stone (khachqar)	13 century		National	
		14.1.13		Cross-stone (khachqar)	13 century		National	
		14.1.14		Cross-stone (khachqar)	13 century		National	
		14.1.15		Nerses and Tirac cross-stone (khachqar)	13 century		National	
		14.1.16		Cross-stone (khachqar)	13 century		National	
		14.1.17		Cross-stone (khachqar)	14 century		National	
		14.1.18		Asil Cross-stone (khachqar)	Year 1451		National	
		14.1.19		Sara Cross-stone (khachqar)	Year 1451		National	
		14.1.20		Marjan and Aleqsan Cross-stone (khachqar)	Year 1495		National	
		14.1.21		Khatun Cross-stone (khachqar)	15 century		National	
		14.1.22		Vardan and Arev Cross-stone (khachqar)	Year 1543		National	
		14.1.23		Cross-stone (khachqar)	Year 1569		National	
		14.1.24		Sultanghul Cross-stone (khachqar)	16 century		National	
		14.1.25		Cross-stone (khachqar)	16 century		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
		14.1.26		Hakob Cross-stone (khachqar)	Year 1601		National	
		14.1.27		Zaqar, Amir and parents Cross-stone (khachqar)	Year 1602		National	
		14.1.28		Stepanos Cross-stone (khachqar)	Year 1602		National	
		14.1.29		Mr Hovhannes Cross-stone (khachqar)	Year 1602		National	
		14.1.30		Kherkhor Cross-stone (khachqar)	Year 1602		National	
		14.1.31		Sultan, Avetiq and Burtel Cross-stone (khachqar)	Year 1603		National	
		14.1.32		Cross-stone (khachqar)	Year 1639		National	
		14.1.33		Sargis Cross-stone (khachqar)	Year 1745		National	
		14.1.34		Cross-stone dedicated to the 50th anniversary of the Armenian Genocide	Year 1965		Local	
		14.1.35		Cross-stone dedicated to the 20th anniversary of patriarchate of Vazgen A	Year 1976		Local	
		14.1.36		Obelisk	8-7 Centuries B.C.		National	
		14.1.37		Obelisk	Year 1603		National	
		14.1.38		Father Khrimyan Memorial fountain	Year 1982		Local	
		14.1.39		Katnakhbyur Memorial fountain	Year 1967		Local	
			14.1.39.1	Cross-stone (khachqar)	13 century		National	
		14.1.40		Cemetery of All Armenian Patriarch Daniel A.Paiazatets	Year 1808		National	
		14.1.41		Cemetery of All Armenian Patriarch Hovhannes Karbecu	Year 1842		National	
		14.1.42		Cemetery of All Armenian Patriarch Nerses E Ashtaraketsu	Year 1857		National	
		14.1.43		Cemetery of All Armenian Patriarch Gevorg D Kostand-nupolsetsu	Year 1882		National	
		14.1.44		Cemetery of All Armenian Patriarch Makar A	Year 1891		National	
		14.1.45		Cemetery of All Armenian Patriarch Mkrtich A Khrimyan	Year 1907		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
		14.1.46		Cemetery of All Armenian Patriarch Matevos B Kostandnupolsetsu	Year 1910		National	
		14.1.47		Cemetery of All Armenian Patriarch George E Tpkhisetsu	Year 1930		National	
		14.1.48		Cemetery of All Armenian Patriarch George Z	Year 1954			
		14.1.49		Cemetery of All Armenian Patriarch Vazgen A	Year 1994			
		14.1.50		Cemetery of All Armenian Patriarch Garegin A	Year 1999			
	14.2			Friars residential house (Yeremyan khcer)	Year 1894		National	
	14.3			Hotel Ghazarapat	1 part of 18 century		National	
	14.4			Matenadaran	1903		National	
	14.5			Canteen	1 part of 17 century		National	
	14.6			Apartment of Catholic	1738-1741		National	
		14.6.1		Cross-stone (khachqar)	13 century		National	
		14.6.2		Atabek Tarsaicj, Burtel and Buxta Cross-stone (khachqar)	Year 1308		National	
		14.6.3		Uluxan Cross-stone (khachqar)	Year 1600		National	
	14.7			Apartment of Catholic	Year 1910		National	
	14.8			Publishing house	Year 1771		National	
	14.9			Trdatadur Monument	17 century		National	
	14.1			Lake Nersisyan	Year 1846		National	
	14.11			Hospital	End of 19th century		National	
15				St. Astvatsatsin Church	Year 1767	In the town	National	
	15.1			Belfry	Year 1767		National	
	15.2			Cross-stone (khachqar)	12th century		National	
	15.3			Cross-stone (khachqar)	Year 1472		National	
	15.4			Cross-stone (khachqar)	16 century		National	
	15.5			Cross-stone (khachqar)	16 century			
	15.6			Shirvan, Marine and Ulubeck Cross-stone (khachqar)	Year 1581		National	
	15.7			Cross-stone (khachqar)	Year 1596		National	
	15.8			Cross-stone(khachqar)	Year 1655		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
16				St. Gayane church	630-20 century	In the southern part	National	
	16.1			Cross-stone (khachqar)	10 century		National	
	16.2			Cross-stone (khachqar)	10 century		National	
	16.3			Cross-stone (khachqar)	10-11 centuries		National	
	16.4			Cross-stone (khachqar)	10-11 centuries		National	
	16.5			Cross-stone (khachqar)	12-13 century		National	
	16.6			Cross-stone (khachqar)	12-13 century		National	
	16.7			Cross-stone (khachqar)	15-16 centuries		National	
	16.8			Cross-stone (khachqar)	15-16 centuries		National	
	16.9			Courtyard	Year 1688		National	
		16.9.1		Cross-stone (khachqar)	11-12 centuries		National	
		16.9.2		Cross-stone (khachqar)	11-12 centuries		National	
		16.9.3		Cross-stone (khachqar)	12-13 centuries		National	
		16.9.4		Cross-stone (khachqar)	Year 1456		National	
		16.9.5		Hovhannes Shahzat Cross-stone (khachqar)	15-16 centuries		National	
		16.9.6		Sargis Cross-stone (khachqar)	15-16 centuries		National	
		16.9.7		Margar Cross-stone (khachqar)	16 century		National	
		16.9.8		Avag Khatun Cross-stone (khachqar)	Year 1599		National	
		16.9.9		Akob Cross-stone (khachqar)	Year 1642		National	
		16.9.10		Cemetery of Nerses	Year 1651		Local	
		16.9.11		Cemetery of All Armenian Patriarch Exiazar A Aintapts	Year 1691		National	
		16.9.12		Cemetery of All Armenian Patriarch Abraham B Mshecu	Year 1734		National	
		16.9.13		Cemetery of All Armenian Patriarch Ghazar	Year 1750		National	
		16.9.14		Cemetery of All Armenian Patriarch Minas A Aknetsi	Year 1753		National	
		16.9.15		Cemetery of All Armenian Patriarch Hakob Sahamakhetsi	Year 1762		National	
		16.9.16		Cemetery of All Armenian Patriarch Simeon A Yerevansi	Year 1780		National	
		16.9.17		Cemetery of All Armenian Patriarch Ghukas Karnetsi	Year 1799		National	
		16.9.18		Cemetery of All Armenian Patriarch Hovsep Arghutyan	Year 1801		National	
		16.9.19		Cemetery of Metropolitan Barsex	Year 1812		Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
		16.9.20		Cemetery of Soghomon Hovsepyan	Year 1829		Local	
		16.9.21		Cemetery of Voski Enakopyanci	Year 1829		Local	
		16.9.22		Cemetery of Tovma Hovsepyanc Ghorghanyac	Year 1842		Local	
		16.9.23		Cemetery of All Armenian Patriarch Mateos A Kostand-nupolsecu	Year 1865		National	
		16.9.24		Cemetery of All Armenian Patriarch Khoren A	Year 1938		National	
	16.1			Residential house	19 century		Local	
	16.11			Cemetery	10-20 centuries		National	
		16.11.1		Cemetery of Vardan Xachatur Abovyan	Year 1896		National	
		16.11.2		Cemetery of Samson Ter-Poghosyan	Year 1912		National	
		16.11.3		Cemetery of Smbat Boroyan	Year 1956		National	
		16.11.4		Cross-stone (khachqar)	10 century		National	
		16.11.5		Cross-stone (khachqar)	10-11 centuries		National	
		16.11.6		Cross-stone (khachqar)	12-13 centuries		National	
		16.11.7		Cross-stone (khachqar)	14-16 centuries		National	
		16.11.8		Cross-stone (khachqar)	15-16 centuries		National	
	16.12			Cemetery	19-20 centuries		National	
	16.13			Annik Derzakyan memorial fountain	Year 1960		Local	
	16.14			Memorial fountain of 1915 Genocide	Year 1983		Local	
	16.15			The order building	Year 1880		National	
		16.15.1.		Cross-stone (khachqar)	Year 1642		National	
	16.16			Basement	Year 1764		Local	
	16.17			Well	7 century		National	
17				St.Hripsime church	618	Across the Mesrop Mashtots and Narekatsi streets	National	
	17.1			Cross-stone (khachqar)	9 century		National	
	17.2			Cemetery of All Armenian Patriarch Philipos Haxbaketsu	Year 1655		National	
	17.3			Belfry	Year 1790		National	
		17.3.1		Cemetery of All Armenian Patriarch Astvatsatur Hamadantsu	Year 1725		National	
		17.3.2		Cemetery of All Armenian Patriarch Karapet B Ulnetsu	Year 1729		National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
	17.4			Church	4-5 centuries		National	
	17.5			Residential house	Year 1894		Local	
	17.6			Residential house of Prior	Year 1894		Local	
	17.7			Fountain	Year 1960		Local	
	17.8			Structure	End of 19 century		Local	
	17.9			Cemetery	4-19 centuries		Local	
		17.9.1		Cross-stone (khachqar)	Year 1195		National	
		17.9.2		Cross-stone (khachqar)	Year 1424		National	
		17.9.3		Cross-stone (khachqar)	Year 1481		National	
		17.9.4		Akobjan Cross-stone (khachqar)	Year 1552		National	
		17.9.5		Marqar Cross-stone (khachqar)	16 century		National	
		17.9.6		Martiros Yepiskopos Cross-stone (khachqar)	16 century		National	
		17.9.7		Cross-stone (khachqar)	16 century		National	
		17.9.8		Ghazar Cross-stone (khachqar)	16 century		National	
		17.9.9		Azamat Cross-stone (khachqar)	16 century		National	
		17.9.10		Cross-stone (khachqar)	Year 1692		National	
	17.1			Fence	Year 1776, 1894		National	
	17.11			Gate	16-17 centuries		National	
18				St. Shoghakat Church	Year 1694	Across the Nalbandyan and Sahak Partev streets	National	
	18.1.			Courtyard	Year 1694		National	
		18.1.1		Cemetery of All Armenian Patriarch Nahapet A Edesatsu	Year 1705		National	
		18.1.2		Cemetery of All Armenian Patriarch Abraham g Krteatsu	Year 1737		National	
	18.2			Cemetery	19 century		Local	
	18.3			Church	4-5 centuries		National	
19				Zvartnonts obelisk	Year 1957	3 km to the east	National	
20				Monument of Xachatur Abovyan	Year 1947	Inside the town	Local	
21				Monument to the Victims of WW II	Year 1970	In the Mesrop Mashtots street	Local	
22				Monument of Komitas	Year 1969	In the center	Local	
23				Monument to the Victims of civil wars in 1921 to establish Soviet rule in Armenia	Year 1953	Inside the town	Local	
24				Monument of Mesrop Mashtots	Year 1981	In the center	Local	
25				Monument of Anastas Mikoyan	Year 1944	Inside the town	Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.2 t. Vagharshapat								
26				Monument of Stepan Shahumyan	Year 1961	Inside the town	Local	
27				Monument to the Russian victims of Russo -Persian war in 1827	Year 1833	In the western part	National	
28				Seminary building, Gevorgyan seminary	Year 1873	Across the Araratyan –Movses Xorenatsi street	National	
	28.1			Monument of Rafael Patkanyan	Year 1901	Inside the town	National	
	28.2			Observatory	Year 1914		National	
	28.3			Dormitory accommodation	Year 1879		National	
	28.4			hospital	The Beginning of 20 century		National	
	28.5			Educational pavilion	The end of 19 century		National	
29				Cultural center	Year 1954	In Mesrop Mashtots street	Local	
30				The Museum of Hovhannes Hovhannisyan	The end of 19 century	In the center	National	
	30.1.			Monument of Hovhannes Hovhannisyan	Year 1959		National	
3.5 v. Aknashen								
1				Settlement	2-1 millennium B.C.	0,3 km to the south east	National	
2				Settlement Khatunarkh	6-5 millennium B.C.	0,5 km to the north	National	
	2.1.			Graveyard	4-3 millennium B.C		National	
3				Memorial fountain	1969	Inside the village	Local	
4				Monument to the Victims of WW II	1983	Inside the village	Local	
3.6 v. Aghavnatun								
1				Citadel	2-1 millennium B.C., 10-19 centuries	5 km to the south-west	National	
	1.1			Church	10-11 centuries		National	
	1.2.			Cemetery	10-20 centuries		Local	
		1.2.1.		Cross-stone (khachqar)	11 century		National	
2				Tower	2-1 millennium B.C.	5 km to the north-west	National	
	2.1.			Graveyard	2-1 millennium B.C.		National	
3				Settlement "Aghvesi ghrer"	4-3 millennium B.C.	In the south-west	National	
4				Settlement	2-1 millennium B.C.	0,3 km to the north-west	National	
	4.1.			Graveyard	2-1 millennium B.C.		National	
5				Charnel house	14 century	In the southern part	National	
6				Graveyard	2-1 millennium B.C. 19 Century	To the north-west	National	
	6.1.			Cemetery	19 century		National	
7				Church of St.Astvacatsin	1860	Inside the village	Local	
8				Church Karmravor	17-18 centuries	0,5 km to the west	Local	
	8.1.			Cemetery	17-20 centuries		Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.8 v. Amberd								
1				Settlement	3-1 millennium B.C.	In the northern part	National	
	1.1.			Graveyard	3-1 millennium B.C.		National	
2				Cemetery	17-19 centuries	To the south east	Local	
3				Former village	18-19 centuries	In the north east part	Local	
4				Church of Tovmas Araqial	12-19 centuries	Inside the village	National	
	4.1.			Cross-stone	Year 1594		National	
	4.2.			Cemetery	18-19 centuries		Local	
5				Church of St. Poghos Petros	19 century	In the center	Local	
3.11 v. Aigeshat (Echmiadzin district)								
1				Settlement	2-1 millennium B.C.	In the north east part	National	
	1.1.			Graveyard	2-1 millennium B.C.		National	
	1.2.			Tower of Ardar David	2-1 millennium B.C.		National	
2				Church of St. Astvatsatsin	19 century	In the west part	Local	
3				Church of Targmanchats	7 century	Inside the village	National	
	3.1.			Cemetery	10-18 centuries		National	
	3.2.			Fence	Beginning of 19 century		Local	
4				Monument to the Victims of WW II	1979	Inside the village	Local	
3.13 v. Aratashen								
1				Settlement	6-5 millennium B.C.	0,5 km to the north east	National	
2				Church	19 century	Aivazyan street	Local	
3				Monument to the Victims of WW II	1980	Inside the village	Local	
3.14 v. Aragats								
1				Citadel	9-6 centuries B.C.	In the south west	National	
	1.1			Cemetery	19-20 centuries		Local	
2				Tower	1st millennium B.C.	1,2km to the south west	National	
3				Settlement	1st - 2nd millennium B.C.	2 km to the north west	National	
	3.1			Graveyard	1st - 2nd millennium B.C.		National	
4				Settlement	1st - 2nd millennium B.C.	1,5 km to the north west	National	
5				Church of St. Stepanos	Year 1870	Inside the village	Local	
6				Memorial fountain of heroes of October revolution	Year 1960	Inside the village	Local	
7				Monument to the Victims of WW II	1985	In the north part	Local	
3.15 v. Arazap								
1				Monument of Tatul Huryan	1973	Inside the village	Local	
3.18 v. Argavand								
1				Cemetery	19-20 centuries	Inside the village	Local	
2				Monument to the Victims of WW II	1975	Inside the village	Local	
3.20 v. Armavir								
1				Settlement Moxrablur Arevik	3 millennium B.C.	2,5 km to the east	National	
2				Monument to the Victims of WW II	1971	Inside the village	Local	
3				Monument of Vahagn	1971	Inside the village	Local	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.21 v. Arshaluys								
1				The village place	14-18 centuries	1 km to the south	Local	
2				The village place	18-19 centuries	In the south part	Local	
	2.1.			Cemetery	18-19 centuries		Local	
3				Church St. Astvatsatsin	1903-1909	Inside the village	Local	
4				Monument to the Victims of WW II	1988	Inside the village	Local	
5				Cultural center	1961	Inside the village	Local	
3.23 v. Artimet								
1				St. Astvatsatsin Church	Year 1876	In the village center	Local	
	1.1.			Cross-stone (khachqar)	12-13 centuries		National	
	1.2.			Cross-stone (khachqar)	12-13 centuries		National	
	1.3.			Cross-stone (khachqar)	12-13 centuries		National	
	1.4.			Cross-stone (khachqar)	12-13 centuries		National	
	1.5.			Cross-stone (khachqar)	15-16 centuries		National	
	1.6.			Cross-stone (khachqar)	Year 1621		National	
3.31 v. Bambakashat								
1				St. Astvatsatsin Church	1901	In the village center	Local	
2				Monument to the Victims of WW II	1968	In the village center	Local	
3.33 v. Gai								
1				St. Sarqis Church	Year 1894	In the village center	Local	
2				Monument to the Victims of WW II	1975	In the village center	Local	
3.35 v. Griboiedov								
1				Kghziak Blur settlement	4-3 millennium B.C.	1,7 km to the west	National	
2				Mokhrablur settlement	4-1 millennium B.C., 2-1 centuries, 10-13 centuries		Local	
	2.1.			Church	4-3 millennium B.C., 3-1 centuries		National	
	2.2			Irrigation system	4-3 millennium B.C.		National	
3.37 v. Dasht								
1				Citadel	2-1 millennium B.C.	1,5 km to the east	National	
	1.1			Settlement	2-1 millennium B.C.		National	
	1.2.			Graveyard	2-1 millennium B.C.		National	
2				Graveyard	2-1 millennium B.C.	0,3 km to the north	National	
3.46 v. Lernamerdz								
1				Citadel	3-1 millennium B.C., 18 Century	In the north west part	National	
	1.1			Tower	2-1 millennium B.C.	In the north part	National	
	1.2.			Graveyard	2-1 millennium B.C.		National	
	1.3.			Rock paintings	3 millennium B.C.		National	
	1.4.			Village place	18 century		Local	
2				"Odzablur" settlement	3 millennium B.C.	0,6 km to the south	National	

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.50 v. Khoronk								
1				Settlement	1 century B.C.	1 km to the south	National	
2				Cemetery	18-20 centuries	In the south part	Local	
3				St. Nshan church	Year 1880	Inside the village	Local	
4				Monument to the Victims of WW II	1988	Inside the village	Local	
5				Oratory	18-20 centuries	0,5 km to the south east	Local	
3.51 v. Tsaghkalanj								
1				Settlement	2-1 millennium B.C.	5 km to the west	National	
	1.1.			Graveyard	2-1 millennium B.C.		National	
2				Settlement	2-1 millennium B.C.	4 km to the west	National	
	2.1.			Graveyard	2-1 millennium B.C.		National	
3				Graveyard	2-1 millennium B.C.	2 km to the north west	National	
4				Graveyard	3-1 millennium B.C.	In the north west part	National	
5				Church	7 century, 19-20 centuries	In the north part	National	
	5.1.			Cemetery	19-20 centuries		Local	
6				St. Astvatsatsin Church	19 century	Inside the village	Local	
3.57 v. Haikavan								
1				St. Astvatsatsin Church	Year 1875	Inside the village	Local	
2				Monument to the Victims of WW II	1975	Inside the village	Local	
3				Armavir settlement	4-1 millennium B.C., 10-13 centuries	In the east	National	
	3.1.			Citadel	4-1 millennium B.C.		National	
	3.2.			Graveyard	1 millennium B.C.		National	
	3.3.			Cave dwelling complex	3-1 millennium B.C.			
3.59 V. Hoktember								
1				Sardarapat citadel	Beginning of 19 century	Inside the village	Local	
2				St. Astvatsatsin Church	Year 1882	Inside the village	Local	
3				Sardarapat battle memorial	1968		National	
	3.1.			State Armenian National Ethanography Museum	1977		National	
	3.2.			Vardavar restaurant	1970		National	
4				Monument to the Victims of WW II	1970	Inside the village	Local	
3.77 v. Shahumyan								
1				Settlement	8-7 centuries B.C.	1 km to the south east	National	
	1.1.			Reservoir	8-7 centuries B.C.		National	
2				Church	18 century	In the western part	Local	
3.95 v. Pshatavan								
1				Monument to the Victims of WW II	1957	Inside the village	Local	
3.60 v. Hovtamej								
1				Church	19th century	In the village center	Local	Half-ruined

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.65 v. Merdzavan								
1				Tower	2-1 millennium B.C.	In the western part	National	In the southern part of the cemetery at the end of the village
2				Graveyard	2-1 millennium B.C.	In the western part	National	In the western part of the cemetery at the end of the village
3.66 v. Miasnikian								
1				Settlement	2-1 millennium B.C.	3 km to the north	National	At the right side of the road, in the area between three knolls
	1.1.			Graveyard	2-1 millennium B.C.		National	On the eastern side of the settlement
2				Settlement	3-2 millennium B.C.	2 km to the north	National	At the right side of the road
	2.1			Graveyard	3-2 millennium B.C.		National	
3				Settlement	2-1 millennium B.C.	3.5 km to the north	National	On the left bank of the river
	3.1.			Graveyard	2-1 millennium B.C.		National	
4				Settlement	2-1 millennium B.C.	2.5 km to the north-west	National	
3.67 v. Mrgashat								
1				"Sev Blur" Settlement ("Kara Tapa")	3rd millennium B.C.	1.5-2 km to the north-east	National	Not far from the railway bridge, on the top of the hill there are Kurdish cemeteries
2				St. Astvatsatsin Church	1900	Inside the village	Local	Near the village club
3				Monument to the Victims of WW II	1969	Inside the village	Local	Architect: R. Alaverdian
3.68 v. Mrgastan								
1				St. Hovhannes Church	19th century	in the northern part	Local	
2				Monument to the Victims of WW II	1984	inside the village	Local	Arch. K. Gabrielyan

Table 2.5-21, Cultural and Historical Monuments within 16 km Zone, cont'd

Table 2.5-21, Cultural and Historic Monuments within the 16 km Zone, Cont'd								
Monument number	Monument Sub-number			Monument, monument group	Period	Location in residential area, address	Significance (national or local)	Notes
1	2	3	4	5	6	7	8	9
3.93 v. Taronik								
1 2				Water collector system Water mill	Years 1730-1732 Mid 18th century		Local Local	Tunnel and Reservoir 10 meters to the east from the man-made reservoir
3				Metsamor settlement	4-1 millennium B.C.	0.5 km to the south-west	National	On the left bank of the river Metsamor
	3.1.			Citadel	3-1 millennium B.C.		National	
		3.1.1.		Palace complex	End of 2nd millennium, beginning of 1st millennium B.C.		National	At the northern part of the citadel
		3.1.2.		Temple complex	2-1 millennium B.C.		National	
		3.1.3.		Ore-mining facility	End of 2nd millennium, beginning of 1st millennium B.C.		National	At the northern slope of the citadel
		3.1.4.		Foundry complex	End of 2nd millennium, beginning of 1st millennium B.C.		National	To the north-east from the citadel
		3.1.5.		Museum building	1968		National	Architect: B.Arzumanian
			3.1.5.1.	Dragon stone	2nd millennium B.C.		National	In front of the main entrance
	3.2.			Observatory	3rd millennium B.C.		National	
	3.3.			Graveyard	2-1 millennium B.C.		National	

Table 2.5-22, Libraries, Theaters and Museums in Marzes of the 50 km Zone

Table 2.5-22, Libraries, Theaters and Museums in Marzes of the 50 km Zone		Marz ->	Aragatsotn Marz	Ararat Marz	Armavir Marz	Kotayk Marz	Shirak Marz	Yerevan City	Total RA
		~ % in 50 km ->	75%	30%	100%	25%	10%	100%	
Libraries by Type, 2005	Total Libraries	Number of Libraries	110	98	106	79	128	30	1,048
	Republic							3	3
	Marz Central		1	1	1	1	1	1	11
	Territorial Central		3	2	1	2	6		33
	Urban		1	5	8	15	4	29	118
	Rural		104	88	93	59	109		846
	Children's		1	2	3	2	8		40
Libraries' Book Stock, 2005	Total Books	Thousand Volumes	797.8	910.4	1,299.0	911.0	1,305.1	8,702.9	19,323.9
	Public-Political		102.7	147.1	235.9	148.8	188.7	1,951.0	3,701.4
	Natural-Medicine		36.8	37.1	57.4	45.8	67.9	1,435.7	1,941.6
	Technical and Agricultural		38.5	32.5	54.7	39.2	72.3	2,169.5	2,637.2
	Art, Physical Education and Sport		38.4	43.0	71.2	46.5	63.8	855.2	1,403.8
	Philological Literature and Fiction		581.4	650.7	879.8	630.7	912.4	2,291.5	9,639.9
State Specialized Theaters, 2005	Total Theaters	Number		1			2	17	25
	Performances	Number		62			169	1,819	2,354
	Attendees	Thousand Persons		11.9			29.5	314.6	397.2
	Revenues	Thousand Dram		2,945.1			8,981.5	220,000.7	244,063.3
Museums, 2005	Total Museums	Number	2	2	3	5	8	58	97
	Historical				2	2	1	17	30
	Land Studies					1	1	1	11
	Memorial		2	1	1	1	6	6	19
	Literary and Art			1		1		32	35
	Branch							2	2
Concerts, 2005	Concert Organizations	Number					2	18	20
	Concerts						10	693	703
	Audience	Thousand Persons					1.1	225.9	227.0
	Audience per performance	Persons					110	326	323

Figure 2.5-1, Map of Republic of Armenia

Figure 2.5-2, Map of 16 km Zone

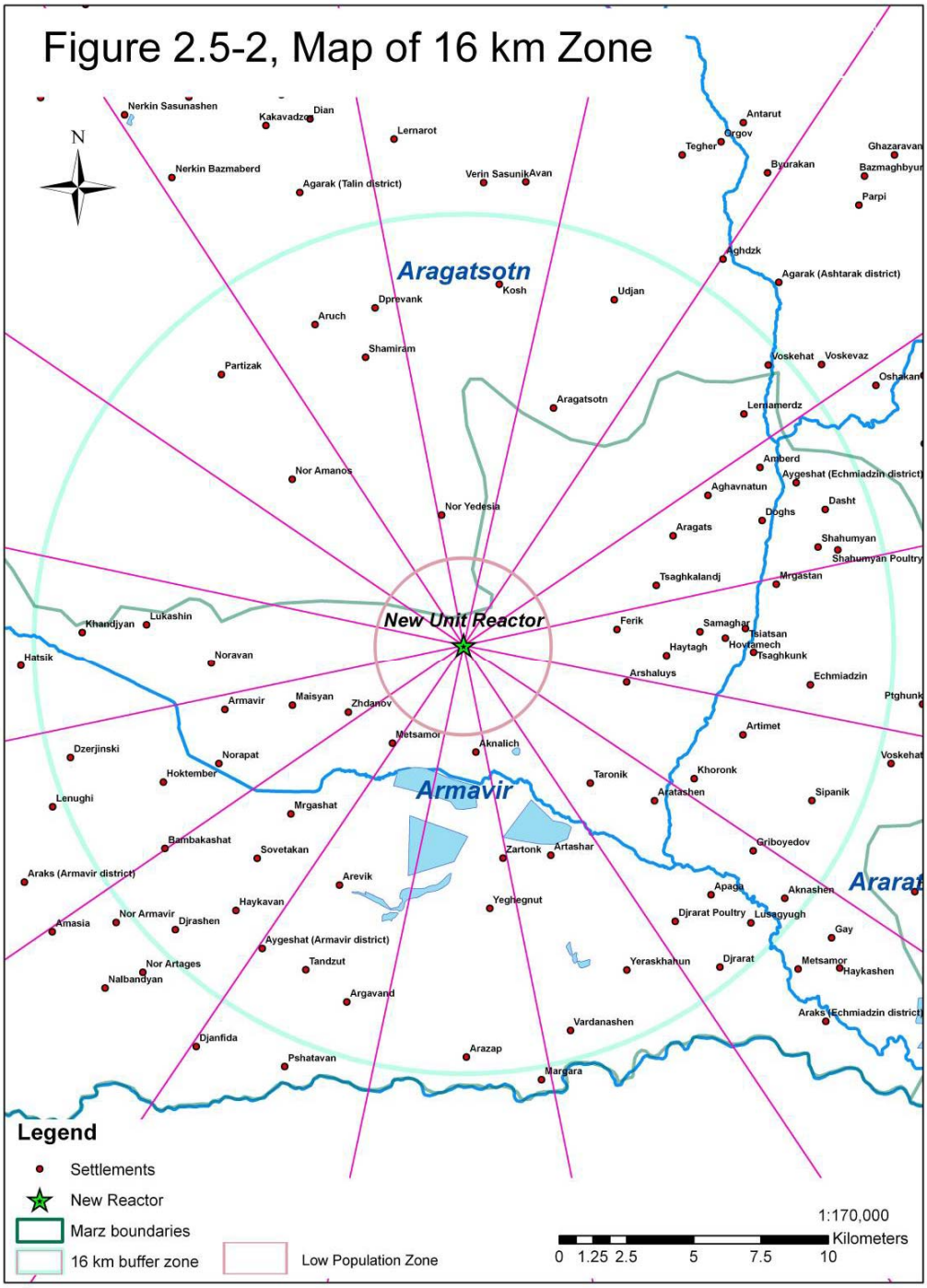


Figure 2.5-3, Population Dynamics by Forecast Options for Years 2005-2035, with linear extrapolation to 2055

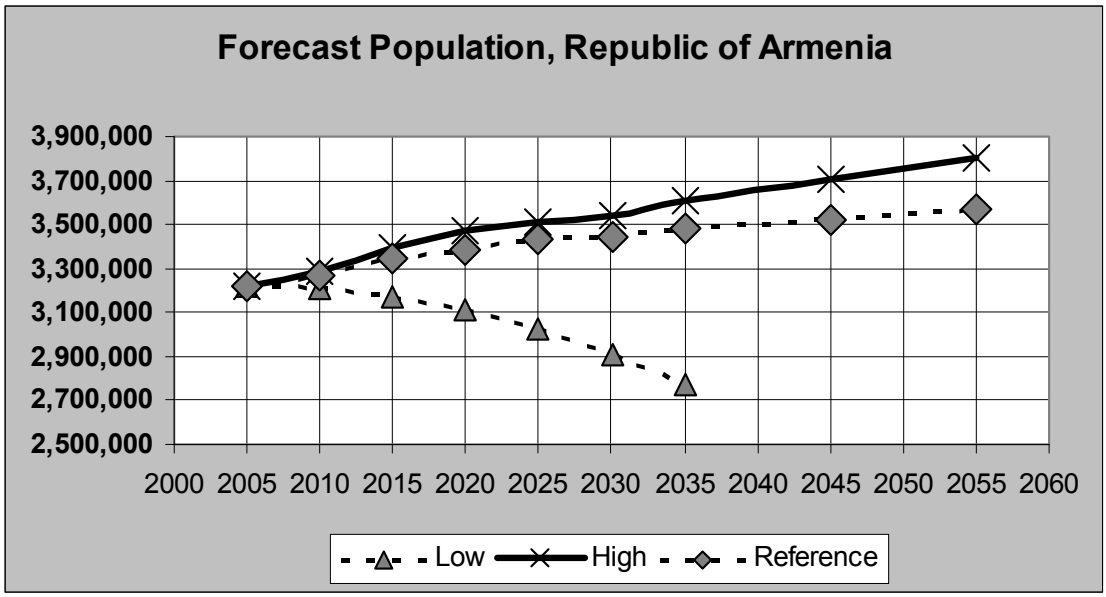


Figure 2.5-4, Map of 50 km Zone

Figure 2.5-5, Concentration of Ethnic Groups in Armenia

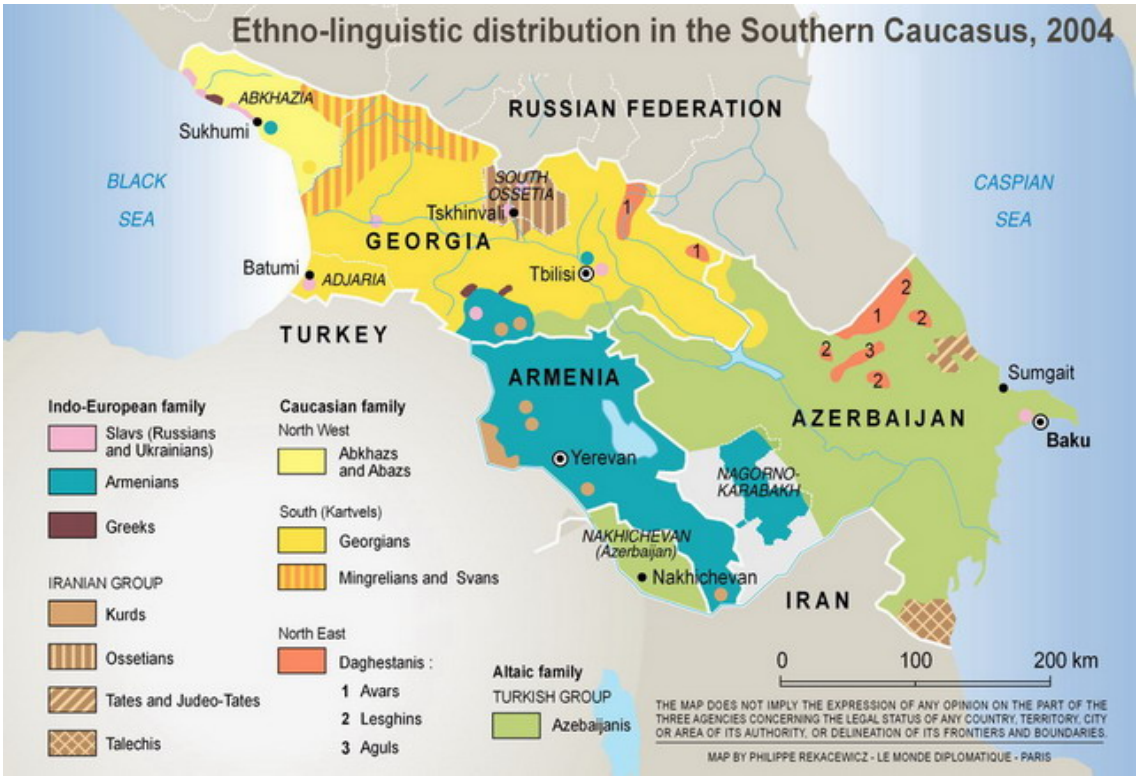


Figure 2.5-6, Key Highways and Railways of Armenia

REFERENCES:

[2.5-1] National Statistical Service, 2006, *Statistical Yearbook of Armenia, 2006*, Population http://www.armstat.am/Arm/StatData/Taregirq_06/Taregirq_06_3.pdf, accessed 18 January 2008.

[2.5-2] National Statistical Service of Republic of Armenia and State Committee of the Organization and Conduction of the RA Census 2001, 2003, *The Results of 2001 Census of the Republic of Armenia (Figures of the Republic of Armenia)* – hereafter: "*The Results of 2001 Census of the RoA*".

[2.5-3] PA Consulting Group, *PA/USAID Program for Institutional and Regulatory Strengthening of Water Management in Armenia*, URL: http://www.paconsulting.am/water/eng/index.asp, accessed 17 January 2008.

[2.5-4] *The Results of 2001 Census of the RoA*, Table 1.1.

[2.5-5] *The Results of 2001 Census of the RoA,* Table 1.4.

[2.5-6] National Statistical Service of Republic of Armenia, Letter dated December 20, 2007 *responding to request in Ministry of Energy Letter dated December 12, 2007*.

[2.5-7] National Statistical Service of Republic of Armenia, 2006, *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical handbook*.

[2.5-8] Web-site of the Ministry of Trade and Economic Development of Armenia, www.minted.am, accessed 10 March 2008.

[2.5-9] National Statistical Service of Republic of Armenia , Presentation "2001-2035 Forecast for Demographic Indicators of the Republic of Armenia" prepared for the United Nations Population Fund.

[2.5-10] Ministry of Finance of Armenia, 2008, *Poverty Reduction Strategy Paper, Revised Version (PRSP-2)*, Table 4.1. Available at URL: http://www.prsp.am/new/en/index.php.

[2.5-11] U.S. Department of Energy, 2005, DOE NP2010, *Nuclear Power Plant Construction Infrastructure Assessment*, MPR-2776, Rev. 0, dated October 21, 2005, prepared for Department of Energy, Washington D.C., under Order No. DE-AT01-020NE23476.

[2.5-12] AtomStroyExport letter No. 7700/01-347 dated 05.06.2008 to the Head of Atomic Energy Department, Ministry of Energy of Republic of Armenia.

[2.5-13] *Armenian Nuclear Power Plant Decommissioning Strategy,* approved by GoA Decision № 48, adopted November 29, 2007, Figure 2.

[2.5-14] Turkish Statistical Institute, 2006, *Turkey's Statistical Yearbook 2005*, URL: http://www.die.gov.tr/ENGLISH/yillik.pdf, Table 3.4, accessed 17 January 2008.

[2.5-15] Website: *The provinces of Turkey and all cities of more than 20,000 inhabitants*, URL: http://www.citypopulation.de/Turkey.html, accessed 17 January 2008.

[2.5-16] *Turkey's Statistical Yearbook 2005*, Table 3.3.

[2.5-17] National Statistical Service and Ministry of Health, 2006, *Armenia Demographic and Health Survey 2005*, Table 2.10.

[2.5-18] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, Household Survey.

[2.5-19] *Armenia Demographic and Health Survey 2005*, Tables 2.4.1 and 2.4.2.

[2.5-20] *The Results of 2001 Census of the RoA*, Table 5.1.

[2.5-21] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_11.pdf.

[2.5-22] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_18.pdf.

[2.5-23] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_11.pdf.

[2.5-24] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_17.pdf.

[2.5-25] *Statistical Yearbook of Armenia 2006*, Employment, URL: http://www.armstat.am/Arm/StatData/Taregirq_06/Taregirq_06_4.pdf, accessed 18 January 2008.

[2.5-26] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, files: MARZ_2006E_17.pdf and MARZ_2006E-21.pdf.

[2.5-27] *Statistical Yearbook of Armenia 2006*, Construction, URL: http://www.armstat.am/Arm/StatData/Taregirq_06/Taregirq_06_15.pdf, accessed 18 January 2008.

[2.5-28] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_21.pdf.

[2.5-29] "Center for Education Projects" PMU, Ministry of Education and Science, 2007, data supplied by e-mail.

[2.5-30] National Statistical Service, 2006, *Social condition of the Republic of Armenia in 2006*.

[2.5-31] Ministry of Health, 2006, *Statistical Yearbook 2006 of the National Institute of Health*, URL: http://www.niharm.am/IAC.htm.

[2.5-32] *Armenia Demographic and Health Survey 2005*, Tables 2.7 and 2.8.

[2.5-33] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007, Section 3.2.14.1.

[2.5-34] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_21.pdf.

[2.5-35] Nor Akunk Closed Joint Stock Company and Kreditanstalt fur Wiederaufbau, 2004, *Communal Infrastructure Project, Design Report WWTP Armavir-Metsamor – First Phase, Wastewater Treatment Plant System*.

[2.5-36] Closed Joint Stock Company "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, (Revision 1), Section 1.4.12.

[2.5-37] Nor Akunk CJSC and Kreditanstalt fur Wiederaufbau, 2004.

[2.5-38] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of Armenian Nuclear Power Plant*, Appendix 12, p. 30 (of English translation by PA Armenia).

[2.5-39] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_14.pdf.

[2.5-40] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007, Section 6.5.

[2.5-41] Ministry of Energy, 2006, *Armenia Power Sector 2006 Least Cost Generation Plan*, Section 3.3.5.

[2.5-42] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.8.

[2.5-43] Minister of Transport and Communication Letter 01-13/3044, 08 August 2007, from A. Manoukyan, to A. Movsisyan, Minister of Energy.

[2.5-44] Government of Armenia Resolution No. 475-N, 14 April, 2005, *On Approval of the List of Roads of Intergovernmental and State Importance*.

[2.5-45] G. Beglaryan, 2002, Map published by Collage, Ltd. *Armenia and Mountainous Karabakh*.

[2.5-46] Harral Winner Thompson Sharp Klein, Inc, 15 October 2006, *Armenian Railway Restructuring Project, Final Report*, p 2-2.

[2.5-47] Government of Armenia Resolution No. 2412, December 29, 2005, *Annual Work Plan for 2006-2008 Three-Year Development and for 2006 Renovation and Maintenance of the RoA State Roads for General Use*.

[2.5-48] Ministry of Transport and Communications, 2007, World Bank Project Information Document (PID) Concept Stage, Report No. AB3064, Project No. P104433, *ARMENIA: Railways Restructuring*.

[2.5-49] Armenian News – PanARMENIAN_Net Armenian News Agency, 16.01.2008 18:37 GMT+4:00, *RZD wins Armenian Railways Administration Tender*.

[2.5-50] Armenian News – PanARMENIAN_Net Armenian News Agency, 31.01.2008 12:41 GMT+4:00, *Georgia may annul Armenian cargo transit discount from March 1*.

[2.5-51] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.8.

[2.5-52] National Statistical Service, 2007, *Statistical Yearbook 2007*, Transport and Communications, file: TAREGIRQ_07_16.pdf.

[2.5-53] Web Page: *Zvartnots-Yerevan International Airport Expansion*, URL: http://www.airport-technology.com/projects/zvartnots/, accessed 18 January 2008.

[2.5-54] Web Page from Wikipedia: *Shirak Airport*, URL: http://en.wikipedia.org/wiki/Shirak_Airport, accessed 18 January 2008.

[2.5-55] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_26.pdf.

[2.5-56] Telephone call, A. Tevosyan (PA Armenia) to N. Margaryan (ANPP personnel department), on 8 January 2008.

[2.5-57] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_23.pdf.

[2.5-58] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_24.pdf.

[2.5-59] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_29.pdf.

[2.5-60] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_25.pdf.

[2.5-61] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file MARZ_2006E_30.pdf.

[2.5-62] World Factbook, *Armenia*, URL: https://www.cia.gov/library/publications/the-world-factbook/geos/am.html#Govt, accessed 18 January 2008.

[2.5-63] Government of Republic of Armenia Official Website, *Regional Administration Bodies*, URL: http://www.gov.am/enversion/regional_7/regional.htm, accessed 18 January 2008.

[2.5-64] Republic of Armenia *Law on Local Self Government Bodies*, May 7, 2002.

[2.5-65] R. Almy and V. Abrahamian, 2001, "Property taxation in Armenia", in Malme and Youngman (Eds), *The Development of Property Taxation in Economies in Transition: Case Studies from Central and Eastern Europe,* pp.85-95. URL:http://www1.worldbank.org/wbiep/decentralization/library9/malme_chap7.pdf, accessed 18 January 2008.

[2.5-66] Government of Armenia resolution № 1592, 27 December 2007, *On Approval of Metsamor town master plan.*

[2.5-67] Government of Armenia Resolution №. 194 dated January 17, 2008, “On Making Amendments in the ROA Government Decree № 2328, dated December 22, 2005.”

[2.5-68] Ministry of Culture , Letter 02/2381, 08 October 2007, to A Movsisyan, the Minister of Energy.

[2.5-69] Government of Armenia Resolution No. 628, 29 May 2002, *On Approval of State List of Historical and Cultural Monuments*, Appendix.

[2.5-70] Web Page from Wikipedia, *Zvartnots*, URL: http://en.wikipedia.org/wiki/Zvartnots, accessed 18 January 2008.

[2.5-71] Web Page from Wikipedia, *Battle of Sardarapat*, URL: http://en.wikipedia.org/wiki/Battle_of_Sardarapat, accessed 18 January 2008.

[2.5-72] Web Page from eTripTips, *Armenia Heritage Trail* URL: http://www.etriptips.com/wiki/Armenia_Heritage_Trail, accessed 18 January 2008.

[2.5-73] Armenian Studies Program at CSU, Fresno, *Encyclopedia of Armenia*; as referenced on Web Page from Wikipedia, *Aruchavank Church*, URL: http://en.wikipedia.org/wiki/Aruchavank_church, accessed 18 January 2008.

[2.5-74] O. Khalpakhchian, 1980, (published in by Iskusstvo Publishers, Moscow), *Architectural Ensembles of Armenia* , as referenced on Web Page from Wikipedia, *Saghmosavank Monastery*, URL: http://en.wikipedia.org/wiki/Saghmosavank_Monastery, accessed 18 January 2008.

[2.5-75] N. Khanjyan, 2004, *Specially Protected Nature Areas of Armenia*.

[2.5-76] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_21.pdf, Tables “Libraries' Activity” and “Libraries' Book Stock by Content”.

[2.5-77] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_21.pdf, Table “State Specialized Theaters”.

[2.5-78] *Marzes (Regions) of the Republic of Armenia in Figures 2001-2005 – Statistical Handbook*, file: MARZ_2006E_21.pdf, Table “Concert Organizations' Activity”.

[2.5-79] Web Page, *The Amazing blend of nature and ancient churches*, URL: http://www.haykland.com/monuments.php, accessed 18 January 2008.

[2.5-80] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007.

2.6 GEOLOGY

The objective of this section is to describe the geological features of the region around ANPP. The geological and seismic conditions of the region around the ANPP have been characterized in several previous studies and analyses. Additional studies are planned to complement the previous work.

2.6.1 Summary of Studies of the Geology of the ANPP Region

The Armenian NPP is located in a region of high seismicity that has been affected by destructive earthquakes in the past. Although the plant did not suffer any damage because of any seismic event, the plant's location had raised serious concern since the beginning of its design, construction and operation.

The original seismic design basis for the Armenian NPP site was based on studies conducted between 1966 and 1972. Those studies concluded that the maximum earthquake intensity anticipated for the site area was I=7 (equivalent to 0.10g as peak ground acceleration) according to the MSK-64 scale. In compliance with the rules valid at that time, the plant was designed according to the Soviet code for earthquake design for conventional structures and buildings and with additional requirements as they were established in several letters of the former USSR GOSSTROJ (Ministry of Construction) and other Soviet scientific and research institutions. During the development of the NPP project design, in 1972, a recommendation letter was issued by CNIISK (Central Building Research Institute of the former USSR), in which it was recommended to increase the seismic input, using a maximum ground acceleration of 0.40g for the reactor shaft and 0.20g for the reactor compartment at the Reactor Building.

As part of the restart ANPP unit 2, a team led by ARMENERGOSEISMICPROJECT in Yerevan performed additional seismic evaluation of the ANPP site. The report on these studies, issued in 1995 (Ref. [2.6-1]) provided several new findings and recommendations. Specifically, in relation to the seismic ground motion, the main conclusions of the report are the following:

- There are no tectonically active faults within 19 km of the ANPP site.
- The potential of surface faulting at the site vicinity may be reasonably excluded in view of the data and information presented to and reviewed and observed by the reviewers.
- The volcanic hazard probability in the ANPP area is very small and volcanic activity is not expected.
- The seismic Review Level Earthquake was established using a deterministic approach and a peak ground acceleration (pga) of 0.35g was obtained for the 84th fractile of confidence level. A value of 0.21g was also obtained for 50th fractile of confidence level.

Since 1995, more information has surfaced regarding possible faults near the ANPP site and their potential to define the most credible earthquake. Also, the seismic activity near ANPP has been continuously monitored using newly installed seismic arrays. Based on new information and recommendations of IAEA review missions, several additional studies have been undertaken to determine the seismic hazard at the ANPP site.

The first of these studies was done in 2003-2004 by Armenian organizations led by National Survey for Seismic Protection and Georisk. This report, *Probabilistic Seismic Hazard Assessment of the Armenian NPP Site* (Ref. [2.6-2]), was reviewed by an IAEA review mission (Ref. [2.6-3]). The IAEA review concluded that the study's results did not comply with the requirements and guidelines of the related IAEA safety standards and, therefore, the report presented was considered as non-acceptable for the established purposes.

In 2006, another Probabilistic Seismic Hazard Assessment was completed (Ref. [2.6-4]). Under a contract financially supported by the British Department of Trade and Industry (UK/DTI), ENCONET subcontracted a British consultancy firm (Aspinall and Associates) as main analyst of the studies, as well as a number of Armenian organizations as subcontractors for providing the available data. The objective of this study was to determine the probabilistic seismic input characterization for a probabilistic safety analysis of the ANPP. The study was based on existing data provided by Armenian specialists and did not include any new investigations or field data collection. The study calculated the peak ground acceleration (pga) expected from all sources as related to frequency of occurrence. The study concluded that, for a frequency of occurrence of once in 10,000 years, the pga was calculated as 0.285g. However, the report explains that there are a number of inconsistencies and uncertainties related to the historical earthquake information, boundaries of seismic sources, and attenuation relationships.

The IAEA review of the 2006 Probabilistic Seismic Hazard Assessment (Ref. [2.6-5]) concluded that the study's results should not be considered as a new definition of the seismic hazard at the Armenian NPP site for which a seismic hazard assessment with a comprehensive uncertainty analysis should be done. The review recommended that the Review Level Earthquake of 0.35g from the 1995 studies should continue to be used for ANPP. The IAEA review also provided 44 specific recommendations to improve the quality of the data and analyses used for the seismic hazard assessment.

2.6.2 Description of Planned Seismic Hazard Assessment of the New ANPP Site

In order to address the IAEA recommendations on previous seismic studies of the ANPP region and to develop data specific to the location of the planned new nuclear unit, MoENR will be conducting a new Seismic Hazard Assessment. A statement of work for the new study has been prepared and reviewed by IAEA specialists. The planned seismic hazard assessment for the new ANPP site will begin in the fourth quarter of 2008 and will take approximately nine months to complete.

The IAEA Safety Requirements NS-R-3, *Site Evaluation for Nuclear Installations* (Ref. [2.6-6]) provides criteria for the suitability of a site for construction of a nuclear facility. With regard to seismic conditions, the document provides essentially two criteria:

1. Hazards due to earthquake induced ground motion shall be assessed for the site with account taken of the seismotectonic characteristics of the region and specific site conditions. A thorough uncertainty analysis shall be performed as part of the evaluation of seismic hazards.

2. The potential for surface faulting (i.e. the fault capability) shall be assessed for the site. Where reliable evidence shows that there may be a capable fault…an alternative site should be considered.

The objectives of the planned seismic assessment study are to determine the earthquake ground motion and fault displacement hazards for the site as part of establishing its

suitability for the new unit(s) of the ANPP. Surface faulting will be evaluated deterministically using a screening approach. The earthquake ground motion hazard for the site will be evaluated using probabilistic methods. Probabilistic seismic hazard analysis (PSHA) is a method for estimating the likelihood that various levels of ground motion will be exceeded at the site in a future period of time. The general requirement for performing the PSHA of the site of the new ANPP unit(s) is to follow the guidelines of IAEA Safety Standards Series No. NS-G-3.3, *Evaluation of Seismic Hazards for Nuclear Power Plants* (Ref. [2.6-7]). The study will also consider the recommendations of previous IAEA Seismic Safety Review Missions for ANPP.

The planned seismic hazard assessment for the new ANPP site includes the following activities:

1. Establishing a quality assurance (QA) plan for the data collection and analyses to be performed, following the IAEA guidelines for QA programs.

2. Developing an integrated database of geological, geophysical, and geotechnical information to be used in developing seismotectonic models and in calculating seismic hazard curves. Information for the Geological, Geophysical and Geotechnical Database shall be obtained from existing databases and studies, supplemented by field data collection and analyses. Collection of the geotechnical data for the site of the new nuclear unit shall include site and laboratory investigations and testing to obtain data defining the static and dynamic engineering properties of the site-specific soil and rock materials.

3. Compiling a catalogue of all relevant historical and instrumentally recorded earthquakes with their associated parameters (the Seismological Database). The catalog shall include all earthquakes that have occurred within the region, reported in common intensity scale.

4. Developing a set of seismotectonic models that will be used to estimate the location, magnitude, and recurrence frequency of future earthquakes that could affect the plant site. The seismotectonic models will be developed in three scales (Regional, Near Regional, and Site Vicinity), becoming more detailed for the smaller areas.

5. Selection of a set of ground motion attenuation relations to be used to estimate the expected ground motions, and their uncertainties, at the plant site from the seismic sources defined in the seismotectonic models. Attenuation relations are used to determine the ground motion that each of the seismic sources would cause at the site, with account taken of local conditions at the site.

6. Performing Probabilistic Seismic Hazard Analysis (PSHA) to determining the levels and characteristics of ground motion hazard at the site of the new ANPP unit. The PSHA will develop the seismic hazard curves and corresponding uniform hazard response spectra (UHRS). From the hazard curves, the acceleration and UHRS corresponding to specific levels of probability of exceedance will be used in establishing the design basis severity level 1 and 2 (SL1 and SL2) earthquakes for the new ANPP unit. The probability levels for SL1 and SL2 will be defined by the State Committee for Regulation of Nuclear Safety (previously ANRA).

Evaluation of the potential for surface faulting in the near region of the ANPP site. Surface faulting is differential ground displacement at or near the surface caused directly by fault movement and is distinct from nontectonic types of ground disruptions, such as landslides, fissures, and craters.

REFERENCES:

[2.6-1]ARMENERGYSEISMICPROJECTS Institute, 1995, *Additional Studies on Armenia Nuclear Power Plant Seismic Conditions*.

[2.6-2] National Survey for Seismic Protection, 2004, *Probabilistic Seismic Hazard Assessment of the Armenian NPP Site*..

[2.6-3] International Atomic Energy Agency (IAEA), 2004, *Review of the Probabilistic Seismic Hazard Assessment of the Armenian NPP Site*, IAEA-TCR-02362..

[2.6-4] Aspinall and Associates, 2006, *Seismic Hazard Assessment for the Armenia Nuclear Power Plant Site*, prepared under DTI Project NSP-04 / A18.

[2.6-5] IAEA, 2006, *Follow Up Review of the Probabilistic Seismic Hazard Assessment (PSHA) for the Armenian NPP Site*, IAEA-TCR-03094.

[2.6-6] IAEA, 2003, *Safety Requirements, Site Evaluation for Nuclear Facilities*, IAEA Safety Standards Series No. NS-R-3, Sections 3.1-7, 3.33-43.

[2.6-7] IAEA, 2002, *Evaluation of Seismic Hazards for Nuclear Power Plants*, Safety Standards Series No. NS-G-3.3.

2.7 METEOROLOGY AND AIR QUALITY

The climate and meteorology at the site and in the surrounding area will affect the operation of the cooling towers, the potential impacts of the cooling towers, and the dispersion of routine and accidental releases to the atmosphere. The rate at which water is evaporated in the condenser cooling system is affected by climate and meteorological conditions at the site. The dispersion of releases to the atmosphere will be affected by prevailing wind speed and direction and by atmospheric stability at the point of release.

Air quality in the site vicinity is often important at sites using natural draft cooling towers because of the potential interaction of the moist tower plume with contaminants in the ambient air. The new unit will be required to comply with applicable air quality regulations and standards.

The geographical features of Armenia have a pronounced effect on both climate and meteorology. The climate is continental reflecting the long distance from Armenia to the open sea and the general direction from which major weather systems approach Armenia. Although the Black Sea and the Caspian Sea are a few hundred kilometers away and can affect local weather occasionally, weather is dominated more extensively by the weather systems coming south and eastward from Europe.

Approaching air masses lose much of their moisture as they rise over mountains to reach Armenia. As the air reaches Armenia, the moisture content is often low. The high elevations result in warm temperatures in the summer and cold temperatures in the winter.

The weather is further influenced by the mountain formations defining Armenia. Weather patterns are sometimes confined to, and to an extent steered by, the Main Caucasus Range to the north and the Ararat Range to the south

2.7.1 Armenia

Knowledge of the climate of Armenia is helpful in understanding the local meteorological phenomena that influence power plant impacts. It is helpful to look at the climate at the site in relation to the climate of a broad area.

The Republic of Armenia maintains a network of 66 meteorological monitoring stations across Armenia. Figure 2.7-1 shows the distribution of the stations (Ref [2.7-3]). At each station the following parameters are recorded]:

- Temperature
- Humidity
- Precipitation
- Wind speed and direction
- Solar radiation

There is a meteorological station located in the southeast corner of the ANPP site. It is outside of the controlled area north of the Greenhouse. The Greenhouse is building 45 on Figure 4.1-1. The on-site meterorological station is aging and is not functioning reliably. At the site, in addition to the standard meteorological observations radio-sounding and pilot-balloon observations up to the height of 300 m. were carried out. (Ref [2.7-13]). The onsite station is operated by the ANPP under an agreement with the Hydromet office and all data are submitted to Hydromet.

From the data collected across the Hydromet monitoring network for an extended period of time, the climate of Armenia has been described as follows (Ref: [2.7-9]):

> A great range of climatic zones have been recorded within Armenia. The country is located centrally in the sub-tropical zone, and thus is prone to arid (desert and semi-desert) conditions. However, the altitudinal variation within the country results in further variation in climatic zones, in addition to existing latitudinal clines.
>
> In general, the country receives a high amount of sunshine; ranging from 2600 hours per year (in Yerevan) to 2800 hours per year (shore of Lake Sevan). The average annual temperature varies geographically from 2.7°C (Mount Aragats) to 14°C (at Meghri).
>
> July and August are usually the warmest months , while average minimum temperatures recorded in winter vary geographically (from -3.1°C at Meghri in the northeast, to -18.9°C at Berdashen).
>
> Average annual precipitation is around 600 mm, but varies in different altitudinal zones (Table 2.7-1). Most precipitation occurs in the spring, while the second half of the summer is dry. Relative humidity averages 60% (ranging from 44% in summer to 80% in winter). Long lasting snows exist on mountains over 1300m. In these areas snowfall may reach 2m, while snowfall reaches 0.5m on the lower steppes (Ref [2.7-9]).

The climate data for the Republic of Armenia are summarized pictorially in the Atlas of Armenia. These data also are averages based on a long period of data collection. Figure 2.7-2, included here from the Atlas, shows the distribution of precipitation in Armenia. (Ref [2.7-11])

A recent study of wind resources of Armenia for the purpose of siting wind generating facilities includes analyses of wind for much of the country (Ref [2.7-6]). The report includes wind roses for many of the stations. The report omitted stations in the Ararat valley because wind speeds were judged to be too low for effective wind power generation. The Atlas, p. 64 (Ref [2.7-11]) contains a summary figure showing areas in Armenia favorable for wind power generation.

2.7.2 Climatology of the Site

Data for the monitoring stations nearest the site have been analyzed in detail in various reports related to the existing ANPP. The Safety Analysis Report for Unit 2 (Ref [2.7-10]), describes the climate at the site as follows:

Spring is humid, with highly variable weather. Summer is usually dry and hot. The average monthly temperature in July and August is more than 25°C, with the maximum reaching 41°C. The beginning of fall is warm and sunny. A sharp temperature drop of 7-8°C occurs in the transition from September to October.

The climate of the ANPP site area is characterized by meteorological observation data from the Hoktemberyan weather station [Ed. Note: This is now called the Armavir meteorological station.], which is 10 km from the site, and the Yerevan AGRO [Ed. Note: The Yerevan Station is no longer in operation.] weather station, which, while fairly distant from the site, has practically the same local readings.

Below is a summary of the key elements of the meteorological conditions, compiled from many years of observations by the aforementioned weather stations.

Average annual daily air temperature, 12.4°C.

Average temperature of the coldest month (January), minus 3.3°C.

Average temperature of the hottest month (July), 25.9°C.

Absolute maximum air temperature, 41°C.

Absolute minimum air temperature, minus 29°C.

Average annual wind velocity, 2.0 m/sec.

Average annual relative air humidity, 59%.

Rated wind pressure for the plant site 10 m above ground level, 42 kg/m^2.

Duration of winter period, 3 months.

Annual amount of precipitation, 312 mm.

Maximum height of snow cover, 42 cm.

Frost line of ground, 0.3 m.

Snow load, 80 kg/m^2.

In snowdrift locations (snow banks) the load can increase to 160 kg/m^2.

The seasonal climate changes extend over a wide range. Table 2.7-2 shows, by month, the range of the key elements of the climate at the site. These data were compiled from many years of observations by the Armavir and AGRO monitoring stations.

2.7.3 Meteorology of the Site

Meteorological conditions at or near the site are used to determine the dispersion of releases to the atmosphere and to calculate the radiological doses due to those releases. Wind data for all stations are available from the RoA Hydromet office, including data from the onsite monitoring station. All Hydromet stations measure wind speed and direction 10 m above the ground at 3 hour intervals. Data are recorded digitally at some stations. At the onsite station wind speed is also measured 10 m above the ground, but only at 4 hour intervals. The onsite data are read from the instruments and recorded manually.

Because of the poor reliability of the data collected on site, complete data were requested for three years (2004, 2005, and 2006) for the Amberd, Armavir, and Artash stations and from the onsite station and there were gaps in the data collection. Therefore, the data could not be used. Data were subsequently obtained from the Zvartnots Airport meteorological station. The analyses utilizing the detailed data are discussed in Chapter 7, Analysis of Postulated Accidents Involving Radioactive Materials.

Wind data collected over a longer time period are more valuable for illustrating prevailing meteorological conditions. The Atlas of Armenia (Ref [2.7-15]) includes four plates summarizing wind speed data as wind roses for all meteorological monitoring stations. The four plates are for January, April, July, and October. These plates are included here

as Figures 2.7-3, 2.7-4, 2.7-5, and 2.7-6. A wind roses show a significant variability of wind in both magnitude and direction seasonally and across the country.

Wind Roses were not computed using recent data collected at the ANPP on site meteorological monitoring Station. The ANPP presented typical wind roses based on the on-site station [2.7-17]. The typical wind roses for the same months as the Atlas and for the annual average are included here as Figure 2.7-7.

An additional aspect of meteorology utilized in the dispersion analysis is the stability of the atmosphere. A determination of stability is usually made by using measurements of air temperature at two heights above the ground. The meteorological stations in Armenia collect data at only one height. However, study of atmospheric stability was performed during the planning of the original ANPP.

In a 1984 study, categories of stability had been calculated according to the methodology of the Leningrad Institute of Hydro-Meteorology based on the data of fixed-period observations carried out at meteorological station of ANPP for 1971-1972. These 1984 study results were more recently summarized (Ref [2.7-13)]. Since other data allowing the computation of stability are not available, the tables from the recent summary are reproduced here as Table 2.7-3 and Table 2.7-4.

Additional observations on stability of the atmosphere at the site were provided (Ref [2.7-13]).

> At night time, during the whole year a stable state of air is observed up to the height of 600 m. Instability develops in summer, in the day time, usually up to the height of 100-300 m. and rarely up to the height of 600 m.
>
> In condition of absolute stability in winter in the night-time, inversions (with gentle breeze) with height of 450-500 m may be observed close to the ground, which hinder ascending motions. This may cause favorable conditions for falling of emissions from the ventilation stack.

The final EA should include dose analyses based on site-specific meteorological data. This will require the installation of new, reliable meteorological monitoring equipment on the site. The monitoring equipment should be designed, installed and utilized to collect data that will be compatible with approved computer-based dose analysis models. Measurements should be made at two elevations to determine atmospheric stability corresponding to the wind velocity measurements.

The analysis of meteorological data performed for the NPP addressed extreme weather events. The maximum observed wind speed at the Armavir meteorological station is 24 m/s. The maximum reported gust is 32 m/s. The maximum wind speeds expected at specified recurrence intervals are shown in table 2.7-5:

The ANPP provided the following comment obtained through “Recommendations on Definition of Designed Characteristics of Tornadoes in Location of Nuclear Power Plants” by AtomEnergyProject, 1991. (Ref [2.7-13]):

> With regard to tornado risk, Armenia is situated in the III graded region Annual probability of tornado occurrence is within the region $19*10^{-7}$ (Ref [2.3-14]). The designed intensity class of probable tornado is 1,07. Maximum horizontal speed of its rotation wall is 43 m/s, pressure differences between the peripheries and the center of funnel-formed tornado is 22 gPa.

> Information on tornadoes was received through "Recommendations on Definition of Designed Characteristics of Tornadoes in Location of Nuclear Power Plants" by AtomEnergyProject, 1991.
>
> Tornado risk in the region of the ANPP site was additionally observed in 1994 by KAMEK Company. According to the results of implemented works, it was stated that the ANPP site does not have tornado risks and there is no need for carrying out activities targeted at protection of spray ponds from tornado effects.

Based only on the rotation wall velocity, this would be in the Range of Fujita category F2.

2.7.4 Air quality

The RoA State of the Environment report (Ref [2.7-8]) describes air quality in Armenia as follows:

> Functions to monitor the state of air are given to the Environmental Impact Monitoring Center, a State Non-Commercial Organization of the Ministry of Nature Protection.
>
> Since 1999, air quality has been monitored as the Armenian cities: Alaverdi, Ararat, Yerevan and Vanadzor (11 permanent monitoring sites) as well as in Gyumri and Hrazdan. Four main pollutants (dust, sulphur dioxide, carbon monoxide and nitrogen dioxide) are monitored in Alaverdi, Yerevan and Vanadzor. Only dust is monitored in Ararat, Gyumri and Hrazdan. In the period 1997-2002, there were no cases of "high" or "extremely high" levels of air pollution.
>
> In 2002 the average annual concentrations of hazardous substances monitored in the atmosphere were in excess of MPC (maximum permissible concentration) in the six cities. Concentrations in excess of maximum one-time concentrations were recorded for dust (in Yerevan, Ararat, Alaverdi, Hrazdan, and Gyumri), for sulphur dioxide and for nitrogen oxides (in Yerevan, Vanadzor, and Alaverdi). In Ararat and Hrazdan, dust concentration were 5 times above MPC. In all of the cities average annual concentrations of nitrogen oxides (one of the components of photochemical smog) were in excess of MPC.

The monitoring locations are intentionally located in areas of degraded air quality. The data may not be representative of conditions nearer the ANPP site.

The closest industrial activity to the site is in Armavir, about 9 km from the power plant. There is no major chemical industry in Armavir.

One ambient air contaminant at the site is dust. The ANPP reports that dust storms occur frequently in summer. In winter they occur very seldom. In accordance with the ANPP monitoring station data for 1970-1980, the average annual number of days with dust storms was 9.1 days in the region of Armenian Nuclear Power plant. In 1970 it was reported that dust storms occurred on 21 days. Nine of these days were in May (Ref [2.7-13]).

Very often, the duration of dust storms does not exceed 1.5 hours. According to the ANPP monitoring station data, the maximum duration of dust storms equaled 6.42 hours. This occurred on 21 June 1971 (Ref [2.7-13]).

Table 2.7-1, Maximum average monthly temperatures in summer and annual rainfall in different altitude zones

Altitude Zone	Average Temperature in Summer, degrees C	Annual Rainfall, mm
Low Level	24 to 26	250 to 300
Mid Level	15 to 20	400 to 600
High Level	10 to 15	700 to 1000

Table 2.7- 2, Summary Climate Data for the ANPP Meteorological Station

Weather element \ Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Air temperature, °C	avg	-1.4	-1.7	4.9	12.2	17.6	21.9	26.2	25.9	21.6	14.8	7.2	-0.6	12.1
	max	16	21	23	31	35	39	41	40	39	34	25	17	41
	min	-28	-28	-21	-6	3	6	12	10	0	-1	-13	-30	-30
Humidity	Relative %	74	67	62	54	54	48	44	45	45	53	67	74	56
	Absolute mb	3.9	4.4	5.5	7.8	10.8	12.4	14.3	14.3	11.6	8.7	7.2	4.6	8.7
Atmospheric precipitation, mm		30	30	32	38	50	40	12	9	12	28	34	25	340
Wind, m/sec		1.1	1.5	2.3	2.7	2.6	2.6	3.0	3.0	2.3	1.6	1.3	0.9	2.1
Hail, days		-	0.12	0.12	0.5	0.4	0.6	0.13	-	-	0.18	-	-	2.4
Cloud cover, scale level		6.6	6.3	6.5	6.0	5.5	3.7	2.7	2.3	2.3	3.8	5.2	6.2	4.8
Thunderstorms, days		-	0.2	0.6	3.5	9.2	8.4	4.2	2.7	1.8	1.2	0.4	0.04	32.6
Dust storms, day		0.2	0.2	0.2	1.2	2.4	1.6	0.8	0.8	1.1	0.7	0	0	9.1
Frost, days		3.7	2.7	0.1	-	-	-	-	-	-	-	-	1.7	8.2
Fog, days		13	7	2	0.2	0.1	0.2	-	-	0.1	1	4	10	38
Snowstorms, days		0.2	0.3	0.1	-	-	-	-	-	-	-	-	-	0.6

Table 2.7-3, Frequency of occurrence of stability categories (%) by seasons and for one year

Category	Winter (12-2)	Spring (3-5)	Summer (6-8)	Autumn (9-11)	Year (1-12)
I - very stable	45.7	33.0	31.9	39.7	37.6
II – moderate stable	.42	5.16	6.25	3.98	4.96
III - weakly stable	4.14	11.0	11.4	5.36	8.00
IV – neutral	11.3	3.12	0.82	2.75	4.48
V – weakly unstable	5.94	6.39	3.26	3.43	4.75
VI- moderate unstable	5.52	4.35	4.62	4.67	4.79
VII- very unstable	22.9	37.0	41.7	40.1	35.5

Table 2.7-4, Combined repeatability of stability categories, speed and directions of wind during the year for the Meteorological station of ANPP (1971-1972)

Wind Speed range	N	NE	E	SE	S	SW	W	NW	Total
Stability Category I- Very Stable - Repeatability 37.6%									
0									28.2
0.5-1	0.65	0.62	0.92	0.38	0.24		0.51	0.21	3.52
2-3	0.24	2.05	2.19	0.10	0.31	0.24	0.44	0.17	5.75
4-5						0.03			0.03
6-7									
>8							0.03		0.03
Total	0.89	2.67	3.11	0.48	0.55	0.27	0.99	0.38	37.6
Stability Category II – Moderately Stable - Repeatability 4.96%									
0									0.38
0.5-1			0.07					0.03	0.10
2-3	0.14	0.72	0.61	0.07	0.17	0.03	0.21	0.21	2.15
4-5	0.14	0.85	0.68	0.14	0.03	0.14	0.24	0.10	2.33
6-7									
>8									
Total	0.27	1.57	1.37	0.21	0.21	0.17	0.44	0.34	4.96
Stability Category III – Weakly Stable - Repeatability 8.00%									
0									0.17
0.5-1	0.03				0.03				0.07
2-3	0.24	0.07	0.41	0.03	0.14	0.07	0.07	0.10	1.13
4-5	0.44	1.16	0.99		0.10	0.31	0.21	0.34	3.56
6-7	0.14	0.79	0.34	0.03		0.07	0.38	0.24	1.98
>8	0.21	0.44	0.17				0.21	0.07	1.09
Total	1.06	2.46	1.92	0.07	0.27	0.44	0.85	0.75	8.00
Stability Category IV – Neutral - Repeatability 4.48%									
0									1.30
0.5-1		0.07	0.07		0.03				0.17
2-3	0.07	0.27	0.62	0.03	0.07		0.03		1.09
4-5	0.07	0.03	0.17			0.03	0.10	0.07	0.48
6-7	0.07	0.10	0.14			0.07	0.24	0.07	0.68
>8	0.03	0.03	0.07			0.07	0.31	0.24	0.75
Total	0.24	0.51	1.06	0.03	0.10	0.17	0.68	0.38	4.48
Stability Category V – Weakly Unstable - Repeatability 4.75%									
0									0.65
0.5-1		0.03		0.07	0.07	0.03			0.21
2-3	0.10	0.10	0.58	0.03	0.14	0.03	0.10	0.10	1.20
4-5	0.14	0.38	0.55	0.03		0.03	0.17	0.07	1.37
6-7	0.07	0.17	0.38	0.03	0.07	0.14	0.17	0.03	1.06
>8	0.07	0.07				0.03	0.07	0.03	0.27
Total	0.38	0.73	1.50	0.17	0.27	0.27	0.51	0.24	4.75
Stability Category VI – Moderately Unstable - Repeatability 4.82%									
0									0.79
0.5-1	0.07	0.10	0.31	0.07	0.03	0.03			0.21
2-3	0.10	0.03	0.75	0.10	0.27	0.21	0.07		1.20
4-5	0.07	0.31	0.79	0.21	0.17	0.07	0.14	0.10	1.37
6-7									1.06

Wind Speed range	N	NE	E	SE	S	SW	W	NW	Total
>8									0.27
Total	0.24	0.44	1.85	0.38	0.48	0.31	0.21	0.10	4.82
Stability Category VII – Very Unstable - Repeatability 35.5%									
0									14.3
0.5-1	0.72	0.89	3.52	0.89	1.23	0.27	0.48	0.03	8.04
2-3	0.48	1.33	5.75	1.47	1.27	0.31	0.55	0.10	11.3
4-5	0.07	0.41	1.03	0.14	0.10	0.03	0.14		1.92
6-7									
>8									
Total	1.27	2.63	10.3	2.50	2.60	0.62	1.16	0.14	35.5

Table 2.7-5, Maximum expected wind velocity at various frequencies of recurrence.

Recurrence interval, years	1 year	5 years	10 years	100 years	1000 years	10000 years
Wind Speed m/s	17 m/s	22 m/s	24 m/s	33 m/s	37 m/s	41 m/s

Figure: 2.7-1, Meteorological Monitoring Stations in Armenia

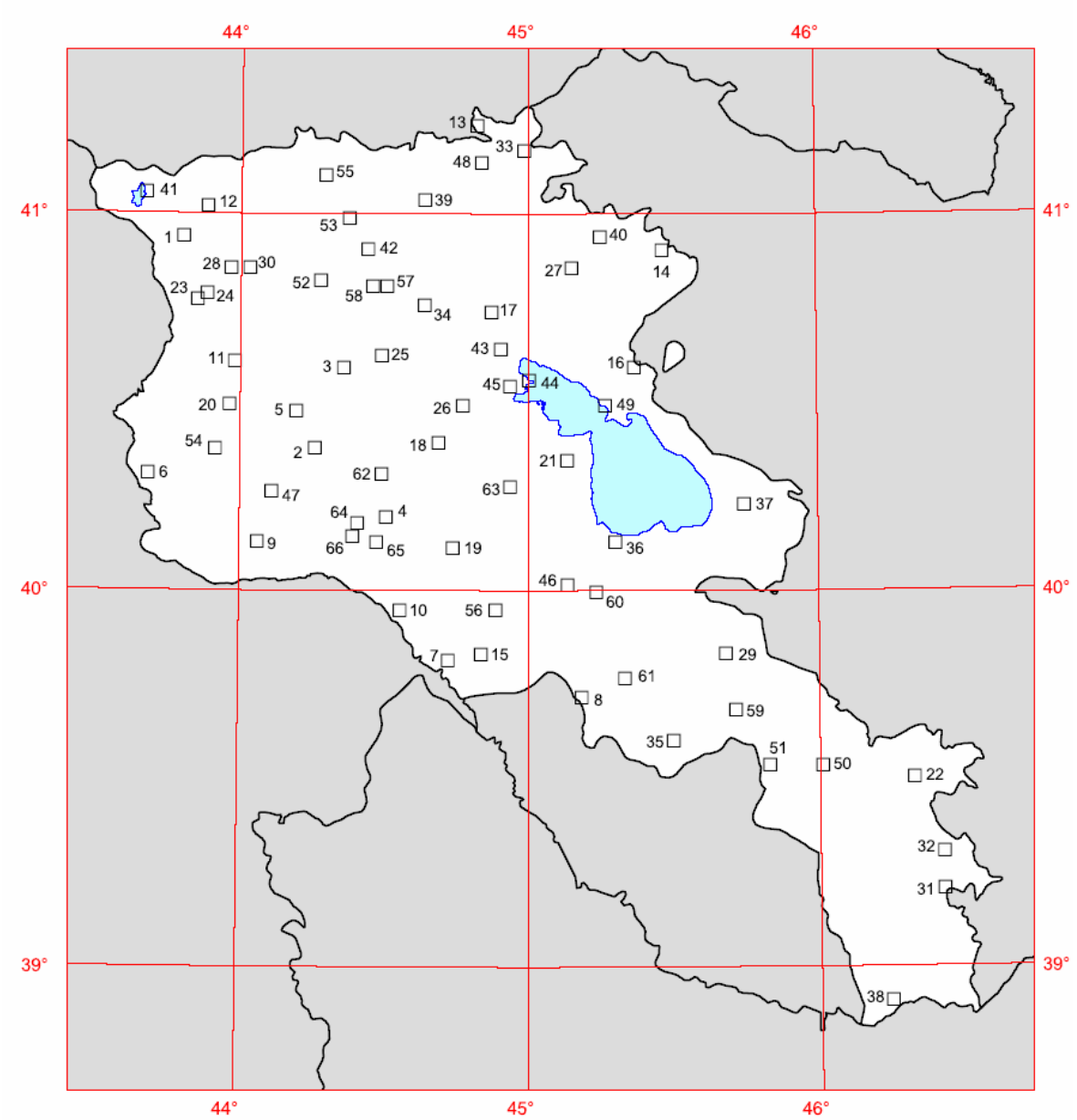


FIGURE 2.7 – 2, Distribution of precipitation across Armenia

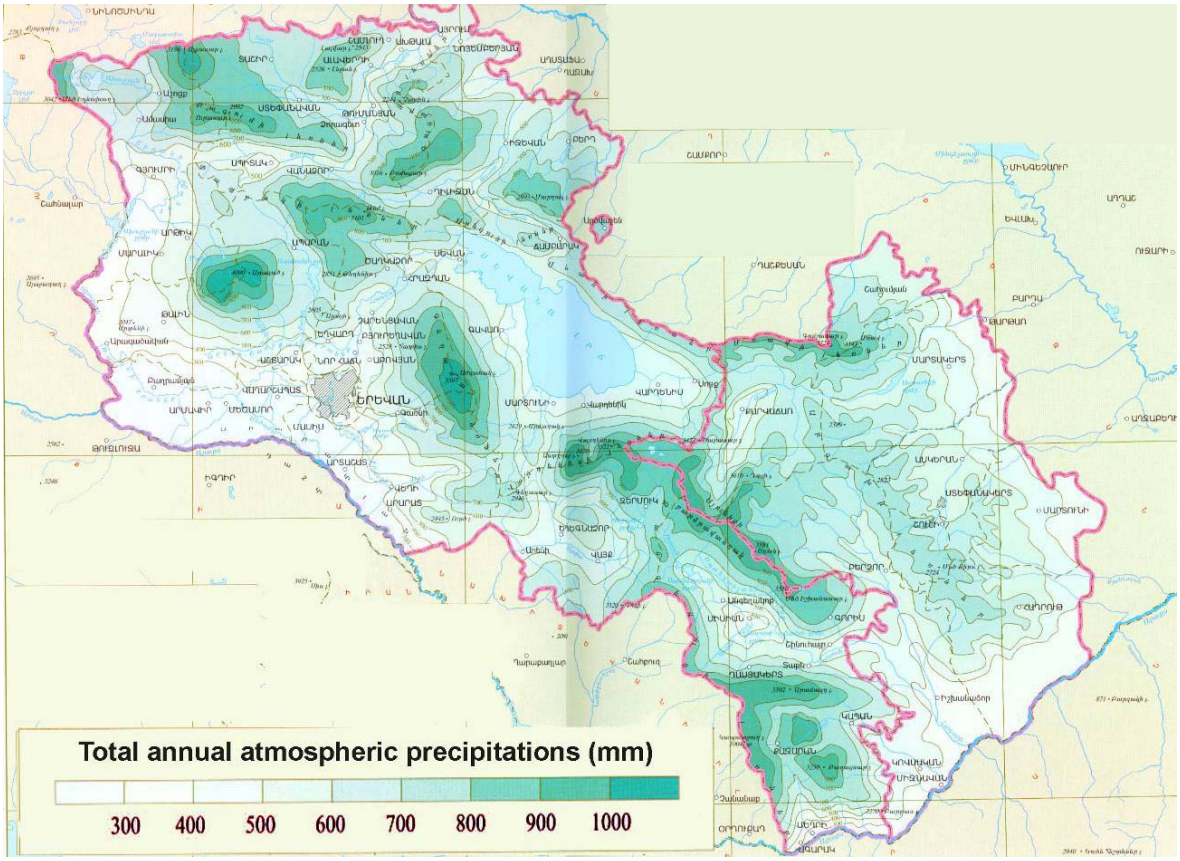


FIGURE 2.7 – 3, Meteorological data for January

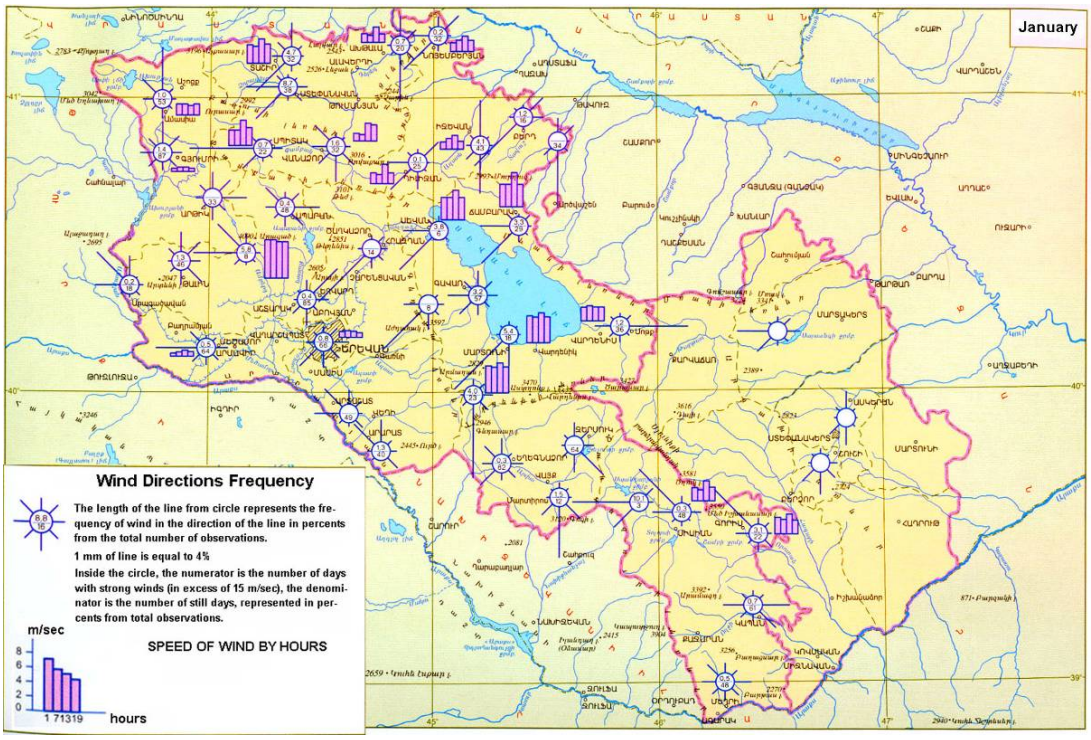


FIGURE 2.7 – 4, Meteorological data for April

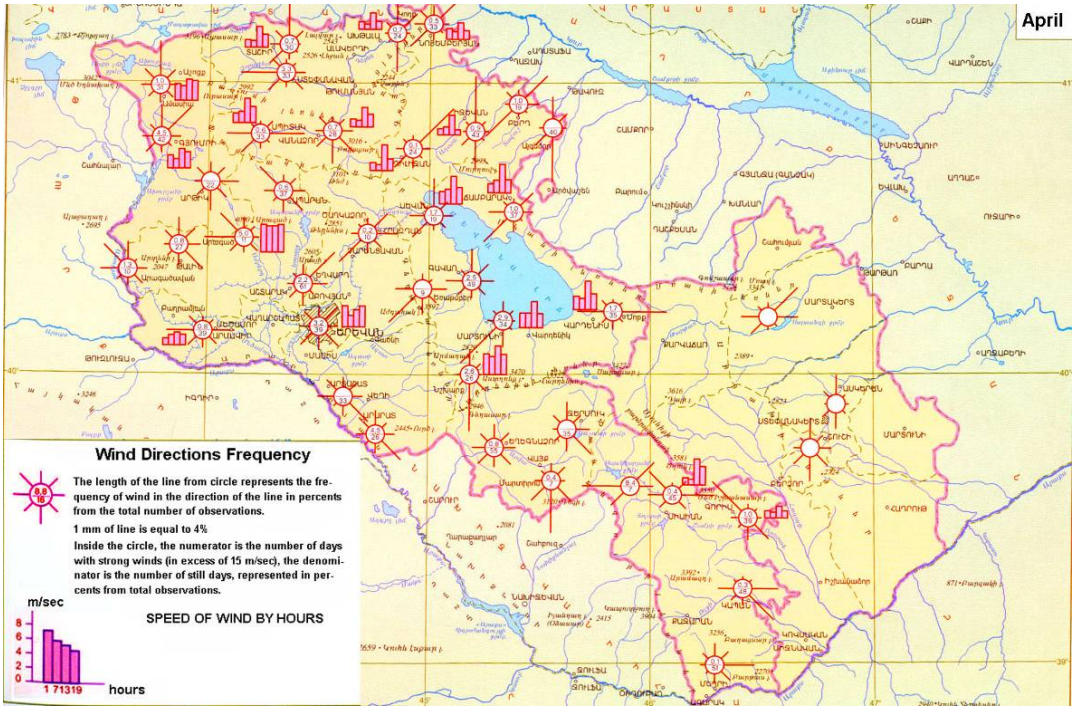


FIGURE 2.7 – 5, Meteorological data for July

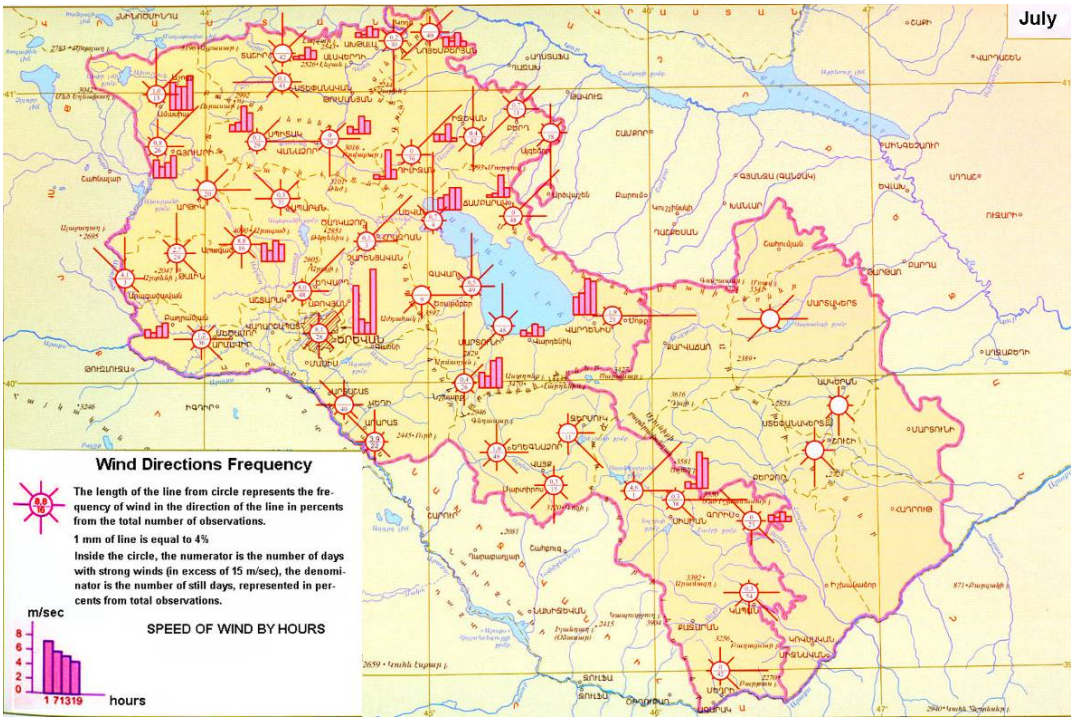


FIGURE 2.7 – 6, Meteorological data for October

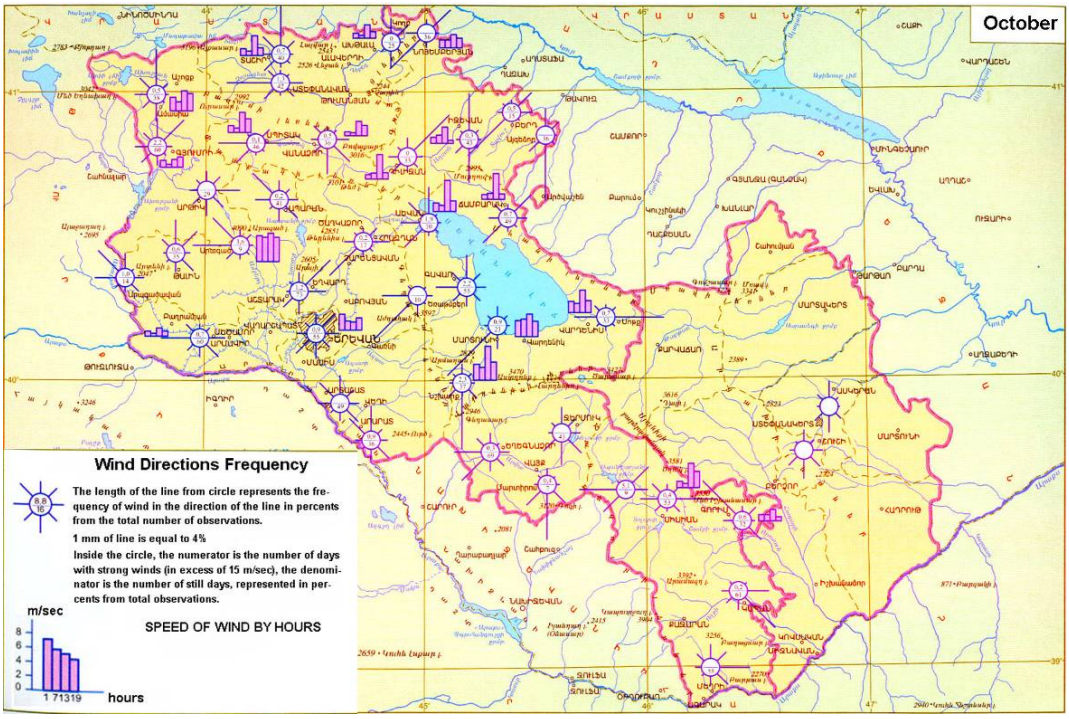
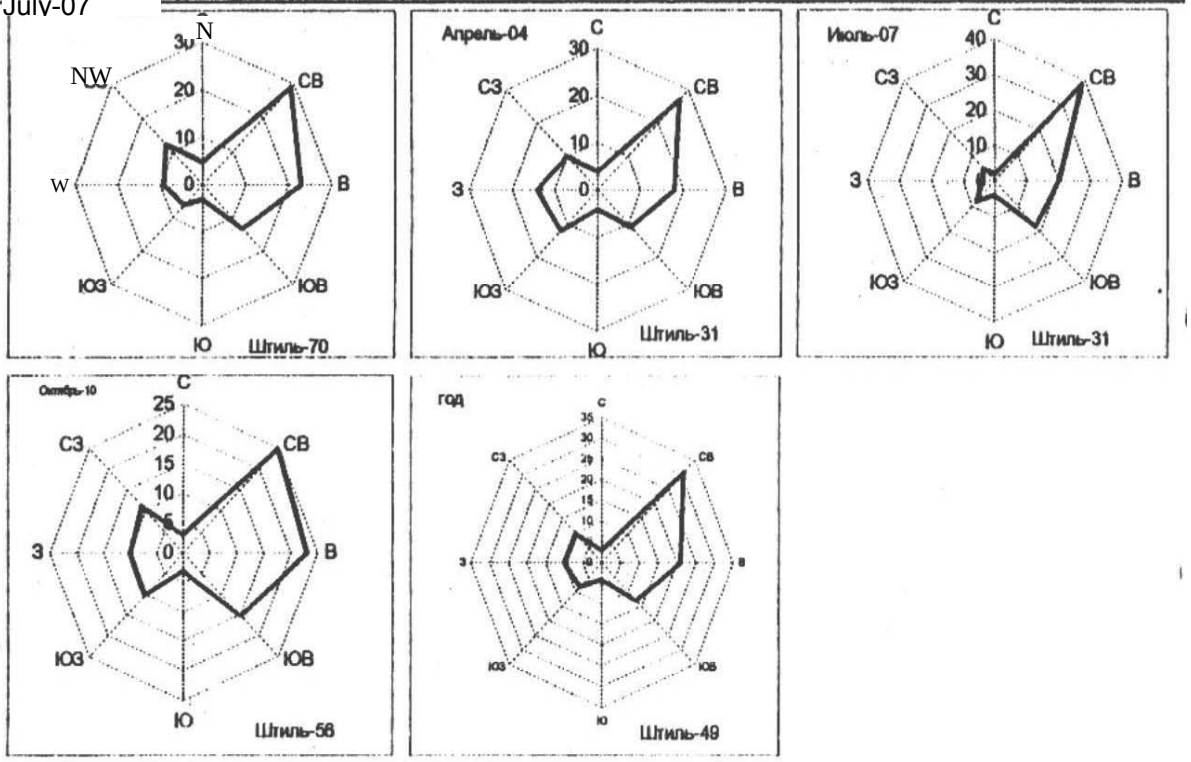


Figure 2.7-7, Typical Wind Roses by Season Using the Data from the ANPP Meteorological Monitoring Station. [2.7-17]

			E	SE	S		W	NW	
	5	29	23	13	3	6	9	12	70
January-01	4	27	18	11	4	12	14	10	31
	2	39	20	18	4	8	4	5	31
April-04	3	25	23	15	3	10	10	11	56
	3	31	21	13	4	8	10	10	49

Julv-07



REFERENCES:

[2.7-1] Ministry of Nature Protection of the Republic of Armenia, *State of the Environment Report for Armenia Year 2000," Includes a section on air quality.* The Report is available on the internet at the following link: http://enrin.grida.no/htmls/armenia/soe2000/eng/index.htm.

[2.7-2] "The participation of the Republic of Armenia in the Convention on Long-range Transboundary Air Pollution," unofficial translation, 1997.

[2.7-3] Republic of Armenia Hydromet Office, undated, *The network of Meteorological Stations in Armenia*

[2.7-5] "First National Communication Of The Republic Of Armenia Under The United Nations Framework Convention On Climate Change," October - 1998

[2.7-6] D. Elliott, M. Schwartz, G. Scott, S. Haymes, D.Heimiller, R. George, July 2003, *Wind Energy Resource Atlas of Armenia*, National Renewable Energy Laboratory, Prepared under Task No. WF7C0202.

[2.7-7] Republic of Armenia Ministry of Nature Protection, 2003, *National Report on the State of the Environment in Armenia in 2002*. Yerevan.

[2.7-8] Information Analysis Center of the Ministry of Nature Protection of the Republic of Armenia, 2003, *National Report on the State of the Environment of the Republic of Armenia in 2002*, Chapter 1, Air Quality, Yerevan.

[2.7-9] Republic of Armenia Ministry of Nature Protection, March 1999, *Republic of Armenia First National Report to The Convention on Biological Diversity, incorporating A Country Study on the Biodiversity of Armenia,* Yerevan.

[2.7-10] CJSC "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, (Revision 1)

[2.7-11] Republic of Armenia State Land Cadastre, October 2007 *Atlas of Armenia*, plate 53

[2.7-12] RoA Government Decree No. 67, Dated January 11, 2007, *On Approval Of Technical Regulations Of Standards For Composition Of Atmospheric Emissions And Control Methods*

[2.7-13] Ministry of Atomic Energy of Russian Federation, State Unitarian Enterprise Scientific and Design-Construction Institute, 2001, *ANPP Unit 2 Essential Service Water Cooling System, Technical Report* A-67217.

[2.7-14] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of Armenian Nuclear Power Plant*, Appendix 12.

[2.7-15] Republic of Armenia Ministry of Nature Protection. *State of the Environment Report for Armenia Year 1998,* Available on the Internet at the following link: http://enrin.grida.no/htmls/armenia/soe_armenia/soeeng.htm

[2.7-16] Republic of Armenia State Land Cadastre, October 2007 *Atlas of Armenia*, plates 57 and 58.

[2.7-17] CJSC “Armenian Nuclear Power Plant”, 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, (Revision 1), section 1.4.6, p 16

Environmental Background Information Document

Chapter 3: Project Description

October 2008

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3. PROJECT DESCRIPTION

This Environmental Background Information Document does not provide the detailed design of the reactor considered for ANPP Unit 3. Rather, it provides bounding parameters and characteristics of these components so that an assessment of potential environmental impacts (and coincidently feasibility) of a new nuclear unit can be made. This is done by use of a plant parameter envelope (PPE) as a surrogate for the nuclear power plant and its associated facilities. The details of PPE development are discussed in section 3.2 and resulting parameters are provided in Appendix 3.2A.

Section 3.1 describes the layout, landscaping, and architectural features of the proposed project and other existing station structures. This includes related facilities such as station access roads and railroads.

Section 3.2 identifies the types and sizes of reactors and electrical generating equipment considered for evaluation and their major performance parameters as tabulated in the Plant Performance Envelope (PPE – Appendix 3.2A). This information supports subsequent environmental reviews that assess operational impacts and commitments of resources.

Section 3.3 addresses plant water use and treatment. Section 3.3.1, referring to the Plant Parameter Envelope (PPE), describes the quantity of water required for plant operation, the amount of water consumed by the plant water systems, and the amount of water discharged to the environment. Section 3.3.2 summarizes the treatment needed for the plant water streams identified in section 3.3.1 using the water supplies described in sections 2.3.1 and 2.3.3. This includes a description of water treatment processes for demineralized water, cooling and recirculating systems. (Identification and quantification of the chemicals used is provided in section 3.6.)

Section 3.4 describes the condenser cooling, component cooling and ultimate heat sink systems. The possible plant cooling system designs are described in Section 3.4.1, which also discusses the anticipated modes of operation for the cooling systems. Section 3.4.2 describes the intake, discharge, and heat dissipation system designs and performance characteristics during each operating mode.

Section 3.5 describes the design of radioactive waste management and effluent control systems, including a determination of the expected quantity of radioactive materials released annually in liquid and gaseous effluents (source terms) resulting from normal operation as reflected in the PPE.

Section 3.6 describes the nonradioactive waste systems. The chemical and biocidal characteristics of each nonradioactive waste stream discharged from the unit are described in Section 3.6.1. Section 3.6.2 describes the sanitary effluent systems to identify anticipated volumes generated during construction and operation, the treatment systems to be employed, and points of discharge to surface waters. Section 3.6.3 describes miscellaneous gaseous, liquid, and solid effluents, including identification and quantification of these wastes and their proposed treatment and disposal methods.

Section 3.7 covers the power transmission system. It describes upgrades and modifications to the power transmission system that will be necessary for Unit 3. The description includes the transmission system from the plant switchyard to its connections with existing systems, including lines, corridors, towers, access roads, substations, and communication stations.

Section 3.8 covers transportation and storage of spent fuel and radioactive materials associated with Unit 3. This section summarizes the results of the Initial Planning Study examination of options for waste management and disposal of spent nuclear fuel for Unit 3. {The final environmental assessment should also reflect the strategy for radioactive waste management in Armenia developed by ANRA (now the State Committee for Regulation of Nuclear Safety), when it is promulgated.} Information from the Initial Planning Study is used to develop transportation scenarios for Unit 3.

3.1 EXTERNAL APPEARANCE AND PLANT LAYOUT

Armenian Nuclear Power Plant Unit 3 (ANPP Unit 3) is located on the ANPP site near Metsamor Town, Armavir Marz (Province). ANPP is approximately 9.2 km east-northeast of Armavir Town, and approximately 32 km west of the Armenian capitol city of Yerevan. Further information related to the site location is provided in section 2.1 of this document. The site lies in the western part of the Ararat Valley, Hoktemberyan (or Armavir) basin, on the southern flanks of Mount Aragats. The site's location is illustrated in Figures 2.1-1 through 2.1-3.

The ANPP site, with a nominal elevation of approximately 930 m above sea level, sits above and is visible from much of the Hoktemberyan basin. Within the site vicinity, only territory in sectors from the west-northwest to northeast lie above the site elevation and are screened from the site by geographical features. During clear weather, the existing cooling towers are visible from Vagharshapat (Echmiadzin) 13 km to the east and the cooling tower plume is sometimes visible from Yerevan, more than 32 km away.

The site boundary line is illustrated in Figure 2.1-4. The station property lines are the same as the site boundary lines, although only a portion of the site is fenced. The exclusion area boundary is assumed to be 800 m from the centerline of the reactor; however the site boundaries as shown in Figure 2.1-4 to the south of the expected reactor location are closer than this distance. Analyses of radiation impacts must take into account the actual distances to the site boundary. The access road and railroad to the site, as well as the highways, railways, and waterways in the vicinity of the site, are illustrated in Figure 2.1-3.

The site layout developed for ANPP Phase 2 (VVER-440 Units 3 and 4) is shown in Figure 3.1-1.

Three candidate reactor designs are encompassed by the present description: the AP1000; the CANDU-6; and VVER-1000. The selected reactor will have a thermal power rating between 2064 (CANDU-6) and 3415 MWth. For assessment of environmental impacts of a new unit, the higher power rating is assumed, unless stated otherwise. The site layouts for these three designs are reflected in Figures 3.1-2, -3, and -4.

Site features and structures are depicted as follows:

- The gaseous release points and their elevations are discussed in Sections 3.5 and 3.6. Structure locations are depicted in Figures 3.1-2, -3, and -4.
- The liquid release points are discussed in Section 3.6. Onsite structure locations are depicted in Figures 3.1-2, -3, and -4.
- The location of the existing meteorological tower is illustrated in Figure 3.1-5.
- The construction site plan is illustrated in Figure 3.1-5.
- The land to be cleared is indicated in Figure 2.1-4; Figure 4.1-1 identifies the location for placement of excavated material.

The site for Unit 3 is encompassed by land owned and controlled by the Closed Joint Stock Company Armenian Nuclear Power Plant operating organization (CJSC ANPP) for the principal purpose of operating nuclear power stations. The site currently has two power-generating units with Soviet-designed VVER-440 (V-270) reactors with power capacity of 407.5 MWe each (referred to as ANPP Phase 1). Unit 1 is permanently shutdown and Unit 2 is expected to be in operation through 2015. Four natural-draft cooling towers provided cooling for the two existing units with makeup water supplied by underground pipelines from the Sevjur River. The original design for Phase 1 was for two cooling towers to serve each unit. During summer months, three of the four cooling towers are necessary to maintain cooling water temperatures for efficient operation of Unit 2.

The ANPP site was originally planned to include four total VVER-440 reactors, with Phase 2 (Units 3 and 4) to be situated to the west of Units 1 and 2. Conceptual designs were developed for ancillary systems, such as raw water supplies, to support Phase 2, and some elements of these designs were implemented and are used to support continued operation of Unit 2. Preliminary site clearance for Phase 2 was conducted in the early 1980's, but construction of further units at ANPP was never begun. ANPP Unit 3 will occupy the area previously planned for the Phase 2 units. As discussed below, the area previously designated for the Phase 2 cooling towers is partially occupied by the Unit 2 essential service water spray ponds.

The ANPP site is illustrated in Figure 2.1-4, which identifies the location of the proposed new unit, structures of the existing Units 1 and 2, and existing support buildings. Alternate plant layouts are illustrated in Figures 3.1-2 through 3.1-4 for the three candidate reactors. Table 3.1-1 provides a legend to identify existing and proposed new structures on Figures 3.1-2 through -4.

3.1.1 External Appearance and Plant Layout, All Reactors

Each of the three reactor designs incorporate structures that are common to most NPPs.

The turbine building for ANPP Unit 3 is a steel column and beam structure of rectangular footprint. In all cases, the turbine building height will be less than for the reactor containment building. The overall size will differ slightly, with AP1000 and VVER-1000 turbines (nominally 1000 MWe) approximately the same size, but CANDU-6 (~740 MWe) would be somewhat smaller. The turbine building will house the turbine generator, condenser, condensate and feedwater systems and the demineralized water system[1].

Additional plant structures include warehouses, administration/office buildings, the training building, and the switchyard and transmission towers.

The existing units of ANPP have buildings for administration and offices; however, since Unit 2 is expected to be operating during the Unit 3 construction period and enter decommissioning shortly after Unit 3 is operational, new administration and office buildings for Unit 3 will be included in its construction. Construction support buildings to the west of the new reactor location, which remain from the period of site preparation for the suspended Phase 2 construction, will be demolished and/or renovated as necessary

[1] Some plants, including many VVERs, use two turbine generators and condensers per unit, housed in a common turbine hall.

to support construction of Unit 3. These buildings may continue to serve as warehouse and support facilities for Unit 3 outages and decommissioning of Units 1 and 2.

The training building for ANPP Unit 2 is in the western portion of the site, among the construction support structures discussed above. This building will be renovated and expanded to accommodate a full-scope simulator for Unit 3.

The existing switchyard will be extended by 100 m to the west and a 400 kV transmission line will be added to increase the capacity of the transmission system to the Armenian power grid. In addition, a 400 kV transmission line may be added to transmit power to a substation in Turkey, but this line is not required to meet capacity needs for Unit 3 and if constructed will be installed after Unit 3 is commissioned; therefore is not evaluated further as part of this EBID. Existing switchyard equipment and transmission lines will need renovation and upgrade to serve the new Unit 3; however the general appearance and layout will remain much the same as now (see further discussion in Section 3.7).

Should a single natural draft cooling be chosen for condenser cooling, it will be the most visible plant feature for Unit 3. A natural draft tower could be as tall as 170 m, compared with the existing Phase 1 cooling towers that are 110 m in height. As discussed in section 3.4, alternative cooling systems would not be as tall, but may require more land area to accommodate cooling tower equipment. Although architecturally pleasing to some people, natural draft cooling towers are taken by many as symbols that represent an ever-present danger of radiation. Should a natural draft tower be erected for Unit 3, it will be visible over large portions of Armavir marz and in the territory of Turkey adjacent to the Araks River.

Other than a natural draft cooling tower, the tallest and most visible structure will be the reactor building that will rise approximately 72 meters above grade level (VVER-1000, with other reactors of less height). In the event that the selected reactor is a VVER-1000, the tallest structure will probably be the ventilation stack, approximately 100 m in height.

The off-site pumping stations that supply makeup water to the existing ANPP units will also serve Unit 3, as well. The pumping station buildings are low-rise structures near the village of Taronik. The pumping systems will be upgraded to serve Unit 3, but the existing structures will be adequate and no new structures will be required. (See more detail and discussion in Section 3.4.)

Safety upgrades for Unit 2 included construction in 2000 of spray ponds for the essential service water system. These spray ponds are located to the northwest of the ANPP switchyard, occupying some of the area originally allocated for the Phase 2 cooling towers. These spray ponds occupy 0.4 ha of land. Spray ponds for cooling of the Unit 3 service water system will be located adjacent to the Unit 2 essential service water ponds if space is available; otherwise they may be located near the area indicated for the cooling tower. Mechanical cooling towers for the circulating water system, if selected in lieu of a natural-draft tower, and for the service water system, if selected in lieu of spray ponds, will be constructed in the same vicinity. Mechanical towers and spray ponds and associated coolant channels and pumping facilities will be low-rise structures that will not have a visual impact beyond the site.

Construction and operation of Unit 3 will employ the existing access roads to the site from Republican Highway M-5; one from the southwest, leading through Metsamor Town, and the other from the southeast along the pipeline access corridor. Should these access roads require upgrading to support construction, the same alignments will be used and their appearance will be much the same as now.

The ANPP site is currently served by a rail-access spur that links the plant site (Arshaluis station) with the Armavir station of the Yerevan-Tbilisi railway. This spur is used for transportation of operating staff of ANPP Units 1 and 2 and may also serve the construction workforce. Any modification of the rail spur to support construction or operation of Unit 3 will involve no more than a few hundred meters of track and be totally within the existing ANPP boundaries.

The overall plant arrangement for ANPP Unit 3 is such that building configurations and structural designs minimize the building volumes and quantities of bulk materials (concrete, structural steel, rebar) consistent with safety, operational, maintenance, and structural needs to provide an aesthetically pleasing effect.

The ANPP site has moderately rugged terrain with absolute marks of 927-949 m above sea level. The site vicinity is natural desert landscape and except for low-lying areas near the Sevjur River, has few trees. Natural features of the site are preserved as much as possible but offer little to reduce the station's impact on the visual environment. Landscaping for the site, areas adjacent to the structures and in the parking areas blend with the natural surroundings.

Figure 3.1-5 {to be added by the developer of the final environmental assessment} is an architectural rendering of the site with the addition of Unit 3. Photographs which show the station from several vantage points where a visual impact can be expected are included in Figures 3.1-6, 3.1-7, 3.1-8, and 3.1-9. These photographs have been modified to depict the likeness of the ANPP Unit 3 as described below. Figure 3.1-6 illustrates the visual impact from a nearby residential vantage point “Collective Gardening Society of State Farm Maisyan”, a residential and dacha settlement near the western ANPP guard station. Figure 3.1-7 illustrates the visual impact from a local transportation corridor, the Republican M-5 highway at the junction with the eastern ANPP access road. Figure 3.1-8 illustrates the visual impact from a cultural vantage point, the Metsamor Archeological Museum. Figure 3.1-9 illustrates the visual impact from the new church “Saint Ghazar” in Metsamor town. Figure 3.1-10 illustrates the appearance of the ANPP site with the addition of Unit 3 {to be added by the developer of the final environmental assessment}.

3.1.2 External Appearance and Plant Layout, AP1000

ANPP Unit 3 is composed of five principle building structures: the nuclear island, turbine building, annex building, diesel generator building, and a radwaste building. The structures that make up each nuclear island are the containment building, shield building, and auxiliary building. The containment building is surrounded by a Seismic Category I reinforced concrete shield building that will rise approximately 71 meters above plant grade level. The shield building is a Seismic Category I reinforced concrete structure. In conjunction with the internal structures of the containment building, the shield building provides the required shielding for the reactor coolant system, and the other radioactive systems and components housed in the containment. The auxiliary building is a Seismic Category I reinforced concrete structure. It shares a common basemat with the containment building and the shield building.

The annex building is a combination of reinforced concrete and steel-framed structure with insulated metal siding. The portion of the annex building adjacent to the nuclear island is a Seismic Category II structure.

The diesel generator building is a single-story, steel-framed structure with insulated metal siding. Since the diesel generators are not required for response to accidents within the AP1000, the diesel generator building is Seismic Category II.

The radwaste building includes facilities for segregated storage of various categories of waste prior to processing, for processing by mobile systems, and for storing processed waste in shipping and disposal containers.

3.1.3 External Appearance and Plant Layout, CANDU-6

ANPP Unit 3 power block is composed of seven principle building structures: the reactor building, turbine building, service building, high pressure emergency core cooling building, secondary control area building, D_2O upgrader building and diesel generator building.

The reactor building is housed within the containment structure, which will rise approximately 60 m above plant grade. It is a steel-lined[2], prestressed, post-tensioned concrete building structure, with access airlocks and a containment isolation system. It houses the reactor core and heat transport system. The reactor building is designed to withstand the design basis earthquake.

The service building houses the main control room (MCR) and associated controls. The service building houses emergency core cooling pumps. The service building complex includes the fuel shipping bay, new fuel storage and spent fuel bay. Radwaste management systems are also housed in the service building. The service building is seismically qualified for the design basis earthquake.

The seismic category high-pressure emergency core cooling building houses the high-pressure accumulators that supply water to the reactor heat transfer system in the event of a loss of coolant accident. The substructure is a reinforced concrete open top box with the base slab below and the walls terminated above grade. The superstructure is a one story steel structure of braced frame construction. Stairs provide access to the basement flooring and steel platforms. The building is clad with insulated metal siding and built-up roofing.

The seismic category secondary control area (SCA) has sufficient control and monitoring equipment to shut down the unit, initiate the required cooling and ensure the unit remains in a safe shutdown state should the main control room (MCR) become uninhabitable or not functional. The SCA is located so that the MCR and the secondary control area cannot be simultaneously rendered inoperable due to any design basis event. The SCA also houses the two emergency power supply diesel generators. The SCA is a single story concrete superstructure with a reinforced concrete basement.

The seismic category diesel generator building is a reinforced concrete structure adjacent to the turbine and service buildings.

The D_2O upgrader building houses the equipment used to purify D_2O for reactor moderation and cooling.

In addition to the described buildings, the standard CANDU design includes an emergency water supply reservoir and pumps. This is equivalent to the essential service water system described in section 3.4. The pumps are housed in a pump house that has a reinforced concrete substructure consisting of a floor slab and foundation walls extending up to grade level and a one story steel braced frame superstructure clad with sheet metal and built-up roofing.

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[2] Early CANDU plants used epoxy-lined containments.

3.1.4 External Appearance and Plant Layout, VVER-1000

ANPP Unit 3 power block is composed of three principle structures: the main building (comprised of the reactor building, turbine room and deaerator room); special services building; and the diesel generator building.

The Unit 3 reactor building includes a leak-tight, pre-stressed, post-tensioned, reinforced concrete cylindrical shell with internal diameter of 45 m, external diameter of approximately 52 m, and overall height of 67.5 m (reactor containment). The reactor containment houses the reactor vessel, primary coolant piping and pumps, horizontal steam generators, pressurizer and spent fuel storage pool. Reactor auxiliary equipment is housed in a steel-framed structure 66 m x 66 m square that surrounds the containment. The containment and reactor auxiliaries structure share a common basemat. The Unit 3 ventilation stack rises to a height of 100 m above grade from the southeast corner of the reactor building.

The turbine room and deaerator room are within the same basic structure. The structure is approximately 125 m long and 57 m wide, oriented end-on with the reactor building.

The special services building, adjacent to the reactor building, houses radwaste processing equipment and systems. Fresh fuel receiving and storage are also in the special services building. The special services building is approximately 56 m x 27 m and approximately 30 m high.

The diesel generator building houses three diesel generators. The diesel generator building is a reinforced concrete structure designed for the maximum design earthquake loads and other natural phenomena.

Table 3.1-1, Legend for Plant Layout Drawings			
Existing Structures and Features			
1.	Main building	28.	Cooler N1
2.	Special building	29.	Cooler N2
3.	Water pumping building for 2nd pumping	30.	Cooler N3
4.	Pumping station of fire-fighting foam	31.	Cooler N4
5.	Complex building of pumping station	32.	Water supply
6.	Building of diesel pumping station	33.	Water discharge
7.	Relay protection building	34.	Technical water intake part for unit 1
8.	Building for mazut and oil	35.	Technical water intake part for unit 2
9.	Dry storage of worked radioactive materials	36.	Radioactive wastes disposal area
10.	Building for the water chemical treatment	37.	Slag disposal and neutralization reservoirs
11.	Alkali and acid storage	38-1.	Pumping station N1
12.	Lime storage	38-2.	Pumping station N2
13.	Central workshop	38-3.	Water reserve
14.	Building of diesel generator	38-4.	Operator's room
15.	Building of acetylene oxygen	38-5.	Guard's house
16.	Passage for sanitation laboratory	39.	Crane mobile storage
17.	Central storage	40.	Car parking, cover
18.	Fire station	41.	Fence/wall
19.	Nitrogen oxygen storage	42.	Water discharge
20.	Filtering unit for industrial flows of water treatment plant	43.	Area, car parking
21.	Reserve boiler house	44.	Equipment complex storage
22.	Administrative building with cafeteria	45.	Green house
23.	Special protection building	46.	Residential building
24-1.	Automobile administrative building	47.	Administrative building
24-2.	Parking area for 25 automobile	48.	Vegetable storage
24-3.	Storage with cover	49.	Mechanical manufactory for electrical mounting works
24-4.	Fuel storage	50.	Workshop for manufacturing armature
24-5.	Garage for 3 cars	51.	Electrical mounting materials storage
24-6.	Parking area for trailers	52.	Crane mobile repair division
24-7.	Fence/wall	53.	Wood processing workshop
25.	Repair construction and administrative division	54.	Concrete factory compressor station
26.	Ventilation stack	55.	Materials central storage
27.	Area for connection of main building and ventilation stack	56.	Concrete center

Table 3.1-1, continued			
Existing Structures and Features			
57.	Steam engine wagon workshop	72.	Engineering residential building
58.	Building with medical unit	73.	Complex works workshop
59.	Wood work workshop of construction department	74.	Radioactive waste storage
60.	Equipments and materials complex storage	75.	Ventilation fittings manufactory
61.	Equipments and heat-insulating materials complex storage	76.	Mechanical manufactory for metal treatment works
62.	Equipments and materials storage	77.	Garage
63.	storage	78.	Workshop-non complete building for anti corrosion works
64.	Oxygen station	79.	Non complete treatment plant
65.	Acetylene station	80.	High-voltage power substation
66.	Repair mechanical workshop and small mechanical storage	81.	Non complete cafeteria
67.	Storage for sanitary technical works	82.	Railway station
68.	Workshop for electrical equipments testing and repair	83.	“Auto service”
69.	Sanitary technical fabrications storage	84.	Construction administration base
70	Workshop for manufacturing heat-insulating materials	85.	Radioactive materials storage of “Yerkaghsovet”
71.	Workshop for pre-mounting works	86.	Seismic station building
New Structures			
A	Reactor Building	E	400 kV Switchyard
B	Auxiliary Building	F	Cooling Tower
C	Diesel Generator Building	G	Erection Crane Pad (AP1000)
D	Service Water Spray Ponds	H	Turbine Building
I	Reactor Building Vent	J	Turbine Building Vent

Figure 3.1-1 – Site Layout for ANPP Phase 2, 1975

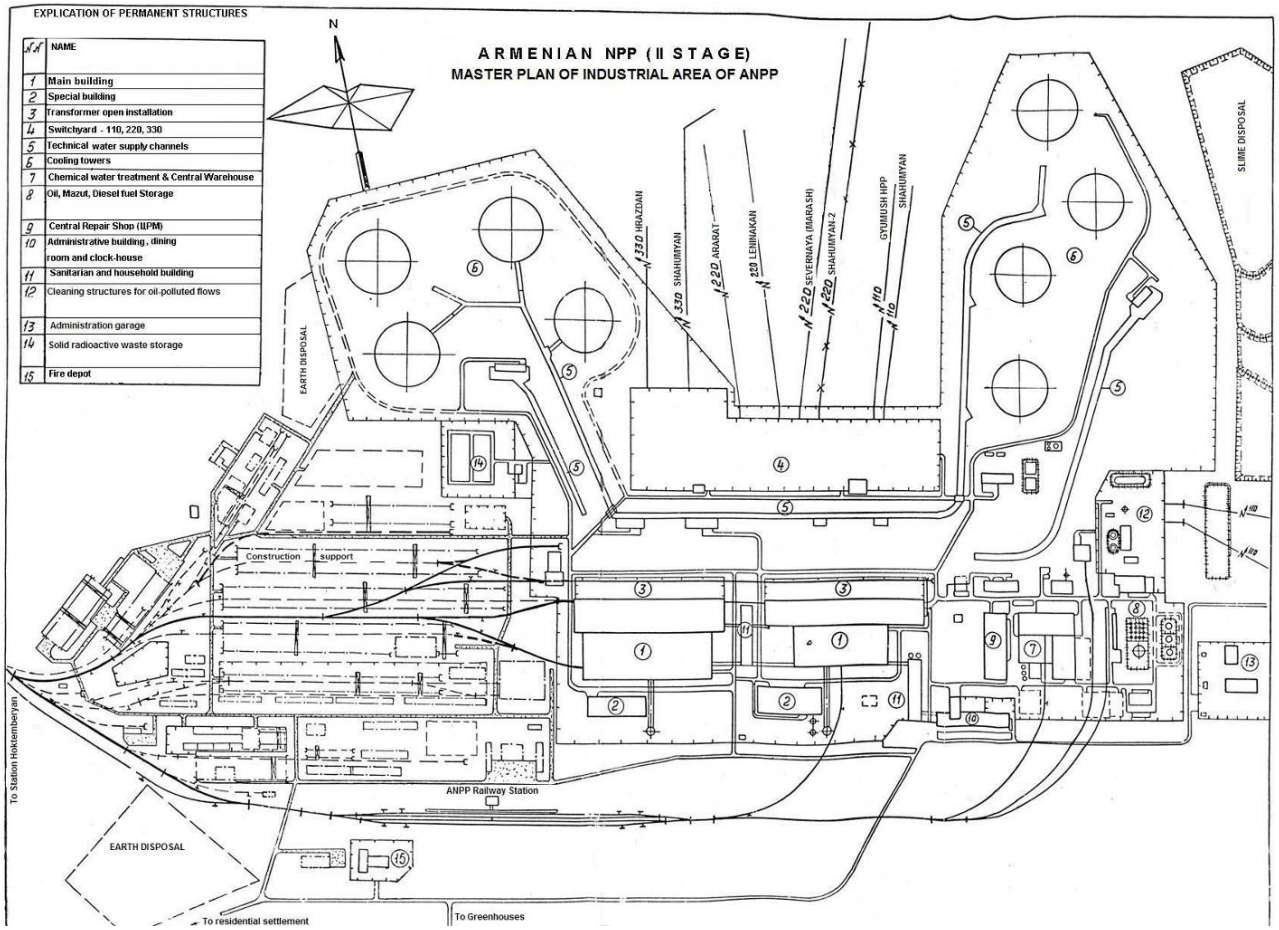

Figure 3.1-2 – Site Layout with AP1000 Reactor

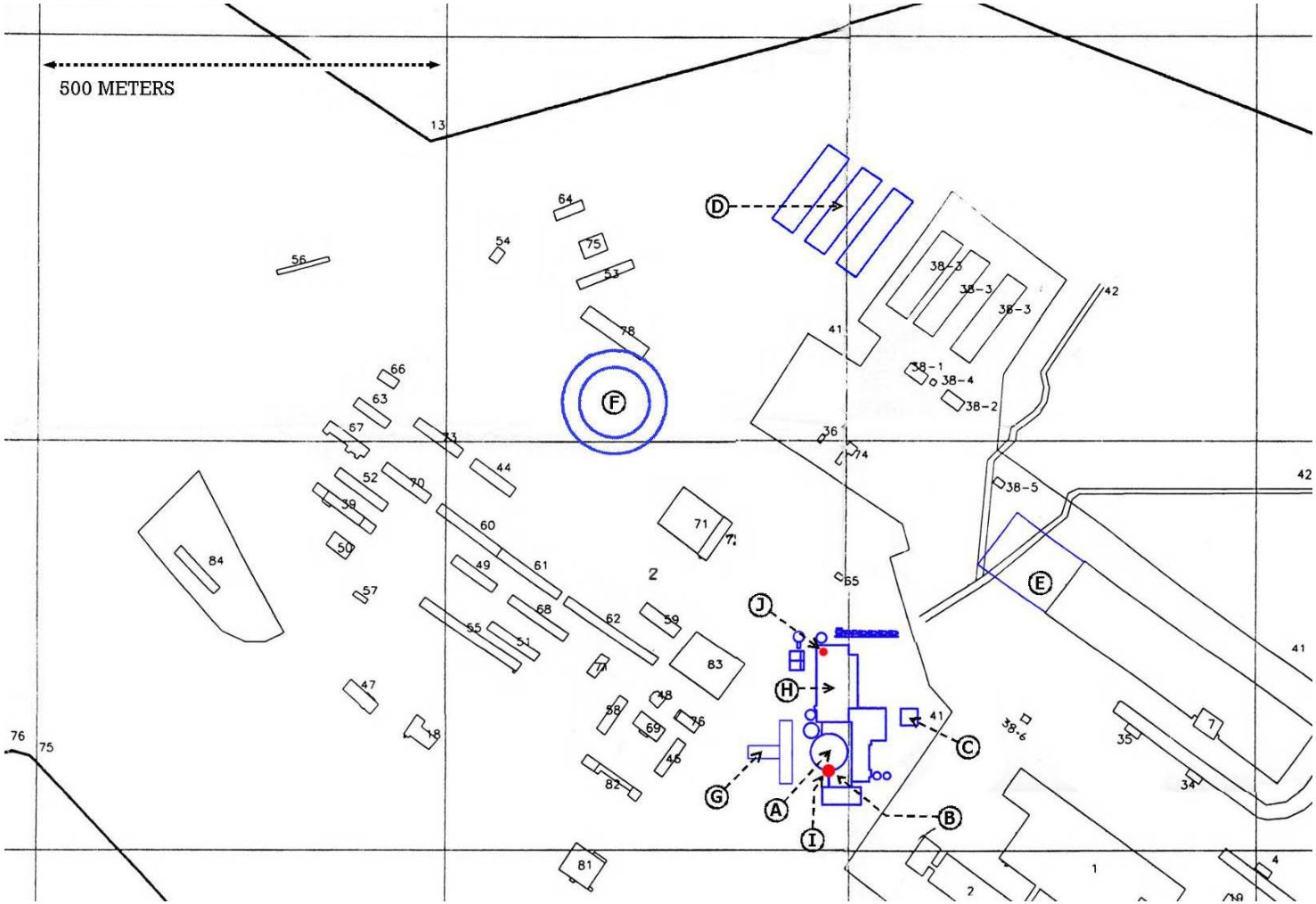

Figure 3.1-3 – Site Layout with CANDU-6 Reactor

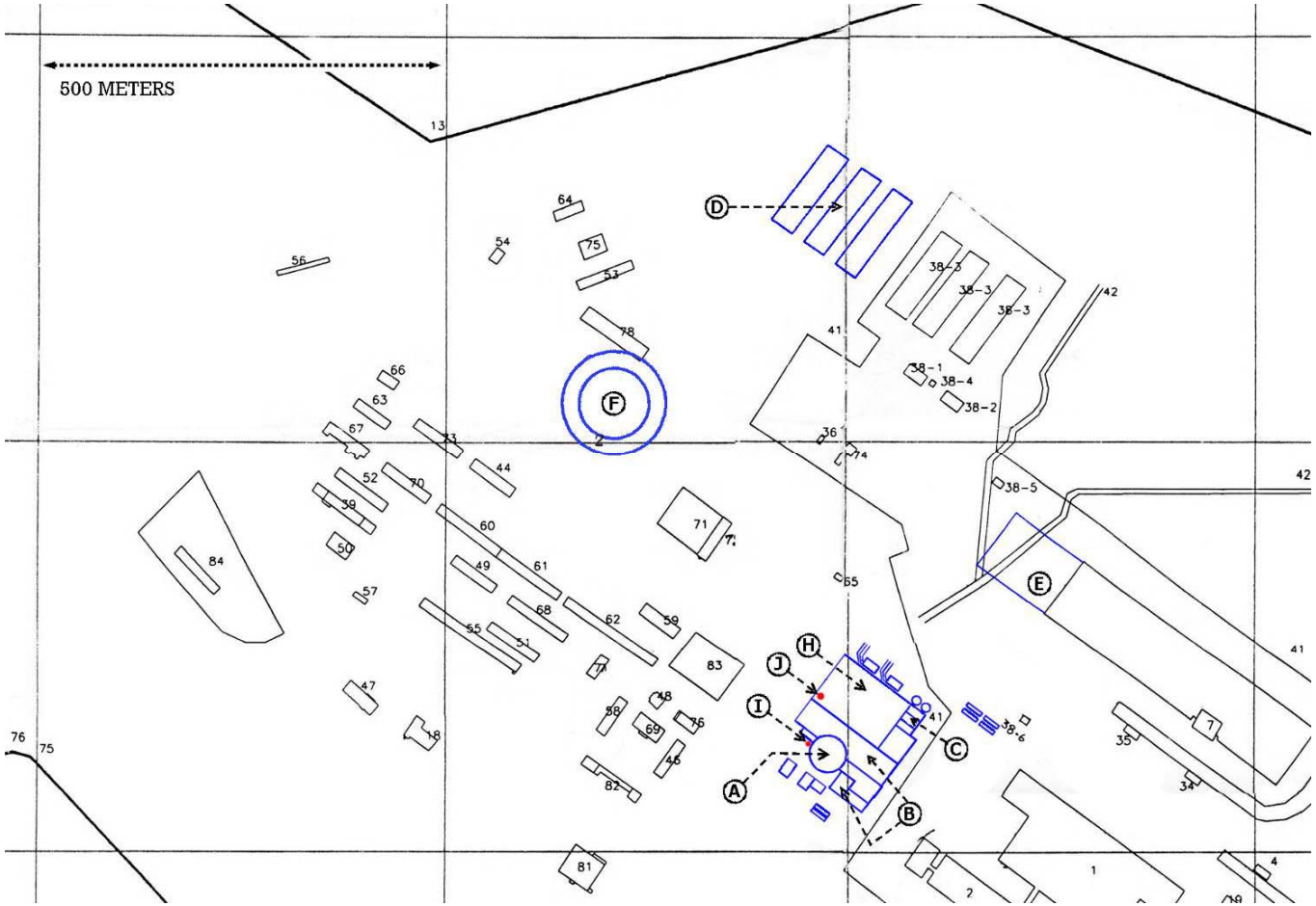

Figure 3.1-4 – Site Layout with VVER-1000 Reactor

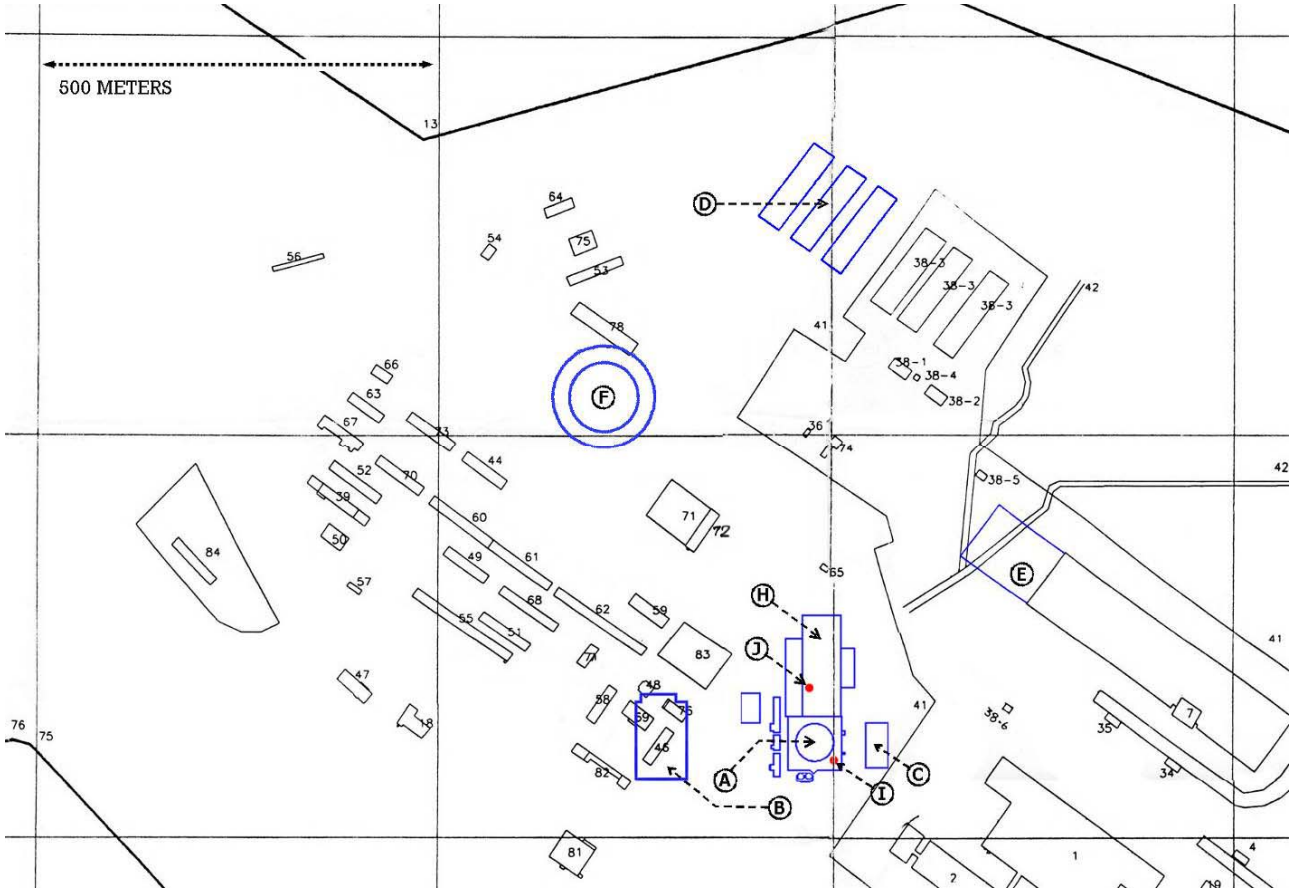

Figure 3.1-5 - {to be added by the developer of the final environmental report} architectural rendering of the site with the addition of Unit 3, including location of meteorological tower.

Figure 3.1-6 - Photo from Nearby Residential Vantage Point – Collective Gardening Society of Maisyan

Figure 3.1-7 - Photo from a Local Transportation Corridor – ANPP Eastern Access Intersection with M-5

Figure 3.1-8 - Photo from Cultural Vantage Point – Metsamor Museum

Figure 3.1-9 - Photo from Cultural Vantage Point – Metsamor Town Church

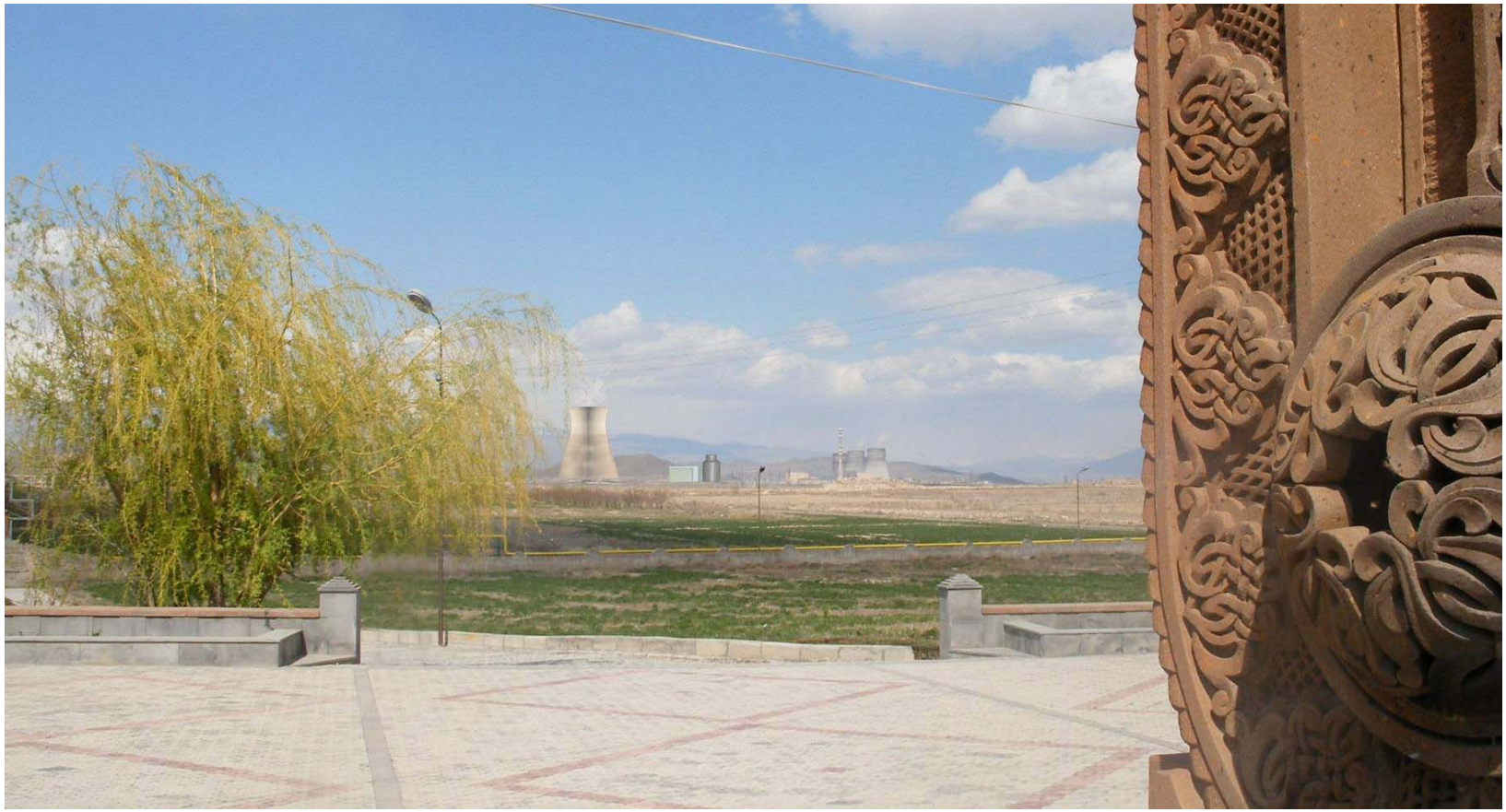

Figure 3.1-10 – {to be added by the developer of the final environmental assesment} low, oblique aerial photograph of the site and vicinity on which major station features are superimposed (identical to what is needed for Figure 2.1-5, with new plant features added.)

3.2 REACTOR POWER CONVERSION SYSTEM

ANPP Unit 3 will consist of one reactor plant and auxiliaries. A specific plant design has not been chosen for ANPP Unit 3, but candidate reactors all use pressurized water as the primary coolant. Water under high pressure (so it cannot boil) is pumped through the reactor core where it is heated by contact with fuel rods containing uranium. The heated water passes through the steam generators where the heat is transferred to the secondary loop, and then returns to the core. In the steam generators, water in the secondary loop is heated to boiling. This steam drives a turbine-generator system, is liquefied in the condenser, and returns to the steam generators. The condenser is cooled by a circulating water system employing one or more cooling towers. The reactor has two or four primary loops, depending on the selected reactor type, and one secondary loop[3]. The turbine-generator system has not been selected, neither has the architect-engineer.

Simplified diagrams of a pressurized light water reactor (representative of AP1000 and VVER reactors) and a CANDU reactor are provided in Figures 3.2-1 and 3.2-2, respectively. Ref. [3.2-1] Simplified diagrams depicting natural draft cooling tower and mechanical draft cooling tower systems are provided in Figures 3.2-3 and 3.2-4, respectively. Ref. [3.2-2]

At design conditions, the plant will generate up to 1,120 MWe net electrical power (AP1000) and will reject as much as 2,300 MWth waste heat to the environment. More detailed operating parameters are discussed below. Those parameters not covered by the Plant Parameter Envelope, including percent uranium-235 enrichment, kg fuel loading, and planned MW-tonne/day fuel burnup values will be specified in documents submitted in connection with the application for construction and/or operation of ANPP Unit 3.

Design details such as fuel assembly design and engineered safety features are dependent on the selected reactor plant design and as such will be provided in documents connected with the application for construction and/or operation of Unit 3 and are not addressed in this report.

3.2.1 Plant Parameter Envelope

This document does not provide a detailed design of a reactor considered for ANPP Unit 3. Rather, it provides bounding parameters and characteristics of these components so that an assessment of potential environmental impacts (and coincidently feasibility) of a new nuclear unit can be made. This is done by use of a plant parameter envelope (PPE) as a surrogate for the nuclear power plant and its associated facilities.

The PPE is a set of values of plant design parameters that are expected to bound the design characteristics of the reactor or reactors that might be constructed in Armenia. In effect, it serves as a surrogate for actual reactor design information. Use of this PPE approach allows the Ministry to defer the selection of a reactor design until after completion of additional studies to determine those reactor designs that are viable for construction and operation in Armenia within the next eight to ten years.

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[3] VVER plants often use two turbine generators and two condensers; in such a case, it could be considered that the plant has two secondary loops.

The PPE provided as Appendix 3.2A reflects the upper-bound (or lower-bound, as appropriate) values for each parameter it encompasses rather than the characteristics of any specific reactor design.

When the selected reactor design is known, design-specific parameters should be compared against those in Appendix 3.2A to confirm that the parameters critical to the environmental assessment are bounded by those used in this EBID. For any parameters outside those in Appendix 3.2A, the impacts of those parameters should be assessed. (Many parameters were not specifically evaluated, and thus changes in bounding parameters may not impact the environmental conclusions of the EBID.)

3.2.1.1 REACTOR DESIGNS CONSIDERED IN THE PPE

The values in this environmental background information document are not design-specific. Rather, they are used to determine the environmental impact of any reactor design that falls within the bounding values used in this document. The parameter definitions and many of the bounding values are developed based on a Plant Parameter Envelope Worksheet developed by the Nuclear Energy Institute (NEI) in the USA. Ref. [3.2-6] These reactor designs include the following four light-water and heavy-water reactor types:

- Advanced Pressurized Water Reactor (AP1000) – This is an early version of the AP1000 reactor final design developed by Westinghouse Electric Company, using low enriched uranium and a light water cooling system. This design is not the AP1000 that has been certified under U.S. Nuclear Regulatory Commission (NRC) requirements; therefore, this design is referred to as the “surrogate AP1000.”

- Canadian Deuterium Reactor (CANDU-6) – This is a heavy-water cooled, heavy-water moderated reactor using natural (non-enriched) uranium fuel developed by Atomic Energy Canada Limited (AECL). (AECL suggests alternatives to natural uranium as fuels, including spent fuel from light water reactors.) Some information has been provided by AECL on their enhanced CANDU-6 plant (EC-6), similar to that being built at the Qinshan site in China. Ref. [3.2-7] The parameters supplied by AECL for the EC-6 plant are compared with those in the NEI PPE Worksheet to confirm that the ANPP Unit 3 PPE bounds the expected values from the EC-6, should it be chosen for Armenia. Pending receipt of more detailed CANDU-6- or EC-6-specific plant parameter information from AECL, values from the NEI PPE Worksheet for the Advanced Canada Deuterium Uranium Reactor (ACR-700), which is no longer offered by AECL and thus is not under consideration for Armenia, are used as surrogate values for a CANDU-6 (indicated in the PPE as CANDU(S)).

- Vodo-Vodyanoi Energetichesky Reactor (Russian: Водо-водяной энергетический реактор) VVER-1000, Model AES-92 – This reactor concept developed by the Atomenergoproekt Institute in Moscow in cooperation with EDO Gidropress and the Kurchatov Institute is presently being considered for NPP construction in Russia, in particular Novovoronezh NPP units 6 and 7. Ref. [3.2-8] The VVER-1000 is a light-water cooled and moderated reactor using low enriched uranium fuel. Values for many parameters were provided for the advanced VVER-1000 plants designated V-412, V-428, and V-466 (Ref. [3.2-9]) and for the AES-91 plant being built at the Tianvan site in China (Ref. [3.2-10]). (The Model V-466 appears as AES-92 in some promotional materials.) Where values for the V-400 plants are

on an equivalent basis as those in the NEI PPE worksheet, they have been compared with values for the other reactors to ensure that the resulting parameters bound potential VVER plants[4]. With Ref. [3.2-9] was a data sheet on the VBER-300 reactor that is scheduled to be built in Kazakhstan by 2016. The VBER-300 reactor is not under consideration by the Government of Armenia because the design has not progressed to the point that it has received regulatory approval and there will be no construction experience with this plant in time for serious consideration by Armenia.

Power ratings and other key attributes of the above reactors are provided in Table 3.2-1.

3.2.1.2 DERIVATION OF PARAMETERS IN THE PPE

The following describes the basic approach to development of the PPE and derivation of parameters therein.

PPE definitions and structure (i.e. parameter numbering and organization) are taken from the NEI PPE Worksheet (Ref. [3.2-6]), as were parameter values for the Surrogate AP1000, the ACR-700, and the bounding composite values.

Units for all parameters expressed in English units were converted to equivalent metric units. Radiation/radioactivity parameters (e.g., Rem, Ci) were converted to equivalent units in current use (Sv, GBq).

Many parameters in the NEI PPE Worksheet result from requirements in a Utility Requirements Document (URD) developed by the Edison Electric Institute on behalf of utilities in the U.S. rather than values predicted by the designers of the plants encompassed by the PPE Worksheet. Since the values of these parameters would generally be established as design requirements in tendering documents for a new plant and derived from data specific to Armenia (such as extreme meteorological conditions), such values are not included in the ANPP Unit 3 PPE. Other parameters needed for environmental analysis, such as noise levels, are identified in Table 3.2A-1 as US URD values.

Since the NEI PPE Worksheet parameters are for plants with two units of both the AP1000 and the ACR-700, those parameters that are dependent on number of units were factored by 0.5 to yield per unit values. Table 3.2A-1 includes a column indicating the factor used to convert between a two-unit site and a one-unit site; this information is provided in the event that it is concluded a different factor should be used for some parameters.

The upper bound (or lower bound, as appropriate) value of each parameter for the Surrogate AP1000, ACR-700, CANDU-6 (if available), and VVER-1000 was chosen as the ANPP Unit 3 bounding value. Where not obvious if upper bound or lower bound was appropriate, the appropriate logic was inferred from the bounding composite values chosen by NEI.

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[4] The AES-91 parameters are reflected in the PPE only where such parameters were not provided for the V-400 plants.

The values for a number of parameters were modified from those derived from the NEI values. These were primarily for those parameters judged to be significantly different based on conditions in Armenia. Key among these are the following parameters that are considered site-specific:

Cooling system cycles of concentration – NEI used a value of 4. Because of the high mineral content of the makeup sources of water, which exceed some Armenian guidelines for water quality, the ANPP Unit 3 PPE uses a value of 2 (PPE Sections 2.4.6, 2.5.6, 3.3.6, and 3.5.5), which is consistent with the operational objective of ANPP Unit 2. In addition:

- Lower cycles of concentration requires higher expected blowdown rates (see PPE Sections 2.4.4, 2.5.4, 3.3.4, and 3.5.3) and changes to other parameters related to blowdown (PPE Sections 2.2, 2.2a, 2.4.13, 2.5.13, 3.3.13, and 3.5.10).

- Blowdown rates are set to equal Drift rates plus Evaporation Rates. Drift rates for cooling towers are calculated as a percentage of cooling water flow: 0.02% for natural draft cooling towers (Ref. [3.2-3]); and 0.04% for mechanical draft cooling towers (Ref. [3.2-4]). Drift rates for spray ponds is set equal to evaporation rate (consistent with Ref. [3.2-5]).

- Higher blowdown requires higher makeup rates with changes to those parameters, as well (PPE Sections 2.4.9, 2.5.9, 3.3.9, and 3.5.7).

Blowdown mineral composition – the blowdown constituent compositions (PPE Sections 2.4.3, 2.5.3, 3.3.3, and 3.5.2 and Table 3.2A-2) were adjusted to reflect constituents currently monitored in Armenia, maximum concentrations currently discharged by ANPP Unit 2 (from section 2.3 and Ref. [3.2-11]), expected constituents accounting for makeup water quality from the Sevjur River (from section 2.3).

Plant Population – NEI values for plant population are based on expected values for a plant in the U.S. The number of employees at ANPP is substantially higher than for typical plants in the U.S. The explanation given for this is the fact that ANPP is the sole nuclear facility in Armenia and does not have a mobile workforce to support refueling and maintenance outages, so maintains a relatively high number of employees year-round. Pending completion of a manpower study currently being performed by the Ministry of Energy and the IAEA, values in the PPE (Sections 17.5.1 and 17.5.2) are similar to the current ANPP staffing for Unit 2. Since potable water demands and sanitary waste volumes are related to plant population, those values were factored to be consistent with the expected plant population at ANPP Unit 3 (PPE Sections 5.1 and 5.2). Note: the operating plant population shown in the PPE is considered an upper bound and staff size projections in Section 2.5 and 5.8 are lower.

Post-accident and Severe Accident dose limits – PPE Sections 9.3.2 and 9.3.3 reflect the limits embodied in Armenian laws and resolutions. Refs. [3.2-12] and [3.2-13]

Auxiliary Boiler effluents – NEI values that correspond to Table 3.2A-4 (Yearly Emissions from Auxiliary Boilers) assumed oil-fired auxiliary boilers. ANPP Unit 3, like Unit 2, will use a natural gas-fired auxiliary boiler. Effluents in Table 3.2A-4 are calculated using a spreadsheet from the State of Utah Department of Air Quality that assumes a heat value of 1000 Btu/ft^{3}of natural gas. Ref. [3.2-14]

Table 3.2-1 - Operating Parameters for Candidate Reactor Plants [(a)]

Parameter	Surrogate AP1000	Surrogate CANDU-6	VVER-1000
Core Thermal Power, MWth	3,430	2,158	3012
Net Electrical Output, MWe	1117	666	1,060
Waste Heat Rejected, MWth	2,313	1,492	1,952
Efficiency, %	32.6%	30.9%	35.2%

[(a)] Values are nominal or brochure values; efficiency calculated as ratio of MWe/MWth; heat rejected is MWth-MWe, VVER values are for the V-428 (Ref. [3.2-9]), which bound parameters for other VVER models.

Figure 3.2-1, Simplified Diagram of Pressurized Light Water Reactor, Ref. [3.2-1]

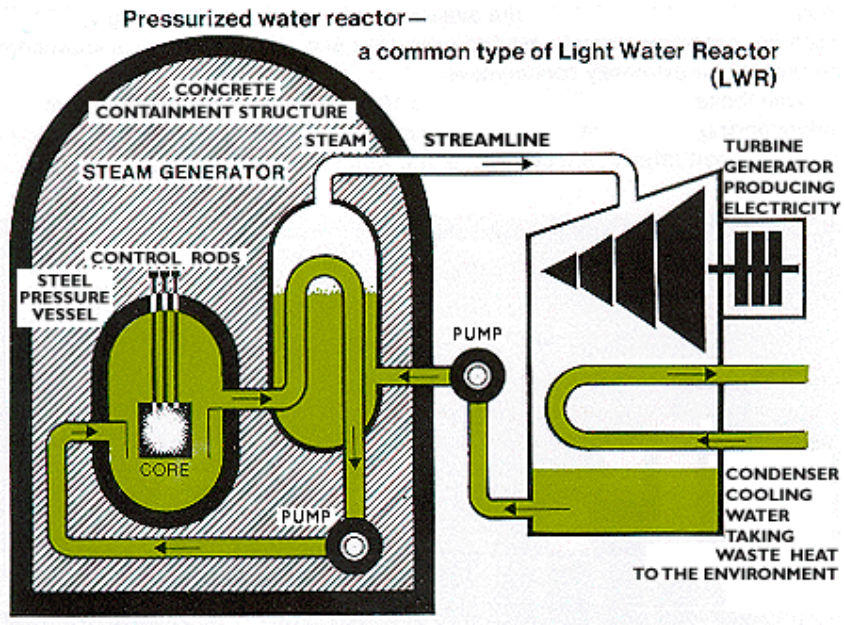


Figure 3.2-2, Simplified Diagram of CANDU Reactor, Ref. [3.2-1]

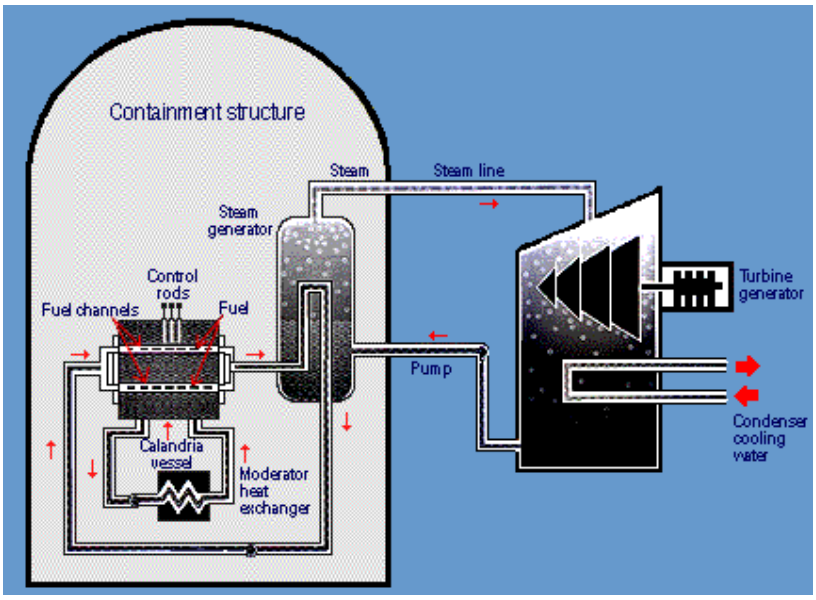


Figure 3.2-3, Simplified Diagram of Natural Draft Cooling System, Ref. [3.2-2]

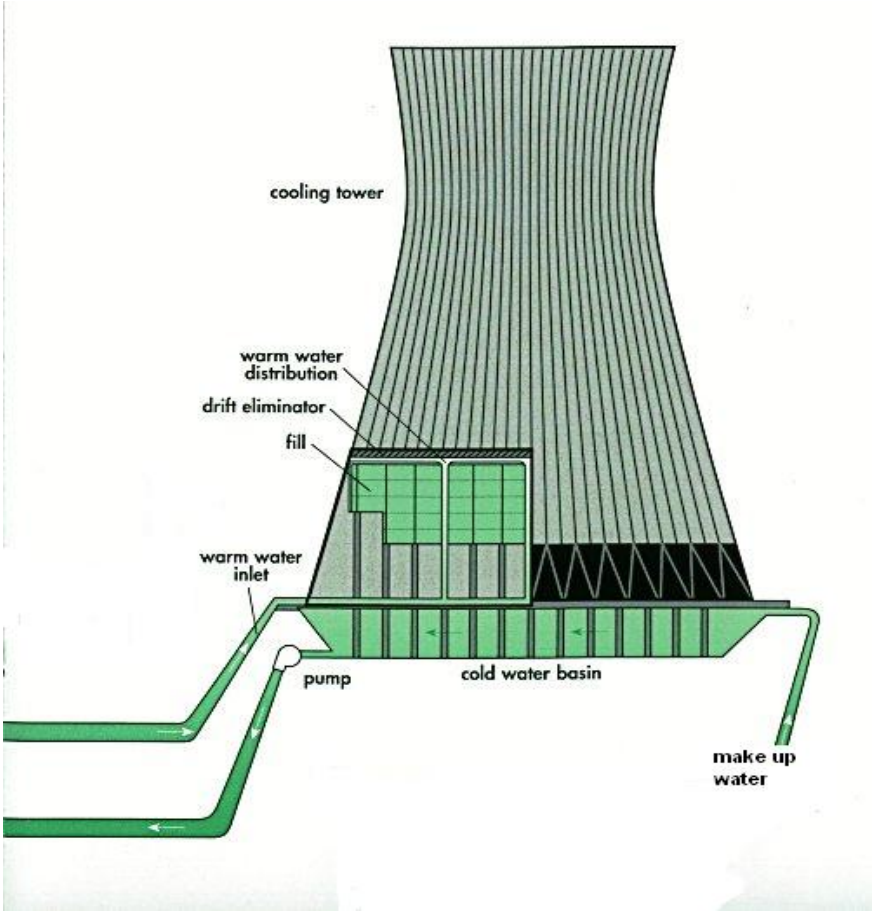
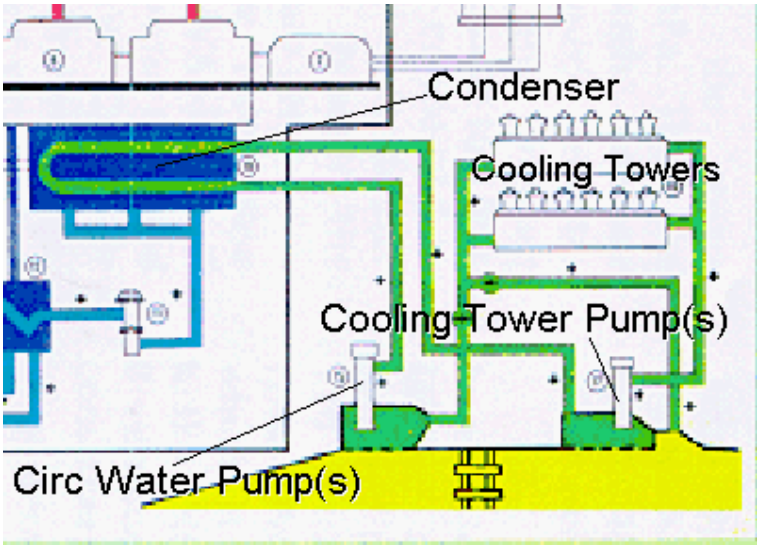


Figure 3.2-4, Simplified Diagram of Mechanical Draft Cooling System, Ref. [3.2-2]



References:

[3.2-1] Image source: Australian Uranium Association, 2007, *Nuclear Power Reactors Briefing Paper # 64*, URL: http://www.uic.com.au/nip64.htm, accessed 19 February 2008.

[3.2-2] Image source: The Virtual Nuclear Tourist, 2006, *Cooling Towers*, URL: http://www.nucleartourist.com/, accessed 19 February 2008.

[3.2-3] U.S. Environmental Protection Agency, 2001, *Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities, EPA-821-R-01-036*, Table 2-1.

[3.2-4] Tennessee Valley Authority, 2007, *Bellefonte Nuclear Plant, Units 3 & 4 COL Application, Part 3, Environmental Report*, Section 3.4.

[3.2-5] State Unitarian Enterprise Scientific-Research Design and Construction Institute of the Ministry of Atomic Energy of the Russian Federation, 2001, *Armenian Nuclear Power Plant Unit 2, Essential Service Water Cooling System, Substantiation of Safety of the Essential Service Water System, including Issues of Environmental and Radiological Safety*, Section 8.1.

[3.2-6] Nuclear Energy Institute (NEI), 2003, *ESP Plant Parameters Envelope Worksheet*, transmitted by NEI Letter (R.L. Simard) to US NRC (J.E. Lyons), dated February 7, 2003.

[3.2-7] AECL, 2006, *Technical Information* (dated 15 June 2006, developed for a proposal related to potential new reactor at the Ignalina site in Lithuania).

[3.2-8] V. Novak, A. Podshibiakin and M. Rogovi, *Development of Improved Safety Reactor Plant with VVER-1000,* URL: http://www.npcil.nic.in/nupower_vol11_4/vver1000n.htm, accessed 25 January 2008.

[3.2-9] AtomStroyExport letter No. 7700/01-338 dated 03.06.2008 to the Head of Atomic Energy Department, Ministry of Energy of Republic of Armenia.

[3.2-10] AtomStroyExport letter No. 7700/01-347 dated 05.06.2008 to the Head of Atomic Energy Department, Ministry of Energy of Republic of Armenia.

[3.2-11] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of the Armenian Nuclear Power Plant*, Appendix 10.

[3.2-12] Government of Armenia Decree № 1219, 18 August 2006, *On Approval of Radiation Safety Norms*, Article 1, paragraph 3.c.

[3.2-13] Government of Armenia Decree № 1489-N, 18 August 2006, *On Approval of Radiation Safety Rules,* paragraph 230.

[3.2-14] State of Utah, Department of Air Quality, Boiler-Natural Gas URL: www.airquality.utah.gov/Permits/FORMS/boilers-ng.xls

APPENDIX A:

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
1. Structure		
1.1 Height	m	The height from finished grade to the top of the tallest power block structure, excluding cooling towers.
1.1.2 Foundation Embedment	m	The depth from finished grade to the bottom of the base mat for the most deeply embedded power block structure.
1.2 Precipitation (for Roof Design)		
1.2.1a Maximum Rainfall Rate	mm/hr	The probable maximum precipitation (PMP) value that can be accommodated by a plant design Expressed as maximum precipitation for 1 hour in 1 square mile with a ratio for five minutes to Inches in the 1 hour PMP of .32 as found in National Weather Service Publication HMR No 52.
1.2.1b Maximum Rainfall Rate	mm/5min	
1.2.2 Snow & Ice Load	kg/m^2	The maximum load on structure roofs due to the accumulation of snow and ice that can be accommodated by a plant design.
1.3 Safe Shutdown Earthquake (SSE)		
1.3.1 Design Response Spectra	n/a	The assumed design response spectra used to establish a plant's seismic design.
1.3 2 Peak Ground Acceleration	g	The maximum earthquake ground acceleration for which a plant is designed, this is defined as the acceleration which corresponds to the zero period in the response spectra taken in the free field at plant grade elevation.
1.3.3 Time History	n/a	The plot of earthquake ground motion as a function of time used to establish a plant's seismic design.
1.3 4 Capable Tectonic Structures or Sources	n/a	The assumption made in a plant design about the presence of capable faults or earthquake sources in the vicinity of the plant site (e g, No fault displacement potential within the investigative area).
1.4 Site Water Level (Allowable)		

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
1.4.1 Maximum Flood (or Tsunami)	m	Design assumption regarding the difference in elevation between finished plant grade and the water level due to the probable maximum flood and probable maximum precipitation (defined in ANSI/ANS 2.8-1992) used in the plant design.
1.4.2 Maximum Ground Water	m	Design assumption regarding the difference in elevation between finished plant grade and the maximum site ground water level used in the plant design.
1.5 Soil Properties Design Bases		
1.5.1 Liquefaction	n/a	Design assumption regarding the presence of potentially liquefying soils at a site (e.g., None at Site-Specific SSE)
1.5.2 Minimum Bearing Capacity (static)	kPa	Design assumption regarding the capacity of the competent load-bearing layer required to support the loads exerted by plant structures used in the plant design.
1.5.3 Minimum Shear Wave Velocity	m/s	The assumed limiting propagation velocity of shear waves through the foundation materials used in the plant design.
1.6 Tornado (Design Bases)		
1.6.1 Maximum Pressure Drop	kPa	The design assumption for the decrease in ambient pressure from normal atmospheric pressure due to the passage of the tornado.
1.6.2 Maximum Rotational Speed	m/s	The design assumption for the component of tornado wind speed due to the rotation within the tornado.
1.6.3 Maximum Translational Speed	m/s	The design assumption for the component of tornado wind speed due to the movement of the tornado over the ground.
1.6.4 Maximum Wind Speed	m/s	The design assumption for the sum of maximum rotational and maximum translational wind speed components.
1.6.5 Missile Spectra	as appropriate	The design assumptions regarding missiles that could be elected either horizontally or vertically from a tornado. The spectra identify mass, dimensions and velocity of credible missiles.
1.6.6 Radius of Maximum Rotational Speed	m	The design assumption for distance from the center of the tornado at which the maximum rotational wind speed occurs.
1.6.7 Rate of Pressure Drop	kPa/s	The assumed design rate at which the pressure drops due to the passage of the tornado.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
1.7 Wind		
1.7.1 Basic Wind Speed	m/s	The design wind, or "fastest mile of wind" with a 100-year return period (NUREG-0800, Sections 2.3.1 and 3.3.1) for which the facility is designed.
1.7.2 Importance Factors	n/a	Multiplication factors (as defined in ANSI A58 1-1982) applied to basic wind speed to develop the plant design.
2 Normal Plant Heat Sink		
2.1 Ambient Air Requirements		
2.1.1 Normal Shutdown Max Ambient Temperature (1% exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design plant systems capable of effecting normal shutdown under the assumed temperature condition.
2.1.2 Normal Shutdown Max Wet Bulb Temperature (1% Exceed.)	°C WB	Assumption used for the maximum wet bulb temperature that will be exceeded no more than 1% of the time -used in design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.
2.1.3 Normal Shutdown Min. Ambient Temp (1% Exceed.)	°C	Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time to design of plant systems that must be capable of effecting normal shutdown under the assumed temperature condition.
2.1.4 Reactor Thermal Power Max Ambient Temperature (0% Exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature that will never be exceeded -used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.1.5 Reactor Thermal Power Max Wet Bulb Temperature (0% Exceed.)	°C WB	Assumption used for the maximum wet bulb temperature that will never be exceeded -used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.1.6 Reactor Thermal Power Min Temperature (0% Exceed.)	°C	Assumption used for the minimum ambient temperature that will never be exceeded -used in design of plant systems that must be capable of supporting full power operation under the assumed temperature condition.
2.2 Blowdown Pond Acreage	hectare (ha)	The land usage required to provide a pond with a capacity to provide holdup for 24 hours of blowdown water from the plant.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
2.3 Condenser		
2.3.1 Maximum Inlet Temperature Condenser/Heat Exchanger	°C	Design assumption for the maximum acceptable circulating water temperature at the inlet to the condenser or cooling water system heat exchangers.
2.3.2 Condenser /Heat Exchanger Duty	kW	Design value for the waste heat rejected to the circulating water system across the condensers.
2.4 Mechanical Draft Cooling Towers		
2.5 Natural Draft Cooling Towers		
2.7 Ponds		
2 4 1, 2 5 1, 2 7.1 Acreage	ha	The land required for cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.
2.4.2, 2.5.2 Approach Temperature	°C	The difference between the cold water temperature and the ambient wet bulb temperature.
2.4.3, 2.5.3, 2.7.2 Blowdown Constituents and Concentrations	ppm	The maximum expected concentrations for anticipated constituents in the cooling water systems blowdown to the receiving water body.
2.4.4, 2.5.4, 2.7.3 Blowdown Flow Rate	l/s l/s max	The normal (and maximum) flow rate of the blowdown stream from the cooling water systems to the receiving water body for closed system designs.
2.4.5, 2.5.5, 2.7.4 Blowdown Temperature	°C	The maximum expected blowdown temperature at the point of discharge to the receiving water body.
2.4.6, 2.5.6, 2.7.5 Cycles of Concentration	number	The ratio of total dissolved solids in the cooling water blowdown streams to the total dissolved solids in the makeup water streams.
2.4.7, 2.5.7, 2.7.6 Evaporation Rate	l/s	The expected (and maximum) rate at which water is lost by evaporation from the cooling water systems.
2.4.8, 2.5.8 Height	m	The vertical height above finished grade of either natural draft or mechanical draft cooling towers associated with the cooling water systems.
2.4.9, 2.5.9, 2.7.8 Makeup Flow Rate	l/s	The expected (and maximum) rate of removal of water from a natural source to replace water losses from closed cooling water systems.
2.4.10, 2.5.10 Noise	dba @ 305 m	The maximum expected sound level produced by operation of cooling towers, measured at 1000 feet from the noise source.
2.4.11, 2.5.11, 2.7.10 Cooling/Pond Tower Temperature Range	°C	The temperature difference between the cooling water entering and leaving the towers or ponds.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
2.4.12, 2.5.12, 2.7.11 Cooling Water Flowrate	l/s	The total cooling water flow rate through the condenser/heat exchangers.
2.4.13, 2.5.13, 2.7.7 Heat Rejection Rate (blowdown)	l/s	The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Fahrenheit.
2.4.14, 2.5.14, 2.7.12 Maximum Consumption of Raw Water	l/s	The expected maximum short-term consumptive use of water by the cooling water systems (evaporation and drift losses).
2.4.15, 2.5.15, 2.7.13 Monthly Average Consumption of Raw Water	l/s	The expected normal operating consumption of water by the cooling water systems (evaporation and drift losses).
2.4.16, 2.5.16, 2.7.9 Stored Water Volume	m^3	The quantity of water stored in cooling water system impoundments, basins, tanks and/or ponds.
2.6 Once-Through Cooling		N/A to ANPP Unit 3.
3 Ultimate Heat Sink (UHS)		(N/A for AP1000)
3.1 Ambient Air Requirements		
3.1.1 Maximum Ambient Temperature (0% Exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.1.2 Maximum Wet Bulb Temperature	°C WB	Assumption used for the maximum wet bulb temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.1.3 Minimum Ambient Temperature (0% Exceed.)	°C	Assumption used for the minimum ambient temperature in designing the UHS system to provide heat rejection for 30 days under the assumed temperature condition.
3.2 CCW Heat Exchanger		
3.2.1 Max Inlet Temperature to CCW HX	°C	The maximum temperature of safety-related service water at the inlet of the UHS component cooling water heat exchanger.
3.2.2 CCW (RCW) HX Duty	kW	The heat transferred to the safety-related service water system for rejection to the environment in UHS heat removal devices.
3.3 Mechanical Draft Cooling Towers		
3.5 Ponds		
3.3.1, 3.5.1 Acreage	ha	The land required for UHS cooling towers or ponds, including support facilities such as equipment sheds, basins, canals, or shoreline buffer areas.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
3.3.2 Approach Temperature	°C	The difference between the cold water temperature and the ambient wet bulb temperature.
3.3.3, 3.5.2 Blowdown Constituents, Concentrations	ppm	The maximum expected concentrations for anticipated constituents in the UHS blowdown to the receiving water body.
3.3.4, 3.5.3 Blowdown Flowrate	l/s expected	The normal (and maximum) flow rate of the blowdown stream from the UHS system to receiving water body for closed system designs.
3.3.5, 3.5.4 Blowdown Temperature	°C	The maximum expected UHS blowdown temperature at the point of discharge to the receiving water body.
3.3.6, 3.5.5 Cycles of Concentration	number	The ratio of total dissolved solids in the UHS system blowdown streams to the total dissolved solids in the makeup water streams.
3.3.7, 3.5.6 Evaporation Rate	l/s	The expected (and maximum) rate at which water is lost by evaporation from the UHS system.
3.3.8 Height	m	The vertical height above finished grade of mechanical draft cooling towers associated with the UHS system.
3.3.9, 3.5.7 Makeup Flowrate	l/s	The expected (and maximum) rate of removal of water from a natural source to replace water losses from the UHS system.
3.3.10 Noise	dba @ 305 m	The maximum expected sound level produced by operation of mechanical draft UHS cooling towers, measured at 1000 feet from the noise source.
3.3.11, 3.5.8 Cooling Tower/Pond Temperature Range	°C	The temperature difference between the cooling water entering and leaving the UHS system.
3.3.12, 3.5.9 Cooling Water Flowrate	l/s	The total cooling water flow rate through the UHS system.
3.3.13, 3.5.10 Heat Rejection Rate (blowdown)	l/s @ °C	The expected heat rejection rate to a receiving water body, expressed as flow rate in gallons per minute at a temperature in degrees Celsius.
3.3.14, 3.5.11 Maximum Consumption of Raw Water	l/s	The expected maximum short-term consumptive use of water by the UHS system (evaporation and drift losses).
3.3.15, 3.5.12 Monthly Average Consumption of Raw Water	l/s	The expected normal operating consumption of water by the UHS system (evaporation and drift losses).
3.3.16, 3.5.13 Stored Water Volume	m^3	The quantity of water stored in UHS impoundments, basins, tanks and/or ponds.
3.4 Once-through Cooling		(Probably N/A to ANPP.)
3.4.1 Cooling Water Discharge Temperature	°C	Expected temperature of the cooling water at the exit of the UHS system.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
3.4.2 Cooling Water Flow Rate	l/s	Total cooling water flow rate through the UHS (also the rate of withdrawal from and return to the water source).
3.4.3 Cooling Water Temperature Rise	°C	Temperature rise across the heat exchangers cooled by the UHS (temperature of water out minus temperature of water in).
3.4.4 Minimum Essential Flow Rate	l/s	Minimum flow required to maintain required heat removal capacity under design-basis accident conditions.
3.4.5 Evaporation Rate	l/s	The expected (and maximum) rate at which water is lost by evaporation from the UHS a result of heat rejection from the plant.
3.4.6 Heat Rejection Rate	kW	The expected heat rejection rate to the UHS.
4 Containment Heat Removal System (Post Accident)		N/A to AP-1000 and to ACR-700
4.1 Ambient Air Requirements		
4.1.1 Maximum Ambient Air Temperature (0% exceedance)	°C	Assumed maximum ambient temperature used in designing the containment heat removal system.
4.1.2 Minimum Ambient Temperature (0% exceedance)	°C	Assumed minimum ambient temperature used in designing the containment heat removal system.
5 Potable Water/Sanitary Waste System		
5.1 Discharge to Site Water Bodies		
5.1.1 Flow Rate	l/s	The expected (and maximum) effluent flow rate from the potable and sanitary waste water systems to the receiving water body.
5.2 Raw Water Requirements		
5.2.1 Maximum Use	l/s	The maximum short-term rate of withdrawal from the water source for the potable and sanitary waste water systems.
5.2.2 Monthly Average Use	l/s	The average rate of withdrawal from the water source for the potable and sanitary waste water systems.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
6 Demineralized Water System		
6.1 Discharge to Site Water Bodies		
6.1.1 Flow Rate	l/s	The expected (and maximum) effluent flow rate from the demineralized system to the receiving water body.
6.2 Raw Water Requirements		
6.2.1 Maximum Use	l/s	The maximum short-term rate of withdrawal from the water source for the demineralized water system.
6.2.2 Monthly Average Use	l/s	The average rate of withdrawal from the water source for the demineralized water system.
7 Fire Protection System		
7.1 Raw Water Requirements		
7.1.1 Maximum Use	l/s	The maximum short-term rate of withdrawal from the water source for the fire protection water system.
7.1.2 Monthly Average Use	l/s	The average rate of withdrawal from the water source for the fire protection water system.
7.1.3 Stored Water Volume	m^3	The quantity of water stored in fire protection system impoundments, basins or tanks.
8 Miscellaneous Drain		
8.1 Discharge to Site Water Bodies		
8.1.1 Flow Rate	l/s	The expected (and maximum) effluent flow rate from miscellaneous drains to the receiving water body.
9 Unit Vent/Airborne Effluent Release Point		
9.1 Atmospheric Dispersion (Chi/Q) (Accident)	EAB, km	Distance to Exclusion Area Boundary (EAB)

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
	LPZ, km	Distance to Low Population Zone (LPZ) boundary.
9.1.1 0-2 hr @ EAB 9.1.2 0-8 hr @ LPZ 9.1.3 8-24 hr @ LPZ 9.1.4 1-4 day @ LPZ 9.1.5 4-30 day @ LPZ	s/m^3 s/m^3 s/m^3 s/m^3 s/m^3	The atmospheric dispersion coefficients used in the design safety analysis to estimate dose consequences of accident airborne releases.
9.2 Atmospheric Dispersion (Chi/Q) (Annual Average)	s/m^3	The atmospheric dispersion coefficients used in the safety analysis for the dose consequences of normal airborne releases.
9.3 Dose Consequences		
9.3.1 Normal	Sv	The estimated design radiological dose consequences due to gaseous releases from normal operation of the plant.
9.3.2 Post-Accident	Sv	The estimated design radiological dose consequences due to gaseous releases from postulated accidents.
9.3.3 Severe Accidents	Sv WB probability	
9.4 Release Point		
9.4.1 Configuration	n/a	The orientation of the release point discharge flow.
9.4.2 Elevation (Normal Operation)	m	The elevation above finished grade of the release point for routine operational releases.
9.4.3 Elevation (Post-Accident)	m	The elevation above finished grade of the release point for accident sequence releases.
9.4.4 Minimum Distance to Site Boundary	m	The minimum lateral distance from the release point to the site boundary.
9.4.5 Temperature	°C	The temperature of the airborne effluent stream at the release point.
9.4.6 Volumetric Flow Rate	l/s	The volumetric flow rate of the airborne effluent stream at the release point.
9.5 Source Term		
9.5.1 Gaseous (normal)	GBq/yr	The annual activity, by isotope, contained in routine plant airborne effluent streams.
9.5.2 Gaseous (Post-Accident)	GBq	The activity, by isotope, contained in post-accident airborne effluents.
9.5.3 Tritium (normal)	GBq/yr	The annual activity of tritium contained in routine plant airborne effluent streams.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
10 Liquid Radwaste System		
10.1 Dose Consequences		
10.1.1 Normal	Sv	The estimated design radiological dose consequences due to liquid effluent releases from normal operation of the plant.
10.1.2 Post Accident	Sv	The estimated design radiological dose consequences due to liquid effluent releases from postulated accidents.
10.2 Release Point		
10.2.1 Flow rate	l/s	The discharge (including minimum dilution flow, if any) of liquid potentially radioactive effluent streams from plant systems to the receiving water body.
10.3 Source Term		
10.3.1 Liquid	GBq/yr	The annual activity, by isotope, contained in routine plant liquid effluent streams.
10.3.2 Tritium	GBq/yr	The annual activity of tritium contained in routine plant liquid effluent streams.
11 Solid Radwaste System		
11.1 Acreage		
11.1.1 Low Level Radwaste Storage	ha	The land usage required to provide onsite storage of low level radioactive wastes.
11.2 Solid Radwaste		
11.2.1 Activity	GBq/yr	The annual activity, by isotope, contained in solid radioactive wastes generated during routine plant operations.
11.2.2 Principal Radionuclides	GBq/yr	The principal radionuclides contained in solid radioactive wastes generated during routine plant operations.
11.2.3 Volume	m^3/year	The expected volume of solid radioactive wastes generated during routine plant operations.
12 Spent Fuel Storage		
12.1 Spent Fuel Dry Storage		
12.1.1 Acreage	ha	The land usage required to provide onsite dry storage of spent fuel for the expected plant lifetime, including the fenced off area necessary to provide an acceptable radiation protection and security zone.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
12.1.2 Minimum Distance to Nearest Residence	m	The minimum distance from the spent fuel dry storage facility to the nearest residence to ensure that radiation exposures meet 10CFR72 limitation.
12.1.3 Minimum Distance to Power Block	m	The minimum distance from spent fuel dry storage facility to the nearest unit power block necessary to ensure that occupational radiation exposures meet 10CFR20 requirements.
12.1.4 Storage Capacity	yr	The years of plant operation for which spent fuel dry storage should be provided without taking credit for capacity in the spent fuel pool.
13 Auxiliary Boiler System		
13.1 Exhaust Elevation	m	The height above finished plant grade at which the flue gas effluents are released to the environment.
13.2 Flue Gas Effluents	kg/yr	The expected combustion products and anticipated quantities released to the environment due to operation of the auxiliary boilers, diesel engines and gas turbines.
13.3 Fuel Type	n/a	The type of fuel required for proper operation of the auxiliary boilers.
13.4 Heat Input Rate	kW	The average heat input rate due to the periodic operation of the auxiliary boilers.
14 HVAC System		
14.1 Ambient Air Requirements		
14.1.1 Non-safety HVAC max ambient temperature (1% exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.
14.1.2 Non-safety HVAC min ambient temperature (1% exceed.)	°C	Assumption used for the minimum ambient temperature that will be exceeded no more than 1% of the time, to design the non-safety HVAC systems.
14.1.3 Safety HVAC max ambient temperature (0% Exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
14.1.4 Safety HVAC min ambient temperature (0% exceed.)	°C	Assumption used for the minimum ambient temperature that will never be exceeded, to design the safety-related HVAC systems.
14.1.5 Vent System max ambient temperature (5% Exceed.)	°C DB °C WB	Assumption used for the maximum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
14.1.6 Vent System Min ambient temperature (5% exceed.)	°C	Assumption used for the minimum ambient temperature that will be exceeded no more than 5% of the time to design the non-HVAC ventilation systems.
15 Onsite/Offsite Electrical Power System		
15.1 Acreage		
15.1.2 Switchyard	ha	The land usage required for the high voltage switchyard used to connect the plant to the transmission grid.
16 Standby Power System		
16.1 Diesel		
16.1.1 Diesel Capacity	number kW	The capacity of diesel engines used for generation of standby electrical power.
16.1.2 Diesel Exhaust Elevation	m	The capacity of diesel engines used for generation of standby electrical power.
16.1.3 Diesel Flue Gas Effluents	kg / yr	The expected combustion products and anticipated quantities released to the environment due to operation of the emergency standby diesel generators.
16.1.4 Diesel Noise	dba @ 305 m	The maximum expected sound level produced by operation of diesel engines turbines, measured at 50 feet from the noise source.
16.1.5 Diesel Fuel Type	n/a	The type of fuel oil required for proper operation of the diesel engines.
16.2 Gas Turbine		N/A for ANPP
17 Plant Characteristics		
17.1 Access Routes		
17.1.1 Heavy Haul Routes	ha	The land usage required for permanent heavy haul routes to support normal operations and refueling.
17.1.2 Spent Fuel Cask Weight	tonne	The weight of the heaviest expected shipment during normal plant operations and refueling.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
17.2 Acreage		
17.2.1 Office Facilities 17.2.2 Parking Lots 17.2.3 Permanent Support Facilities 17.2.4 Power Block 17.2.5 Protected Areas	ha ha ha ha ha	The land area required to provide space for plant facilities.
17.3 Megawatts Thermal	MWth	The thermal power generated by all units.
17.4 Plant Design Life	yr	The operational life for which the plant is designed.
17.5 Plant Population		
17.5.1 Operation	Persons	The number of people required to operate and maintain the plant.
17.5.2 Refueling / Major Maintenance	Persons	The additional number of temporary staff required to conduct refueling and major maintenance activities.
17.6 Station Capacity Factor	%	The percentage of time that a plant is capable of providing power to the grid.
<u>18 Construction</u>		
18.1 Access Routes		
18.1.1 Construction Module Dimensions Reactor Vessel/Assembly Steam Generator Turbine Rotor Generator Stator Modules by Rail / Road	 m D or H m W m L m D m L m D m L m D m L m H m W m L	The maximum expected length (L), width (W), diameter (D) and height (H) of the largest construction modules or components and delivery vehicles to be transported to the site during construction.

Plant Parameter Envelope Definitions for ANPP Unit 3		
PPE Section	**Units (Metric)**	**Definition**
18.1.2 Heaviest Construction Shipment	tonne	The maximum expected weight of the heaviest construction shipment to the site.
18.2 Acreage		The land area required to provide space for construction support facilities.
18.2.1 Laydown Area	ha	
18.2.2 Temporary Construction Facilities	ha	
18.3 Construction		
18.3.1 Noise	db @15 m	The maximum expected sound level due to construction activities, measured at 50 feet from the noise source.
18.4 Plant Population		
18.4.1 Construction	persons	Peak employment during plant construction.
18.5 Site Preparation Duration	mo	Length of time required to prepare the site for construction.

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value [(1)]	Conversion from 2 units	Notes
1. Structure				
1.1 Height	m	72	1	above grade, VVER Bounding
1.1.2 Foundation Embedment	m	22	1	Bounding is ACR-700 (no value available for ACR-1000)
1.2 Precipitation (for Roof Design)				Design Assumptions
1.2.1a Maximum Rainfall Rate	mm/hr	n/s	n/a	
1.2.1b Maximum Rainfall Rate	mm/5min	n/s	n/a	
1.2.2 Snow & Ice Load	kg/m^2	n/s	n/a	
1.3 Safe Shutdown Earthquake (SSE)				Design Assumptions
1.3.1 Design Response Spectra		n/s	n/a	
1.3 2 Peak Ground Acceleration	g	0.40	n/a	Armenia specific value
1.3.3 Time History		n/s	n/a	
1.3 4 Capable Tectonic Structures or Sources		No fault displacement within investigative area		
1.4 Site Water Level (Allowable)				Design Assumptions
1.4.1 Maximum Flood (or Tsunami)	m	n/s	n/a	
1.4.2 Maximum Ground Water	m	n/s	n/a	
1.5 Soil Properties Design Bases				Design Assumptions
1.5.1 Liquefaction		none		
1.5.2 Minimum Bearing Capacity (static)	kPa	n/s	n/a	
1.5.3 Minimum Shear Wave	m/s	n/s	n/a	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
Velocity				
1.6 Tornado (Design Bases)				Design Assumptions
1.7 Wind				Design Assumptions
1.7.1 Basic Wind Speed	m/s	n/s	n/a	
1.7.2 Importance Factors	n/a	n/s	n/a	
2 Normal Plant Heat Sink				
2.1 Ambient Air Requirements				
2.1.1 Norm Shutdown Max Ambient Temperature (1% exceed.)	°C DB	n/s	n/a	US URD - DB Coincident w/ WB
	°C WB	n/s	n/a	US URD
2.1.2 Norm Shutdown Max Wet Bulb Temperature (1% Exceed.)	°C WB	n/s	n/a	US URD non-coincident
2.1.3 Normal Shutdown Min. Ambient Temperature (1% Exceed.)	°C	n/s	n/a	US URD
2.1.4 RX Thermal Power Max Ambient Temperature (0% Exceed.)	°C DB	n/s	n/a	US URD - DB Coincident w/ WB
	°C WB	n/s	n/a	US URD
2.1.5 Rx Thermal Pwr Max Wet Bulb Temperature (0% Exceed.)	°C WB	n/s	n/a	US URD - non-coincident
2.1.6 Rx Thermal Pwr Min Temperature (0% Exceed.)	°C	n/s	n/a	
2.2 Blowdown Pond Acreage	ha	6.5	1	Definition specifies 24 hrs of blowdown (a volume) rather than acreage (an area) –

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
2.2a Blowdown Pond Volume	m^3	83,000	n/a	VVER Bounding on acreage
2.3 Condenser				
2.3.1 Maximum Inlet Temperature Condenser/Heat Exchanger	°C	32.8	1	
2.3.2 Condenser /Heat Exchanger Duty	kW	2.23E+06	0.5	
2.4 Mechanical Draft Cooling Towers				
2.5 Natural Draft Cooling Towers				
2.4.1 / 2.5.1 Acreage	ha	20 / 2.2	1	Mechanical Draft / Natural Draft
2.4.2 / 2.5.2 Approach Temperature	°C	5.6	1	
2.4 3 / 2.5.3 Blowdown Constituents and Concentrations	ppm	See Table 3.2A-2	n/a	Values based on water conditions in Armenia.
2.4.4 / 2.5.4 Blowdown Flow Rate	l/s	960 / 950	n/a	Assumes drift = 0.04% / 0.02% of flow
	l/s max	1,300	n/a	Assumes 40% increase in evaporation due to higher heat load.
2.4.5 / 2.5.5 Blowdown Temperature	°C	38	1	
2.4.6 / 2.5.6 Cycles of Concentration	number	2	n/a	Revised from NEI value of 4.
2.4.7 / 2.5.7 Evaporation Rate	l/s	950	0.5	
2.4.8 / 2.5.8 Height	m	18 / 170	1	Mechanical Draft / Natural Draft
2.4.9 / 2.5.9 Makeup Flow Rate	l/s	1,900	n/a	Evaporation + Drift + Blowdown
	l/s max	2,700	n/a	140% of 2.4.7/2.5.7 + drift + max blowdown
2.4.10 / 2.5.10 Noise	dba @ 305 m	55	1	US URD
2.4.11 / 2.5.11 Cooling Tower Temperature Range	°C	10	1	VVER (AES-91) bounding

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
2.4.12 / 2.5.12 Cooling Water Flowrate	l/s	38,000	0.5	
2.4.13 / 2.5.13 Heat Rejection Rate (blowdown)	l/s	960 / 950	n/a	@ 100 F (37.8 °C), value from 2.4.4/2.5.4
	l/s max	1,300	n/a	@ 100 F (37.8 °C), value from 2.4.4/2.5.4 (max)
2.4.14 / 2.5.14 Maximum Consumption of Raw Water	l/s	1,300	n/a	calculated as 140% of 2.4.7/2.5.7, plus drift
2.4.15 / 2.5.15 Monthly Average Consumption of Raw Water	l/s	960 / 950	n/a	Evaporation + drift
2.4.16 / 2.5.16 Stored Water Volume	m^3	26,000 / 51,000	0.5	VVER bounding for 2.5.16 due to use of two towers
3 Ultimate Heat Sink (UHS)		***Note: AP1000 has no UHS requirements.***		
3.1 Ambient Air Requirements				
3.1.1 Maximum Ambient Temperature (0% Exceed.)	°C DB	n/s	n/a	US URD - DB coincident w/ WB
	°C WB	n/s	n/a	US URD
3.1.2 Maximum Wet Bulb Temperature	°C WB	n/s	n/a	US URD - non-Coincident
3.1.3 Minimum Ambient Temperature (0% Exceed.)	°C	n/s	n/a	US URD
3.2 CCW Heat Exchanger				
3.2.1 Max Inlet Temperature to CCW HX	°C	35	1	
3.2.2 CCW (RCW) HX Duty	kW	2.6E+04	0.5	Normal Operation
	kW Max	1.4E+05	0.5	VVER bounding (accident mode)
3.3 Mechanical Draft Cooling Towers				
3.3.1 Acreage	ha	0.2	1	
3.3.2 Approach Temperature	°C	8.3	1	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
3.3.3 Blowdown Constituents, Concentrations	ppm	See Table 3.2A-2	n/a	Values based on water conditions in Armenia.
3.3.4 Blowdown Flowrate	l/s expected	13	n/a	Assumes drift = 0.04% of flow
	l/s max	36	n/a	Assumes drift = 0.04% of flow
3.3.5 Blowdown Temperature	°C	35	1	
3.3.6 Cycles of Concentration	number	2	n/a	Reduced from NEI value of 4
3.3.7 Evaporation Rate	l/s expected	12	0.5	
	l/s max	35	0.5	
3.3.8 Height	m	18	1	
3.3.9 Makeup Flowrate	l/s expected	26	n/a	= evaporation + drift + blowdown
	l/s max	71	n/a	= evaporation + drift + blowdown
3.3.10 Noise	dba @ 305 m	55	1	US URD
3.3.11 Cooling Tower Temperature Range	°C	8.9	1	
3.3.12 Cooling Water Flowrate	l/s expected	1,300	0.5	
	l/s max	2,300	0.5	
3.3.13 Heat Rejection Rate (blowdown)	l/s expected	4.9	0.5	@ 95 F (35 C)
3.3.14 Maximum Consumption of Raw Water	l/s	36	n/a	= evaporation + drift
3.3.15 Monthly Average Consumption of Raw Water	l/s	13	n/a	= evaporation + drift
3.3.16 Stored Water Volume	m^3	9.0E+07	0.5	
3.5 Ponds				Bounding is ACR-1000(S) calculated
3.5.1 Acreage	ha	24	1	
3.5.2 Blowdown Constituents,	ppm	See Table	n/a	Values based on water conditions in

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
Concentrations		3.2A-2		Armenia.
3.5.3 Blowdown Flowrate	l/s expected	25	n/a	Assumes drift = evaporation
	l/s max	69	n/a	Assumes drift = evaporation
3.5.4 Blowdown Temperature	°C	35	1	
3.5.5 Cycles of Concentration	number	2	1	
3.5.6 Evaporation Rate	l/s expected	12	0.5	
	l/s max	35	0.5	
3.5.7 Makeup Flowrate	l/s expected	49	n/a	Assumes drift = evaporation
	l/s max	140	n/a	Assumes drift = evaporation
3.5.8 Cooling Pond Temperature Range	°C	8.9	1	
3.5.9 Cooling Water Flowrate	l/s expected	1,300	0.5	
	l/s max	2,300	0.5	
3.5.10 Heat Rejection Rate (blowdown)	l/s expected	25	n/a	@ 95 F (35 C), value from 3.5.3
3.5.11 Maximum Consumption of Raw Water	l/s	69	n/a	= evaporation (max) + drift (max)
3.5.12 Monthly Average Consumption of Raw Water	l/s	25	n/a	= evaporation (expected) + drift (expected)
3.5.13 Stored Water Volume	m^3	5.3E+05	0.5	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value [1]	Conversion from 2 units	Notes
4 Containment Heat Removal System (Post Accident)				
4.1 Ambient Air Requirements				Design Assumption
4.1.1 Maximum Ambient Air Temperature (0% exceed.)	°C DB	n/s	n/a	
	°C WB	n/s	n/a	
4.1.2 Minimum Ambient Temperature (0% exceed.)	°C	n/s	n/a	
5 Potable Water/Sanitary Waste System				
5.1 Discharge to Site Water Bodies				
5.1.1 Flow Rate	l/s expected	6.1	n/a	Based on Plant Population (Section 17.5.1)
	l/s max	11	n/a	Max/Expected ratio same as NEI.
5.2 Raw Water Requirements				
5.2.1 Maximum Use	l/s	27	n/a	5.2.1/5.1.1 same ratio as NEI
5.2.2 Monthly Average Use	l/s	20	n/a	5.2.2/5.2.1 same ratio as NEI
6 Demineralized Water System				
6.1 Discharge to Site Water Bodies				
6.1.1 Flow Rate	l/s expected	5.4	0.5	
	l/s max	7.2	0.5	
6.2 Raw Water Requirements				
6.2.1 Maximum Use	l/s	50	0.5	VVER bounding
6.2.2 Monthly Average Use	l/s	27	0.5	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
7 Fire Protection System				
7.1 Raw Water Requirements				
7.1.1 Maximum Use	l/s	140	1	VVER bounding
7.1.2 Monthly Average Use	l/s	0.32	0.5	
7.1.3 Stored Water Volume	m^3	5,900	1	
8 Miscellaneous Drain				
8.1 Discharge to Site Water Bodies				
8.1.1 Flow Rate	l/s expected	1.6	0.5	
	l/s max	5.0	0.5	VVER bounding
9 Unit Vent/Airborne Effluent Release Point				
9.1 Atmospheric Dispersion (Chi/Q) (Accident)	EAB, km	0.8	n/a	See Chapter 7
	LPZ, km	3.2	n/a	See Chapter 7.
9.1.1 0-2 hr @ EAB	s/m^3	3.37E-05	n/a	See Table 7.1-2.
9.1.2 0-8 hr @ LPZ	s/m^3	8.2E-06	n/a	See Table 7.1-2.
9.1.3 8-24 hr @ LPZ	s/m^3	2.5E-06	n/a	See Table 7.1-2.
9.1.4 1-4 day @ LPZ	s/m^3	3.0E-06	n/a	See Table 7.1-2.
9.1.5 4-30 day @ LPZ	s/m^3	2.8E-06	n/a	See Table 7.1-2.
9.2 Atmospheric Dispersion (Chi/Q) (Annual Average)	s/m^3	2.8E-06	n/a	= 9.1.5 value (as in NEI PPE)

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
9.3 Dose Consequences				
9.3.1 Normal, Public Individual Effective Equivalent	Sv	1.0E-04	n/a	GoA Resolution 1489, para. 20.
Collective Annual Public Dose	Man-Sv/yr	1	n/a	GoA Resolution 1291, para. 10.
9.3.2 Post-Accident (limit of annual dose due to contamination of territory)	Sv	5.0 E-03	n/a	GoA Resolution 1489, paragraph 230.
9.3.3 Severe Accidents	Sv WB		n/a	Not Specified
	Proba-bility	< 1E-06	n/a	GoA Resolution 1219, para. 12
9.4 Release Point				
9.4.1 Configuration (Horizontal vs Vertical)	n/a	Vertical	n/a	
9.4.2 Elevation (Normal)	m	49	1	
9.4.3 Elevation (Post-Accident)	m	0	1	grade level elevation
9.4.4 Minimum Distance to Site Boundary	m	480	1	Exclusion Area
9.4.5 Temperature	°C est.	40	1	
	°C max	60	1	VVER bounding
9.4.6 Volumetric Flow Rate	l/s	28,000	0.5	
9.5 Source Term				
9.5.1 Gaseous (normal)	GBq/yr	560,000	0.5	See Table 3.2A-6 for bounding values by isotope.
9.5.2 Gaseous (Post-Accident)	GBq	Table 3.2A-7	1	Bounding is CANDU(S), AP1000 uses alternate source term approach.
9.5.3 Tritium (normal)	GBq/yr	120,000	0.5	CANDU-6 bounding
<u>10 Liquid Radwaste System</u>				
10.1 Dose Consequences				

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
10.1.1 Normal Public Individual Effective Equivalent	Sv	1.0E-04	n/a	GoA Resolution 1489, para 20.
Collective Annual Public Dose	Man-Sv/yr	1	n/a	GoA Resolution 1291, Art. II, 10.
10.1.2 Post Accident (limit of annual dose due to contamination of territory)	Sv	5.0 E-03	n/a	GoA Resolution 1489, paragraph 230.
10.2 Release Point				
10.2.1 Flow rate	l/s	0.18	0.5	
	l/s dilution	76	0.5	
10.3 Source Term				
10.3.1 Liquid	GBq/yr	See Table 3.2A-8	0.5	See Table 3.2A-8 for bounding values by isotope, VVER data not included
10.3.2 Tritium	GBq/yr	67,000	0.5	CANDU-6 Bounding
11 Solid Radwaste System				
11.1 Acreage				
11.1.1 Low Level Radwaste Storage	Ha	< 0.4	1	
11.2 Solid Radwaste				
11.2.1 Activity	GBq/yr	55,000	0.5	Composite AP1000&CANDU(S) bounding, VVER data not considered
11.2.2 Principal Radionuclides		See Table 3.2A-3	1	
11.2.3 Volume	m^3/year	160	0.5	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
12 Spent Fuel Storage				
12.1 Spent Fuel Dry Storage				
12.1.1 Acreage	ha	6.1	0.5	
12.1.2 Minimum Distance to Nearest Residence	m	1,100	1	
12.1.3 Minimum Distance to Power Block	m	460	1	
	m	670	1	
12.1.4 Storage Capacity	yr	60	1	
13 Auxiliary Boiler System				
13.1 Exhaust Elevation	m	34	1	Above Grade
13.2 Flue Gas Effluents		See Table 3.2A-4	n/a	
13.3 Fuel Type	n/a	Natural Gas	n/a	
13.4 Heat Input Rate	kW	4.6 E+04	0.5	
14 HVAC System				
14.1 Ambient Air Requirements		Design Assumptions –		NEI values, not ANPP
14.1.1 Non-safety HVAC max ambient temperature (1% exceed.)	°C DB	38	1	DB coincident w/ WB
	°C WB	25	1	
14.1.2 Non-safety HVAC min ambient temperature (1% exceed.)	°C	-23	1	
14.1.3 Safety HVAC max ambient temperature (0% Exceed.)	°C DB	46	1	DB coincident w/ WB
	°C WB	27	1	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value [1]	Conversion from 2 units	Notes
14.1.4 Safety HVAC min ambient temperature (0% exceed.)	°C	-40	1	
14.1.5 Vent System max ambient temperature (5% Exceed.)	°C DB	35	1	DB coincident w/ WB
	°C WB	25	1	
	°C WB	26	1	non-coincident
14.1.6 Vent System Min ambient Temperature (5% exceed.)	°C	-20	1	
15 Onsite/Offsite Electrical Power System				
15.1 Acreage				
15.1.1 Switchyard	ha	3.5	n/a	Existing 110kV and 220kV + new 400kV
16 Standby Power System				
16.1 Diesel				
16.1.1 Diesel Capacity	number	4	n/a	VVER bounding, number of diesels assumed.
	kW	8000	1	
16.1.2 Diesel Exhaust Elevation	m	10	1	
16.1.3 Diesel Flue Gas Effluents		See Table 3.2A-5	0.5	
16.1.4 Diesel Noise	dba @ 305 m	55	1	US URD
16.1.5 Diesel Fuel Type			n/a	
17 Plant Characteristics				
17.1 Access Routes				
17.1.1 Heavy Haul Routes	ha	1.6	1	

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value (1)	Conversion from 2 units	Notes
17.1.2 Spent Fuel Cask Weight	tonne	110	1	VVER bounding
17.2 Acreage				
17.2.1 Office Facilities	ha			
17.2.2 Parking Lots	ha			
17.2.3 Permanent Support Facilities	ha			
17.2.4 Power Block	ha	16		CANDU-6 bounding
17.2.5 Protected Areas	ha	48	0.5	VVER bounding (half of value for AES-91 two units)
17.3 Megawatts Thermal	MWth Core	3,400	0.5	
	MWth NSSS	3,430	0.5	
17.4 Plant Design Life	yr	60	1	
17.5 Plant Population				
17.5.1 Operation	Persons	1,750	n/a	Assumed for current ANPP, pending completion of IAEA/MoE study.
17.5.2 Refueling / Major Maintenance	Persons, additional	250	n/a	
17.6 Station Capacity Factor	%	93%	1	
18 Construction				
18.1 Access Routes				
18.1.1 Construction Module Dimensions				
Reactor Vessel/Assembly	m D or H m W m L			No bounding values assumed, pending receipt of official data for CANDU-6 and VVER.
Steam Generator	m D m L			

Table 3.2A-1, Plant Parameter Envelope for ANPP Unit 3

PPE Section	Units (Metric)	Bounding Value [1]	Conversion from 2 units	Notes
Turbine Rotor	m D m L			
Generator Stator	m D m L			
Modules by Rail / Road	m H m W m L	3.7 3.7 24.4	1 1 1	
18.1.2 Heaviest Construction Shipment	tonne	860	1	
18.2 Acreage				
18.2.1 Laydown Area	ha	8	1	
18.2.2 Temporary Construction Facilities	ha	10	1	
18.3 Construction				
18.3.1 Noise	db @15.2 m	76	1	US URD
	db @15.2 m	101	1	US URD
18.4 Plant Population				
18.4.1 Construction	persons	2,400	n/a	Value from US DOE NP2010, pending completion of IAEA/MoE study.
18.5 Site Preparation Duration	mo	28	1	VVER bounding

[1] Bounding value for AP1000, ACR-700 (as surrogate for CANDU), and VVER-1000, single units.

Table 3.2A-2, Blowdown Constituents and Concentrations for ANPP Unit 3	
Constituent	**Concentration (mg/l)**
BOD, 20-day	7
Total suspended solids	20
Iron	0.3
Copper	0.1
Chlorides	300
Oil and grease	0.6
Ammonium Ion	0.8
Sulfate	900
Nitrates	10
Phosphate	2

TABLE 3.2A-3 Principal Radionuclides in Solid Radwaste (1)	
Radionuclide	**Bounding Value (GBq/yr)**
Fe-55	1.2E+04
* Fe-59	1.2E+01
Co-60	1.1E+04
Mn-54	8.3E+02
* Cr-51	8.4E+02
Co-58	2.3E+03
Ni-63	1.2E+04
H-3	5.9E+01
C-14	1.1E+01
* Nb-95	3.0E+03
* Ag-110m	4.0E+01

TABLE 3.2A-3 Principal Radionuclides in Solid Radwaste [1]	
Radionuclide	**Bounding Value (GBq/yr)**
* Zr-95	1.4E+03
* Ba-137m	4.7E+03
Ba-140	3.2E+00
Pu-241	4.2E+00
La-140	1.5E+00
* Cs-134	2.2E+00
* Cs-137	7.1E+01
* Sr-90	2.0E+00
* I-131	1.5E+03
* I-133	8.4E+01
* Na-24	8.1E+00
* Ru-103	4.0E+01
* Ru-106	2.5E+01
* Sb-124	2.1E+02
* Ce-141	2.6E+00
* Ce-144	2.0E+00
* Gd-153	5.7E+01
Other	1.1E+03
**Total	5.0E+04

[1] See PPE Section 11.2.2

* Bounding is Surrogate CANDU

** Composite AP1000 & CANDU(S)

Table 3.2A-4 Yearly Emissions Auxiliary Boilers[1][2]	
Pollutant	**Bounding Value kg**
Particulates	390
Sulfur oxides	31
Carbon monoxide	4,300
Volatile Organic Compounds	280
Nitrogen oxides	14,300

[1] PPE, Section 13.2

[2] Emissions are based on 30 days of operation per year.

Table 3.2A-5, Yearly Emissions From Standby Diesel Generators [1]	
Pollutant [2][3]	**Bounding Value kg**
Particulates	550
Sulfur oxides	1,700
Carbon monoxide	3,100
Hydrocarbons	2,100
Nitrogen oxides	12,000

[1] See PPE, Section 16.1.3

[2] Emissions are based on 4 hrs/month operation for each DG, bounding is VVER with 8,000 kW of capacity.

[3] Further reduction in emissions can be achieved with the addition of emission control equipment on the D.G.s.

Table 3.2A-6, Composite Average Annual Normal Gaseous Release

Isotope	Bounding Release GBq/yr	Isotope	Bounding Release GBq/yr
Kr-83m	1.6E-02	Sr-89	1.1E-01
Kr-85m	1.3E+03	Sr-90	4.4E-02
Kr-85	1.5E+05	Y-90	8.5E-04
Kr-87	5.6E+02	Sr-91	1.9E-02
Kr-88	1.7E+03	Sr-92	1.5E-02
Kr-89	4.5E+03	Y-91	4.5E-03
Kr-90	6.0E-03	Y-92	1.2E-02
Xe-131m	6.7E+04	Y-93	2.1E-02
Xe-133m	3.2E+03	Zr-95	3.7E-02
Xe-133	1.7E+05	Zr-95	3.7E-02
Xe-135m	7.5E+03	Mo-99	1.1E+00
Xe-135	1.2E+04	Tc-99m	5.5E-03
Xe-137	9.5E+03	Ru-103	6.5E-02
Xe-138	8.0E+03	Rh-103m	2.1E-03
Xe-139	7.5E-03	Ru-106	2.9E-03
1-131	4.8E+00	Rh-106	3.5E-04
1-132	4.1E+01	Ag-110m	3.7E-05
1-133	3.1E+01	Sb-124	3.4E-03
1-134	7.0E+01	Sb-125	2.3E-03
1-135	4.5E+01	Te-129m	4.1E-03
C-14**	3.6E+02	Te-131m	1.4E-03
Na-24	7.5E-02	Te-132	3.5E-04
P-32	1.7E-02	Cs-134	1.2E-01
*Ar-41	5.6E+03	Cs-136	1.1E-02
Cr-51	6.5E-01	Cs-137	1.8E-01

Table 3.2A-6, Composite Average Annual Normal Gaseous Release

Isotope	Bounding Release GBq/yr	Isotope	Bounding Release GBq/yr
Mn-54	1.0E-01	Cs-138	3.1E-03
Mn-56	6.5E-02	Ba-140	5.0E-01
Fe-55	1.2E-01	La-140	3.3E-02
Co-57	3.0E-04	Ce-141	1.7E-01
Co-58	8.5E-01	Ce-144	3.5E-04
Co-60	3.2E-01	Pr-144	3.5E-04
Fe-59	1.5E-02	W-187	3.5E-03
Ni-63	1.2E-04	Np-239	2.2E-01
Cu-64	1.9E-01	Total (w/o H-3)	4.46E+05
Zn-65	2.1E-01	**H-3	1.18E+05
Rb-89	8.0E-04	*Total	5.64E+05

* Bounding is CANDU(S)

** Bounding is CANDU-6

Table 3.2A-7 Gaseous Release Source Term (Post-Accident) [1]

Isotope	Limiting Design Basis Event Releases (GBq)		
	0 to 2 hour	2 to 8 hours	8 to 720 hours
1-131	2.1E+04	6.3E+04	1.5E+06
I-132	2.3E+04	4.4E+04	7.8E+04
1-133	4.3E+04	1.2E+05	6.3E+05
1-134	2.4E+04	3.1E+04	4.8E+04
1-135	3.7E+04	9.3E+04	2.6E+05
Kr-83m	7.7E+04	1.3E+05	2.2E+05
Kr-85m	2.1E+05	4.8E+05	1.1E+06
Kr-85	1.7E+03	5.2E+03	3.0E+05
Kr-87	3.0E+05	4.3E+05	6.7E+05
Kr-88	5.4E+05	1.1E+06	2.1E+06
Kr-89	3.2E+04	3.2E+04	4.8E+04
Xe-131m	9.3E+03	3.0E+04	8.5E+05
Xe-133m	5.2E+04	1.5E+05	1.4E+06
Xe-133	1.7E+06	5.0E+06	8.7E+07
Xe-135m	6.6E+04	6.7E+04	1.0E+05
Xe-135	1.4E+05	3.6E+05	1.2E+06
Xe-137	7.0E+04	7.0E+04	1.1E+05
Xe-138	2.5E+05	2.5E+05	4.1E+05

[1] See PPE Section 9.5.2, Bounding is Surrogate CANDU

AP1000 uses alternate source term

Table 3.2A-8 Average Annual Normal Liquid Release [1]

Isotope	Release, GBq/yr	Isotope	Release -GBq/yr
*C 14	1.40E-02	Ru 103	1.82E-01
Na 24	6.03E-02	Rh 103M	1.82E-01
P-32	3.33E-03	Ru 106	2.72E+00
*Cr 51	1.80E-01	Rh 106	2.72E+00
Mn 54	4.81E-02	Ag 110M	3.89E-02
Mn-56	7.05E-02	Ag 110	5.18E-03
Fe 55	1.07E-01	*Sb 122	7.60E-03
*Fe 59	9.40E-03	*Sb 124	3.29E-02
Ni 63	2.59E-03	*Sb 125	3.70E-03
Cu 64	1.39E-01	Te 129M	4.44E-03
Co 56	9.60E-02	Te 129	5.55E-03
Co 57	1.33E-03	Te 131M	3.33E-03
Co 58	1.24E-01	Te 131	1.11E-03
*Co 60	2.50E-01	I 131	5.24E-01
Zn 65	1.52E-02	Te 132	8.88E-03
W 187	4.81E-03	I 132	6.07E-02
Np 239	5.75E-02	I 133	2.48E-01
Br 84	7.40E-04	I 134	3.15E-02
Rb 88	9.99E-03	Cs 134	3.68E-01
Rb 89	8.16E-04	I 135	1.84E-01
Sr 89	3.70E-03	Cs 136	2.33E-02
*Sr 90	2.79E-04	Cs 137	4.92E-01
Sr 91	1.67E-02	Cs 138	3.52E-03
Y 90	5.75E-05	Ba 137m	4.61E-01
Y 91	2.04E-03	Ba 140	2.04E-01
Sr 92	1.48E-02	La 140	2.76E-01
Y 91M	3.70E-04	Ce 141	3.33E-03
Y 92	1.11E-02	Ce 143	7.03E-03
Y 93	1.67E-02	Pr 143	4.81E-03
*Zr 95	1.70E-01	Ce 144	1.17E-01
*Nb 95	3.61E-01	Pr 144	1.17E-01
Mo 99	2.11E-02	All others	7.40E-04
Tc 99M	2.04E-02	**Total	1.15E+01

[1] See PPE Section 10.3.1

* CANDU(S) bounds AP1000, ** Composite AP1000 & CANDU(S)

3.3 PLANT WATER USE

Section 3.3.1 describes plant water use (e.g., circulating water system, sanitary waste system, radwaste and chemical waste systems, and service water systems). Referring to the Plant Parameter Envelope (PPE) developed in Section 3.2, Section 3.3.1 describes the quantity of water required for plant operation, the amount of water consumed by the plant water systems, and the amount of water discharged to a water body. This section describes variations in water requirements and consumption on a temporal basis and as a function of plant operating modes.

Section 3.3.2 provides a description of the treatment needed for the plant water streams identified in Section 3.3.1 using the water supplies described in Sections 2.3.1 and 2.3.3. This section includes a description of water treatment processes for potable, cooling and recirculating systems and identification and quantification of the chemicals used.

3.3.1 Water Consumption

Raw water is needed to support construction and operation of ANPP Unit 3. The normal heat sink and ultimate heat sink have operational water needs that will be met by the raw water supply system (RWS) using water withdrawn from the Sevjur River, as is the case for the existing ANPP Units 1 and 2 (Phase 1). A backup source of water is a collection pond fed by the same ground water sources that supply the Sevjur River. This collection pond was created in anticipation of water needs to support ANPP Phase 2 (planned VVER 440 Units 3 and 4).

Another existing water source fed by Upper Zeiva is currently used to supply water for general site purposes including potable drinking water, sanitary, and landscape maintenance. The water quality from these springs has degraded due to contamination from agricultural runoff. The current drinking water supply will be replaced by a set of wells to the northeast of the current ANPP Phase 1 cooling towers. The capacity of this system will be sufficient to supply potable drinking water, fire system makeup, and demineralized water system influent for Unit 3. After installation of the new drinking water supply, the current source may be used for construction purposes, such as concrete batch facility operation, dust suppression, and construction base sanitary needs.

The PPE (Appendix 3.2A) provides bounding values for facility water use. Other constraints on facility water use are based on site-specific information. Figure 3.3-1 is a water use diagram corresponding to the systems described below, including flow rates. Table 3.3-1 summarizes water use rates, which come from the PPE or are derived from parameters in the PPE.

3.3.1.1 RAW WATER SUPPLY SYSTEM

The Unit 2 SAR (Ref. [3.3-1]) describes the current raw water supplies, thus:

> The source of raw water to replenish irreversible losses by ANPP is the Sevjur River, which is a left tributary of the Araks River. The Sevjur River is 38 km long. The river is spring-fed. The hydrogeological characteristics of the Sevjur River:
> - average river width, 20 m;
> - average river depth, 2.5 m;
> - average annual velocity of current, 0.3 m/s;
> - average annual river flow rate, 21.7 m^3/s (21,700 l/s, 78,120 m^3/hr).

The estimated flowrate of the Sevjur River at the intake site of the water pumping station (adjacent to the existing irrigation diversion dam) at 95% exceedance probability is a minimum of 11 m^3/s (1.1 x 10^4 l/s, 39,600 m^3/hr) and a maximum of 24.3 m^3/sec (2.43 x 10^4 l/s, 87,480 m^3/hr). The Sevjur River is used during the summer for irrigation. The maximum extraction rate for irrigation is 10.02 m^3/sec; therefore, during the minimum river flow that can occur in any of the months in this period, ANPP's water consumption needs can be met only by reducing the extractions from the Sevjur River for irrigation.

A collection pond, 0.25 km x 0.80 km, 0.4 km^2 in area[5], is situated on the left-bank floodplain of the Sevjur River, 1.2 km above the irrigation diversion dam. The collection pond is fed by three springs, which have an aggregate discharge of 1.25 m^3/sec (1,250 l/s, 4,500 m^3/hr). The quality of the source water from the collection pond is equivalent to the quality of the groundwater that comes into the pond through its bed and is essentially the same as the Sevjur River which is also fed by groundwater.

ANPP Unit 2 is authorized to withdraw a combined 3.1 x 10^7 m^3/yr from the Sevjur River and collection pond. Ref. [3.3-2] This corresponds to an annual average of 980 l/s (3,500 m^3/hr). In recent years, average maximum monthly withdrawals have been 830 l/s (3,000 m^3/hr) – see section 2.3.

ANPP Unit 3 will require its own water use permits, as discussed in section 1.2. Water from the collection pond and the Sevjur River are subject to separate permits under jurisdiction of the Akhurian Basin Management Organization[6]. As noted above, the Sevjur is used during summer months for irrigation and during these months irrigation flows have to be cut back in the past in order to supply ANPP Unit 2 water needs and at the same time maintain the minimum river flow. The National Water Program assigns first priority to ensuring sustainable operation of irrigation and drinking water systems. (Ref. [3.3-3]) In light of this, the Law on Construction of ANPP Unit 3 should contain an article regarding the strategic significance of water supplies to ANPP. EBID Section 1.1.3.3 identifies a series of action that the Government of Armenia should take in order to assure an adequate supply of water to Unit 3 and other water users in the plant vicinity.

Should irrigation needs be considered of such priority that supplies to the ANPP Unit 3 should be limited, alternative cooling systems can be selected to reduce the water consumption rates, as discussed in EBID subsection 3.4.1.1.

3.3.1.2 CIRCULATING WATER SYSTEM

The dominant water use will be makeup water for condenser cooling by the Circulating Water System (CWS). That makeup water replaces water lost by evaporation, drift, and blowdown (assuming a wet cooling tower system). The PPE lists the average makeup water flow as 1,900 l/s and the maximum makeup water flow as 2,500 l/s.[7] Unit 3 CWS water usage by operating mode is provided in Table 3.4-2. These values are intended to

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[5] The ANPP Environmental Passport (Ref. [3.3-4]) lists the pond surface area as 130,000 m^2 = 0.13 km^2.
[6] Although the Akhurian BMO may be issuing water use permits at the time ANPP Unit 3 requests permits, it is most likely that water use permits of national importance will be issued by the Water Resources Management Agency.
[7] Table 3.2A-1, section 2.4.

be bounding values; water usage will be highest during the hotter, drier months of summer, because of higher evaporation rates in the cooling tower(s) and lowest during the cold months of winter.

Average and maximum blowdown from the CWS will be 970 l/s and 1,500 l/s, respectively.[8] CWS blowdown will be directed to the Sevjur River via the ANPP discharge pipe, as described in Section 3.4.

As discussed in Section 3.4, this document considers the potential for four cooling system designs for the normal heat sink: a natural draft cooling tower, mechanical draft wet cooling towers, dry cooling towers and a wet-dry hybrid system. While it can be expected that a wet-dry hybrid system would have lower water demands than a natural draft tower or mechanical draft towers, and a dry cooling system would involve minimal water demand, dry and wet-dry hybrid systems are not included in the PPE since the environmental impact of such cooling systems is bounded by the wet cooling tower systems.

3.3.1.3 ULTIMATE HEAT SINK/SERVICE WATER SYSTEM

The second dominant water use for the ANPP Unit 3 will be the Service Water System (SWS). The SWS supplies cooling water for safety-related heat exchangers necessary to support safe shutdown and to cool down the facility in the event of an emergency, including cooling for the emergency diesel generators (note: the AP1000 does not rely on external power or cooling during accident conditions, so these heat exchangers and the SWS are non-safety-related). In addition to the safety-related cooling systems, the SWS supplies cooling to non-safety related reactor auxiliary systems used during normal operation, radwaste processing systems, and spent fuel pool cooling.

The ANPP Unit 3 SWS design will be an engineered water basin and spray ponds. Alternatively, the SWS may use mechanical draft cooling towers in place of spray ponds. During emergency conditions, SWS blowdown and makeup will be isolated; the SWS will draw water only from the water basin and there will be no demand for makeup water from the RWS.

SWS makeup replaces water lost by evaporation, drift, and blowdown. The PPE lists the average makeup water flow as 49 l/s and the maximum makeup water flow as 140 l/s.[9] ANPP Unit 3 SWS water usage by operating mode is given in Table 3.4-2. Water use due to evaporation will be greatest during periods of high ambient air temperature and low humidity.

Average blowdown is 25 l/s and maximum blowdown as 69 l/s.[10] CWS blowdown will be directed via the ANPP discharge pipe to the Sevjur River as described in section 3.4.

3.3.1.4 POTABLE WATER SUPPLY

The Unit 2 SAR (Ref. [3.3-5]) describes the existing water source, referred to as the household and drinking water supply, currently used to supply water for ANPP general site

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[8] Table 3.2A-1, section 2.4; natural draft tower blowdown value in section 2.5 is lower.
[9] Table 3.2A-1, section 3.5; cooling tower values from section 3.3 are lower.
[10] Table 3.2A-1, section 3.5; cooling tower values from section 3.3 are lower.

purposes including potable drinking water, sanitary, and landscape maintenance, as follows:

> The current ANPP site, the construction depot and the town of Metsamor have a common source of drinking water—the waters of the Upper Zeiva springs, general water-intake structures and main water-supply pipelines.
>
> Water is taken in by a catchment structure built in the form of water-collecting channels. The water goes from the water-intake catchment structures to the drinking-water pumping station, which is equipped with three pumps with a capacity of 300 m^3/hr (8.3 l/s) at a pressure of 2.343 MPa.
>
> Along two main water lines, the water is fed to the plant site into two 1,000 m^3 tanks, from where pumps (two working, one backup) with a capacity of 250-360 m^3/hr (7 -10 l/s) at a pressure of 0.53 – 0.45 MPa feed it into the household and drinking water supply circuit.
>
> Since the startup of the ANPP, the chemical and bacteriological composition of the drinking water has grown markedly worse. The reason for this is that the catchment structures are at a substantial distance from, and at a lower level than, the ANPP site. The land between the plant site and the catchment structures is used for farming and is treated with chemical and organic fertilizers that cause contamination of groundwater.
>
> Surveys were performed for an alternative source of drinking water that is not affected either by ANPP itself nor by agricultural runoff. Surveys near the ANPP site, northeast of the Phase 1 cooling towers, at a distance of 600 m from the fence at absolute levels of 915-920 m, and a 90 m-deep test well revealed an aquifer whose chemical and bacteriological water composition fully meets the requirements for potable quality water. The absolute level of the well is 917.5 m.
>
> Based on these surveys, the Armenian State Planning Institute for Water Resources produced a design that called for the drilling of four deep production wells with an aggregate water discharge of 600 m^3/h (170 l/s). The territory allocated for this new water-intake structure totals 5 ha. Due to financial constraints, the project was never realized, however.

The design developed by the Armenian State Planning Institute for Water Resources will be implemented as part of site preparation activities for ANPP Unit 3. The system described above is more than sufficient to supply the expected potable water needs for ANPP Unit 3 as indicated in the PPE (19 l/s maximum), as well as the operational needs for the demineralized water system (DWS) (50 l/s maximum) and the fire protection system (140 l/s maximum).[11] Once this improved source of potable water is operational, the Upper Zieva Springs source may be available for Unit 3 construction purposes, such as concrete batch facility operation, dust suppression, and construction work force sanitary needs.

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[11] Table 3.2A-1, sections 5.2.1, 6.2.1, and 7.1.1; maximum flows to all systems will not occur at the same time, thus the deep well system should have sufficient capacity.

Potable water discharge to the sanitary sewage system will be 4.2 l/s expected and 8 l/s maximum.[12]

ANPP Unit 2 is authorized to withdraw 5.36 x 10^5 m^3 annually from the Upper Zieva Springs. Ref. [3.3-2] This corresponds to an annual average flow of 17 l/s (61 m^3/hr).

ANPP Unit 3 water withdrawals from the Upper Zieva Springs collector and from the proposed new deep well system must be in accordance with water use permits, as described in Section 1.2. Withdrawals from the Upper Zieva Springs is within the jurisdiction of the Akhuryan BMO, whereas the deep well pumping station will be within the jurisdiction of the Sevan-Hrazdan BMO.[13] If the deep well system will also supply Metsamor Town, it will be subject to a water system use permit, as described in section 1.2. (The Metsamor Master Plan (Ref. [3.3-6]) implies that Metsamor Town has its own water supply; in which case the new source for ANPP may not serve Metsamor Town.)

3.3.1.5 DEMINERALIZED WATER SYSTEM

The Unit 3 demineralized water system (DWS) will receive water from the new potable water supply, process this water to remove ionic impurities and provide demineralized water for makeup to the primary reactor coolant system, the steam cycle feed and condensate system, the spent fuel pool cooling system, and the liquid radwaste system. The DWS will use an average of 27 l/s and a maximum of 50 l/s (97 m^3/hr and 180 m^3/hr, respectively) and discharges 5.4 l/s expected and 7.2 l/s maximum (19.6 m^3/hr and 25.8 m^3/hr, respectively).[14] The DWS effluent will be discharged to the plant discharge pipe, along with cooling tower blowdown.

3.3.1.6 FIRE WATER SUPPLY

The ANPP site firefighting water supply currently draws from the household and drinking water supply system described above. The extensive length of the water supply pipelines from the Zieva Springs site, as well as the difference in the quality of the soils (rocky at the plant site, loose along the pipeline route below the plant site), create risks to this water supply, especially in the event of seismic events. Ref. [3.3-7]

The commissioning of the new water supply consisting of deep wells and water intake from them into the firefighting water supply system will provide a more reliable source of water with volumetric capacity in excess of that indicated in the PPE (0.3 l/s monthly average, 140 l/s maximum)[15]. Installation of additional water tanks of 4,000 m^3 capacity will result in a total storage capacity (6,000 m^3) exceeding that indicated by the PPE (5,900 m^3) for fire protection system stored water volume.[16] In the event that the new potable water system is unavailable to provide makeup water to the fire water system in an emergency, water will be supplied to the storage tanks from the RWS.

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[12] Table 3.2A-1, section 5.1.1.

[13] Although the BMOs may be issuing water permits by the time they are requested for ANPP Unit 3, this will likely be only local-use permits and permits of national importance will still be issued by the Water Resources Management Agency.

[14] Table 3.2A-1, section 6.2.

[15] Table 3.2A-1, sections 7.1.1 and 7.1.2.

[16] Table 3.2A-1, section 7.1.3.

Water use by the fire water system will be minimal under normal conditions, just sufficient to maintain the fire protection water pipes full and pressurized. Water will be used for fire fighting during emergencies only and is independent of plant operating mode or time of year.

3.3.2 Water Treatment

A more complete description of the treatment system for ANPP Unit 3 is provided in Section 3.6, including frequency of treatment for each of the normal modes of operation and the quantities and points of addition of the chemical additives.

3.3.2.1 CIRCULATING WATER SYSTEM

Circulating water chemistry at ANPP Unit 3 will be maintained by the turbine building chemical feed system. Turbine building chemical equipment will inject the required chemicals into the circulating water downstream of the CWS pumps. This maintains a noncorrosive, nonscale-forming condition and limits the biological film formation. Such film formation reduces the heat transfer rate in the condenser and the heat exchangers supplied by the CWS.

The chemicals to be used can be divided into six categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and a silt dispersant. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant will be metered into the system continuously or as required to maintain proper concentrations. A sodium hypochlorite treatment system will be provided for use as the biocide. The biocide application frequency may vary with seasons. The algaecide will be applied, as necessary, to control algae formation in the cooling tower basin and water channels.

Addition of biocide and water treatment chemicals will be performed by turbine building chemical feed metering pumps and will be adjusted as required. Chemical concentrations will be measured through analysis of grab samples from the CWS. Residual chlorine will be measured to monitor the effectiveness of the biocide treatment. Chemical injections will be interlocked with each circulating water pump to prevent chemical injection when the circulating water pumps are not running.

3.3.2.2 SERVICE WATER SYSTEM

Service water chemistry for ANPP Unit 3 will be maintained by the auxiliary building chemical feed system. This injection will maintain a noncorrosive, non-scale-forming condition and will limit biological film formation. Chemicals will be injected into service water pump discharge piping.

As with the CWS, the chemicals used in the SWS can be divided into six categories based upon function: biocide, algaecide, pH adjuster, corrosion inhibitor, scale inhibitor, and silt dispersant. Specific chemicals used within the system, other than the biocide, will be determined by the site water conditions. The pH adjuster, corrosion inhibitor, scale inhibitor, and dispersant will be metered into the system continuously or as required to maintain proper concentrations. A sodium hypochlorite treatment system will be provided for use as the biocide and controls microorganisms that cause fouling. The biocide application frequency may vary with seasons. Algaecide will be applied, as necessary, to control algae formation in the cooling pond / on the mechanical draft cooling tower.

Chemical concentrations will be measured through analysis of grab samples. Chlorine residual will be measured to monitor the effectiveness of the biocide treatment. Addition of water treatment chemicals will be performed by chemical feed system injection metering

pumps and will be adjusted as required. Chemical injections will be interlocked with each service water pump to prevent injection into a train when the associated service water pump is not running.

3.3.2.3 POTABLE WATER SYSTEM

Potable water for ANPP Unit 3 will be supplied by the deep well pumping station and will need no water treatment.

3.3.2.4 DEMINERALIZED WATER SYSTEM

Potable-grade water supplied from the potable water system to the DWS will be treated by filtration and primary and secondary processes consisting of reverse osmosis units and an electro-deionization system. A pH adjustment chemical will be added upstream of the filtration units to adjust the pH of the reverse osmosis influent. The pH will be maintained within the operating range of the reverse osmosis membranes to inhibit scaling and corrosion. A dilute antiscalant, chemically compatible with the pH adjustment chemical, will be used to increase the solubility of salts and decrease scale formation on the membranes. Both the pH adjustment chemical and antiscalant will be injected into the demineralized water treatment process from the turbine building chemical feed system.

3.3.2.5 FIRE PROTECTION WATER SYSTEM

Water for the fire protection system will be provided from the potable water system which is supplied from the deep well pumping station and requires no chemical treatment.

Table 3.3-1, Plant Water Use

Stream	Normal Use (l/s)[h]	Maximum Use (l/s) [h]
Circulating Water System		
Evaporation [a] [b]	950	1,300
Drift [c] [b]	15	15
Blowdown [d]	960	1,300
CWS Makeup Rate [e] [b]	1,900	2,700
Service Water System		
Evaporation [a]	12	35
Drift [f]	12	35
Blowdown [d]	25	69
SWS Makeup Rate [e]	49	140
Demineralized Water System Makeup [a]	27	50
Fire Protection Water Makeup [a]	0.32	140
Potable Water [g]	14	19

[a] Values directly from PPE, as derived from NEI PPE Worksheet

[b] Values for full power operation, which is maximum use.

[c] Cooling tower drift = 0.04 % of cooling water flow (mechanical draft)

[d] Blowdown = Evaporation + Drift (to maintain cycles of concentration = 2)

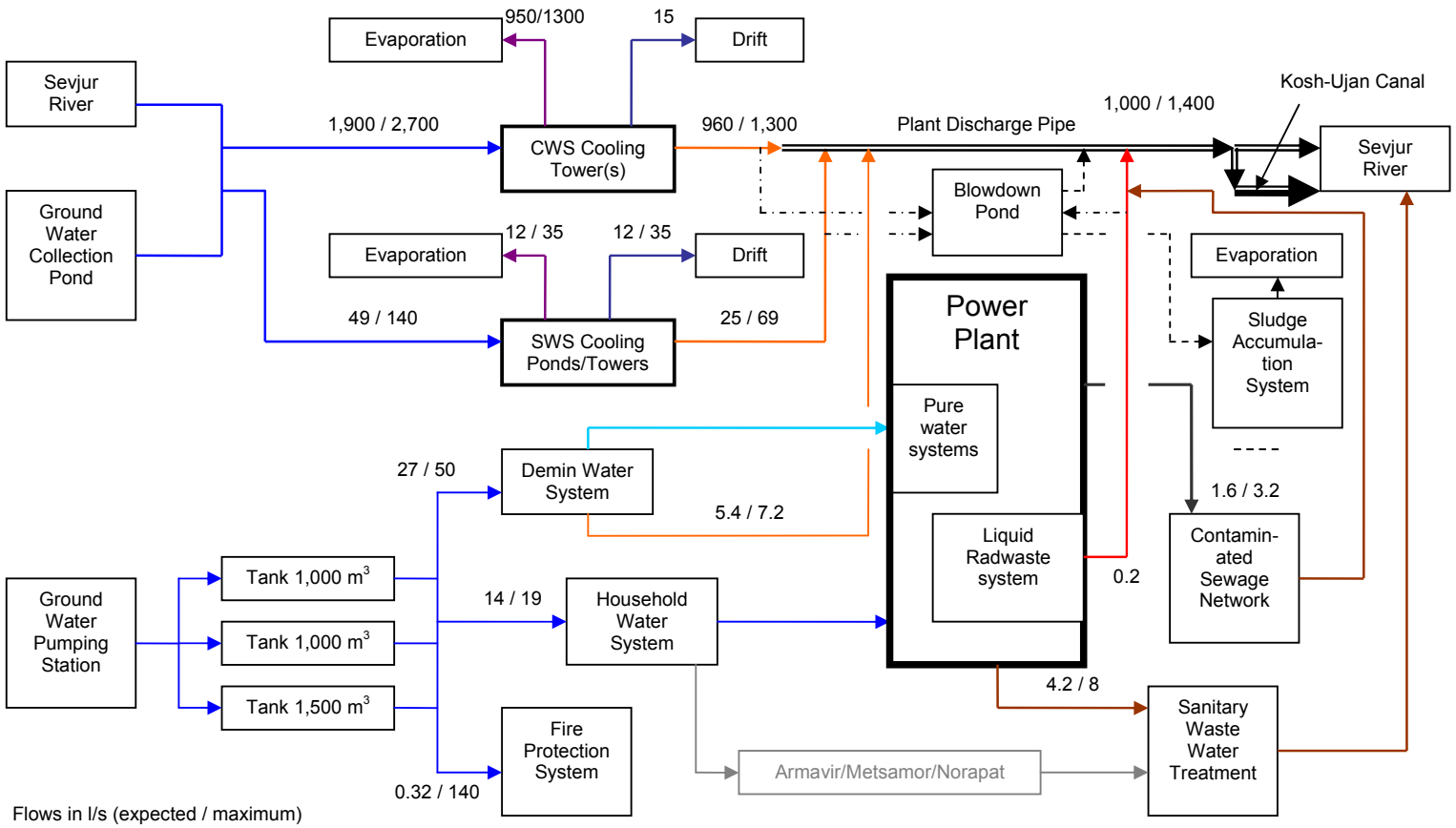
[e] Makeup = Evaporation + Drift + Blowdown

[f] Spray pond drift rate = evaporation, using method of Ref. [3.3-8]

[g] Potable water from PPE, as adjusted for expected plant population.

[h] All values rounded to two significant figures.

Figure 3.3-1, Plant Water Systems and Water Flows



References:

[3.3-1] CJSC "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Rev.1, 2007, Section 1.4.9.

[3.3-2] Water Resources Management Agency of the Republic of Armenia, 2007, *Water Use Permit № 1442*.

[3.3-3] Law of the Republic of Armenia *On the National Water Program of the Republic of Armenia*, November 27, 2006, Article 16.

[3.3-4] CJSC "Armenian Nuclear Power Plant", 2006, *Environmental Passport for ANPP Unit 2*, Section 2.3.

[3.3-5] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.10.

[3.3-6] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007, Section 3.2.14.1.

[3.3-7] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.11.

[3.3-8]State Unitarian Enterprise Scientific-Research Design and Construction Institute of the Ministry of Atomic Energy of the Russian Federation, 2001, *Armenian Nuclear Power Plant Unit 2, Essential Service Water Cooling System, Substantiation of Safety of the Essential Service Water System, including Issues of Environmental and Radiological Safety*, Section 8.1.

3.4 COOLING SYSTEMS

This section describes the condenser cooling, component cooling and ultimate heat sink systems. The proposed plant cooling systems and their operating modes are described in Section 3.4.1. Section 3.4.2 describes the proposed intake, discharge, and heat dissipation system designs and performance characteristics each operating mode.

3.4.1 Cooling System Description and Operational Modes

ANPP Unit 3 is provided with two cooling systems that transfer heat to the environment during normal modes of plant operation. These systems are the Circulating Water System (CWS) and the Service Water System (SWS). There are six anticipated plant operational modes:

- Power operation;
- Startup;
- Hot standby;
- Safe shutdown;
- Cold shutdown; and
- Refueling.

Heat generated during each operational mode is released to the atmosphere from the CWS and SWS. The location of cooling towers/ponds for the CWS and SWS are depicted in Figures 3.1-2 through 3.1-4. The amount of heat released to the atmosphere during each mode of operation is estimated in Table 3.4-1.

The CWS and SWS are supplied with water from the Raw Water System (RWS) in order to makeup for that which has been consumed or discharged as part of system operations. The quantities of water withdrawn, consumed, and discharged for the CWS and the SWS are estimated in Table 3.4-2.

ANPP Unit 2 has current water use permits for water withdrawals from the Sevjur River (Ref. [3.4-1]). New permits are required for ANPP Unit 3 for withdrawals from the Sevjur River and from the groundwater collection pond, as discussed in Section 1.2.

3.4.1.1 CIRCULATING WATER SYSTEM (CONDENSER COOLING)

The base case for the main cooling system (condenser cooling) design is a natural draft (wet) cooling tower, similar in concept to those used for Phase 1 (Units 1 & 2). (Phase 1 included four towers, two for each unit, but if natural draft cooling is selected for Unit 3, it is assumed to be a single tower.) Alternatively, a mechanical draft wet tower system may be used (see further discussion of alternatives, below). Wet cooling towers transfer heat to the atmosphere by direct heat transfer to ambient air and as a result of evaporation. Wet cooling towers gain their relatively high heat transfer rates by the latent heat of water vaporization for the water evaporated.

A single natural draft cooling tower to provide condenser cooling will represent an impact on visibility of the plant and on water use in the plant vicinity[17]:

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[17] Values for the ANPP Unit 3 come from Table 3.2A-1, section 2.5.

- Visual impact of a tower of approximately 170 m height, approximately 60 meters taller than the existing four cooling towers for ANPP Phase 1.
- Monthly average consumption of 950 l/s to makeup for cooling tower drift and evaporation.
- Maximum consumption of 1,300 l/s during peak conditions, with a maximum blowdown rate of 1,300 l/s.

Alternatives to a single natural draft cooling tower include: use of two smaller natural draft towers as is done for many VVER plants; mechanical draft wet cooling towers; a dry cooling tower system; or a hybrid wet/dry cooling tower system.

Use of two natural draft towers would:

- Reduce, to an extent, the visual impact because the towers would be of lesser height than a single tower, likely similar in appearance to the existing towers;
- Increase the land area needed for the cooling towers and water channels over that for a single, larger tower.

A mechanical draft wet cooling tower system would[18]:

- Rely on fans to move the air that cools the water, rather than natural convection;
- Require power to run the forced draft fans, estimated to be 1.5 to 2.0 MW; Ref. [3.4-2]
- Provide no benefit over the natural draft tower with regard to water usage[19];
- Present a potential impact due to misting or fog creation and mineral deposition in the vicinity (which can be mitigated by cooling towers designed with mist eliminators);
- Occupy approximately twice the land that a natural draft tower would use;
- Reduce visual impact because they would not be visible far beyond the site since their estimated 17 m height is substantially less than other power plant structures.

A dry cooling tower system:

- Transfers sensible heat to the ambient air in a heat exchanger cooled by air that is directed over the heat transfer surfaces by fans or natural draft airflow;
- Is essentially a closed system with very little water demand;
- Requires larger heat transfer area and greater volumes of air than used in wet towers (Ref. [3.4-3]);
- Eliminates visual plumes, fog, mineral drift, and water treatment and disposal issues associated with wet cooling towers (Ref. [3.4-4]);

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[18] Values for ANPP Unit 3 come from Table 3.2A-1, section 2.4.

[19] Table 3.2A-1, section 2.4 assumes a higher drift rate than that assumed in section 2.5, resulting in a slightly greater water usage (960 l/s) than for a natural draft tower; this can be mitigated by incorporation of mist eliminator features in the mechanical draft tower design.

- Requires a capital investment of approximately $130M for a design water temperature difference of 2.8ºC (5ºF) to $230M for a design water temperature difference of 5.6 Cº (10ºF) (Ref. [3.4-5])
- Results in an energy penalty (i.e., a reduction in net electrical power delivered to the power grid) of up to 10.7% of full power over a wet cooling tower system, due to higher cooling water temperatures and reduced steam turbine efficiency (Ref. [3.4-6]).

A hybrid wet/dry cooling tower system:

- Uses a combination of wet and dry cooling towers;
- Can be used to reduce impacts of misting and mineral drift from a mechanical draft wet tower;
- Reduces the average raw water usage and blowdown rates, depending on percentage of cooling provided by the wet tower (estimated reduction of the wet-only value of 960 l/s by one-third to one-half);
- Allows using the dry cooling tower portion of the system during periods of low water availability (Note: this would most likely be during the summer period when the energy penalty would be the greatest due to higher ambient air temperatures).

Regardless of the type(s) of cooling tower used, the CWS supplies cooling water to remove heat from the main condensers, the turbine building closed cooling water system heat exchangers, and the condenser vacuum pump seal water heat exchangers under varying conditions of power plant loading and design weather conditions. Circulating water from the cooling tower basin is pumped by three, 1/3 capacity pumps that provide a flow rate of 13,000 l/s each[20], into the main condensers and heat exchangers, then to the cooling tower(s). Once in the cooling tower(s), the water is cooled, as discussed above (depending on the type of tower system used). The heat removed is rejected to the atmosphere, and the cooled water returns to the cooling tower basin.

The basic CWS system configuration is illustrated in Figure 3.4-1.

If a wet tower system is used, the system is provided with a blowdown capability to maintain the system performance by elimination of contaminates that buildup as a result of the evaporation process. The blowdown temperature is 38°C maximum[21] and averages 33°C[22]. The raw water system (RWS) supplies water to the CWS cooling system to make up for water consumed as the result of evaporation, drift and for blowdown. (Raw water consumption values are provided in Table 3.4-2, and are discussed above, in Section 3.3, and in the Plant Parameter Envelope of Appendix 3.2A.) The chemical concentration factor for the CWS cooling tower(s) is two cycles of concentration.

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[20] Table 3.2A-1, sections 2.4.12 and 2.5.12, (total flow rate divided by 3).

[21] Table 3.2A-1, sections 2.4.5 and 2.5.5.

[22] Table 3.2A-1, section 2.3.1 (assumed to be equal to the condenser inlet temperature).

3.4.1.2 SERVICE WATER SYSTEM

The base case for SWS cooling is a spray pond, similar to that used for essential cooling water for ANPP Unit 2. Although the SWS provides cooling for systems containing radioactivity, such as the reactor cleanup and spent fuel pool cooling systems, such systems involve an intermediate, closed circuit cooling water system to provide an additional barrier against transfer of radioactivity to the SWS. Alternatively, and depending on the cooling load for the selected reactor, SWS cooling may be provided by a mechanical draft (wet) cooling tower system.

The following description (based on official design control documentation) applies if the selected reactor is the AP1000, which uses the ambient atmosphere as the ultimate heat sink and does not rely on the SWS for post-accident heat removal.

> The SWS supplies cooling water to remove heat from the non-safety-related component cooling water system (CCS) heat exchangers in the turbine building that serve the reactor chemical and volume control system letdown cooling, radwaste processing systems, spent fuel pool cooling and standby diesel generators.
>
> The SWS is illustrated in Figure 3.4-2a. The system consists of two 100-percent-capacity service water pumps, automatic backwash strainers, a spray pond or two-cell cooling tower with a divided basin, and associated piping, valves, controls, and instrumentation. The service water pumps, located in the turbine building, take suction from piping which connects to the basin of the service water spray ponds / cooling towers. Service water is pumped through strainers to the CCS heat exchangers for removal of heat. The temperature rise across the heat exchangers varies with each mode of operation. During normal operation the temperature rise is approximately 11°C, 18°C during reactor cool down, 8°C during refueling, 4 °C during plant startup, and 19°C during minimum flow to support safe shutdown cooling and spent fuel cooling. Heated service water from the heat exchangers then returns through piping to the spray pond / cooling tower where the system heat is rejected to the atmosphere. Cool water, collected in the pond/tower basins, flows through fixed screens to the pump suction piping for recirculation through the system.
>
> The SWS is arranged into two trains of components and piping. Each train provides 100-percent-capacity cooling for normal power operation. Cross-connections between the trains upstream and downstream of the CCS heat exchangers allows either service water pump to supply either heat exchanger, and allows either heat exchanger to discharge to either cooling tower / spray pond cell.

The following description (based on general plant descriptions and the AP1000 data) is expected to apply to the VVER and CANDU reactors that rely on safety-related portions of the SWS to serve as the ultimate heat sink that provides post-accident heat removal from the reactor coolant system and the containment.

> Under non-accident conditions, the SWS supplies cooling water to non-safety-related CCS heat exchangers that serve the reactor chemical and volume control system letdown cooling, radwaste processing systems, and spent fuel pool cooling. Under shutdown, safe shutdown, and post-accident conditions, the SWS provides cooling water to safety-related heat exchangers for standby diesel generator cooling, residual (decay) heat removal from the reactor, and containment heat removal.
>
> The SWS is illustrated in Figure 3.4-2b. The system consists of four 50-percent-capacity service water pumps, automatic backwash strainers, a spray pond or two-cell cooling tower with a divided basin, and associated piping, valves, controls, and

instrumentation. The service water pumps, located in the auxiliary building, take suction from piping which connects to the basins of the service water spray ponds / cooling tower.

Service water is pumped through strainers to two branches; one the non-safety-related Component Cooling System (CCS); and the other the safety-related Essential Service Water (ESW) branch.

Water is supplied to the CCS heat exchangers for removal of heat. The temperature rise across the heat exchangers varies with each mode of operation. During normal operation the temperature rise is approximately 11°C, 18°C during reactor cool down, 8°C during refueling, 4°C during plant startup, and 19°C during minimum flow to support safe shutdown cooling and spent fuel cooling.

Water in the safety-related ESW system cools: jacket water and lube oil coolers for the standby diesel generators (DGs); residual heat removal (decay heat removal) heat exchangers; and containment air coolers. The temperature rise across these heat exchangers varies with plant conditions. During periodic testing or emergency operation of the EDGs, temperature rise in the EDG cooling loops is approximately 9°C. Temperature rise across the residual heat exchangers is approximately 11°C during reactor cool down, 8°C during refueling, and no more than 13°C during post-accident reactor heat removal. Temperature rise across the containment air coolers is approximately 9°C during normal operation and no more than 13°C during post-accident containment cooling.

Heated service water from the heat exchangers returns through piping to the spray pond / mechanical draft cooling tower where the system heat is rejected to the atmosphere. Cool water, collected in the pond/tower basins, flows through fixed screens to the pump suction piping for recirculation through the system.

The SWS is arranged into two trains of components and piping. Each train includes two service water pumps, two strainers, and one cooling tower / spray pond cell. Each train provides 100-percent-capacity cooling for all operational modes. During post-accident conditions, flow to the CCS is restricted. The cooling tower basin / spray ponds have sufficient capacity for post-accident cooling for more than 30 days without makeup from the RWS.

Under normal conditions, the service water blowdown flow is directed to the plant discharge pipe. This blowdown is used to control levels of solids concentration in the SWS. Blowdown is isolated during emergency conditions.

3.4.1.3 OPERATIONAL MODES

ANPP Unit 3 is estimated to be in the power operation mode for an average of 11.5 months per year based on a 24-month operating cycle (95.8 percent of the operating cycle). ANPP Unit 3 is estimated to be in the startup mode for 8 hours (less than 0.1 percent of the operating cycle), the hot standby mode for 48 hours (approximately 0.5 percent of the operating cycle), safe shutdown mode for 55 hours (approximately 0.6 percent of the operating cycle), cold shutdown mode for 52 hours (approximately 0.6

percent of the operating cycle) and refueling[23]/maintenance mode for 181 hours (approximately 2.1 percent of the operating cycle). These time estimates maximize the estimated amount of water use and heat rejected to the environment by not including forced outages, which cannot be predicted. The power operation mode is paramount, occurring for the majority of the operating cycle and consuming the most flow. Therefore, all other modes are bounded by the power operation mode.

3.4.1.3.1 Circulating Water System (CWS)

The CWS provides cooling during the power operation mode. The power operation mode rejects the most heat to the atmosphere as the CWS removes heat by condensing steam exhausted from the turbine. During startup and hot standby, a smaller amount of heat is rejected by way of the condenser.

3.4.1.3.2 Service Water System (SWS)

[AP1000] The SWS provides heat removal from the CCS during all six modes of normal operation: power operation, startup, hot standby, safe shutdown, cold shutdown, and refueling. During refueling, the SWS also supports a full core offload. SWS cooling is used for the standby DG's during their operation, which under normal circumstances averages four hours each per month, or 48 hours per year.

[VVER/ CANDU] The SWS provides heat removal from the CCS during all six modes of normal operation: power operation, startup, hot standby, safe shutdown, cold shutdown, and refueling. The ESW system provides for residual heat removal from the reactor coolant system during safe shutdown and refueling. During refueling, the SWS also supports a full core offload. Containment heat removal is used as necessary to maintain temperatures in containment less than 54°C during normal and shutdown operations to allow personnel entries and to assist in cooling down the containment for refueling outages, but is otherwise not required during non-emergency conditions. ESW cooling is used for the standby DG's during their operation, which under normal circumstances averages four hours each per month, or 48 hours per year.

3.4.1.4 HEAT GENERATED, DISSIPATED INTO THE ATMOSPHERE, AND RELEASED IN LIQUID DISCHARGES

3.4.1.4.1 Circulating Water System

In the power operation mode, heat is generated, dissipated to the atmosphere, and released in liquid discharges from the CWS. The CWS releases heat to the atmosphere via the CWS cooling tower(s) and to the plant discharge system in liquid discharges via blowdown. The quantities of heat released are summarized in Table 3.4-1.

3.4.1.4.2 Service Water System

The SWS is operating in all six modes of operation and releases heat to the atmosphere via the SWS cooling pond/tower, and in liquid discharges to plant discharge system in the form of blowdown. The amount of heat released during each of these modes of operation is shown in Table 3.4-1.

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[23] The CANDU reactor uses on-line refueling on almost continuous basis during the operating cycle, but must have a periodic shutdown for maintenance and inspections.

3.4.1.5 RAW WATER SUPPLY

3.4.1.5.1 Supply to the Circulating Water System

During power operation and limited portions of the startup and hot standby modes, the CWS requires makeup water. This water is provided by the RWS from the Sevjur River and/or groundwater collection pond. The RWS must provide sufficient capacity to makeup for cooling tower losses due to evaporation, drift and blowdown. The CWS operation results in the release of this water back to the environment. Evaporation from wet cooling tower(s) to the atmosphere is the major consumptive water use (dry cooling towers release insignificant amounts of water to the atmosphere and therefore will require negligible amounts of makeup from the RWS). This evaporation causes an increase in dissolved solids in the water of the CWS. In order to maintain the concentration of dissolved solids in a range to support efficient heat transfer and minimize wear on pumps and heat exchangers, CWS blowdown is necessary. Blowdown is controlled to maintain a concentration factor of two (CWS concentration over RWS concentration). CWS blowdown goes to the plant discharge system. The amount of water supplied by the system from the Sevjur River along with the discharge quantities for each of the six modes is provided in Table 3.4-2.

The RWS makeup to the CWS consists of several pumps sized to meet maximum makeup flow for the CWS plus the SWS. At the intake pumping station(s), debris is removed from the raw water by trash rakes and traveling screens.

3.4.1.5.2 Supply to the Service Water System

The SWS is operating in all six modes of operation and requires makeup water from the Sevjur River or groundwater collection pond. The RWS must provide sufficient capacity to supply the SWS with makeup for spray pond / cooling tower losses due to evaporation, drift and blowdown. Evaporation from the spray pond / cooling tower to the atmosphere is the major consumptive water use. As with the CWS, blowdown is necessary to maintain dissolved solids within a suitable range. The SWS blowdown goes to the plant discharge. The amount of water supplied to the SWS from the Sevjur River and/or collection pond, along with the discharge quantities for each of the modes is provided in Table 3.4-2. Blowdown is controlled to maintain a concentration factor of two (SWS concentration over RWS concentration). The basic system configuration is illustrated in Figure 3.4-2. The RWS makeup to the SWS during normal operation is supplied by the same pumps supplying the CWS (described above). During shutdown and refueling periods, the SWS is supplied by one of two 100-percent capacity pumps. At the intake pumping station(s), debris is removed from the raw water by trash rakes and traveling screens.

3.4.1.5.3 Raw Water Supply for ANPP Unit 3 Cooling Systems

During normal operation, the RWS provides 1,900 l/s makeup to the CWS and 49 l/s as makeup for the SWS, for a total of less than 2,000 l/s. The estimated monthly average water need from the RWS is 1.6×10^9 l (1.6×10^6 m^3). Normal operation of the system is from 10 percent to 100 percent of power operation, which is at maximum makeup demand, therefore, the maximum is approximated to be the same as the normal need. The minimum demand is during an outage when the only flow being taken from the RWS is the SWS makeup (49 l/s). The estimated monthly minimum water demand from the RWS is 4.3×10^7 l (4.3×10^4 m^3) (SWS system demand only). The RWS has a multiple pump arrangement that allows for pump maintenance while not stopping flow to necessary plant systems.

3.4.2 Component Descriptions

ANPP Unit 3 will use the intake system developed for Phase 1 (Units 1 & 2), which takes water from the Sevjur River, with backup source from a groundwater collection pond created with anticipation for supply to Phase 2 (Units 3 & 4) operating in combination with the two Phase 1 plants. Both the Sevjur River and the groundwater collection pond are fed by groundwater.

ANPP Unit 3 cooling systems will make use of two discharge paths. The primary discharge path will be to the existing discharge pipe that drains by gravity, ending in the Kosh-Ujan storm water drainage canal that enters the Sevjur River downstream of the plant intake structure. As part of construction for Unit 3, the plant discharge pipe will be extended to the Sevjur River.

In the event of heat exchanger leaks resulting in chemical or radioactive contamination that exceeds Republic of Armenia discharge limits, blowdown from the SWS and/or the CWS will be directed from these systems to the blowdown pond. From the blowdown pond, water will be directed either to the discharge pipe or the Phase 1 sludge accumulation system that uses a neutralizer pool and an evaporation pond, depending on the final water quality with respect to discharge limits.

3.4.2.1 INTAKE SYSTEMS

Cooling system makeup will be provided by the RWS system, relying on the existing intake systems that take water from one or both of two water sources, as described below.

The Unit 2 safety analysis report (Ref. [3.4-8]) describes the existing water sources. The following is adapted from that description:

> The source of raw water to replenish irreversible losses by the ANPP is the Sevjur River, which is a left tributary of the Araks River, and which also supplies irrigation water to the region. The authorized extraction rate for ANPP Unit 2 is 3.1 x 10^7 m^3/yr (Ref. [3.4-9]). This corresponds to an annual average of 980 l/s (3,500 m^3/hr). During the minimum average daily flow, which can occur during irrigation months, the ANPP's water consumption needs can be met only by reducing the extractions from the Sevjur River for irrigation.[24]
>
> A collection (settling) pond is situated in the left-bank floodplain of the Sevjur 1.2 km above the irrigation diversion dam. The settling pond is fed by three springs, which have an aggregate discharge of 1.25 m^3/s (1.25x10^3 l/s, 4,500 m^3/hr).

A report developed to support design of ANPP Phase 2 (originally planned Units 3 and 4) also describes the existing water sources. Ref. [3.4-10] The following is adapted from that description:

> <u>Sevjur River Supply</u>
>
> For blowdown of the cooling system and loss compensation, the water is pumped through two pipes 1000 mm in diameter from water intake structure of the Sevjur

[24] Allowed extraction rates for Unit 3 will be established in connection with the water use permits for Unit 3 and GoA Resolution 592.

River. The water intake structures consist of water collector on the Sevjur River, open concrete canal and pumping station in which 6 pumps are installed with capacity of 3,000 m^3/hr and with pressure of 135 meters water column.

Collection Pond Supply

At a distance of less than 6 km from ANPP, there is a pump station for make-up water drawn from a collection pond. The pump station has four pumps (three operating and one standby) which compensate for water loss in the circulation system. Two trash racks are installed in the water receiving channels. The pump station is semi-sunken. Its underground part is made of monolithic reinforced concrete. The precast reinforced concrete elements are similar to the elements of make-up water pump station and water intakes from the Sevjur, described above. Two pipes with diameter of 1000 mm lead from the make-up water pump station. In the pump station area, one conduit is connected to two make-up water conduits of the first phase; the other one is independently directed to the site of ANPP, where it is connected with the conduits of the first phase.

New pumps will be installed in the existing river intake pumping station and/or collection pond pump station to supply ANPP Unit 3. Trash racks and traveling screens (or similar facilities) will be used to prevent debris from entering the intake pumps. Pumps with a combined capacity of 3,000 l/s will supply water to Unit 3 during normal operation and one of two pumps with 150 l/s capacity each will supply makeup water during periods when the CWS is not in operation. The flow rates for these pumps vary based on system demand; however, during normal operating conditions, the operating pumps provide 1,500 l/s or less. During outage periods, when the CWS is not operating, one of the two smaller pumps provides makeup to the SWS at a nominal rate of 49 l/s and a maximum rate of 140 l/s. Should the operating pump stop, the second pump will start to provide required makeup flow.

The pipes carrying water from the pumping station(s) to Unit 3 will be new pipes paralleling or replacing those currently supplying Unit 2; they will be sized based on maximum design flows following selection of the reactor plant.

For the river intake channel, the maximum water velocity of the cross-section will be less than 0.15 m/s. Historical water temperatures show the average temperature of the Sevjur River (and also the groundwater entering the collection pond) is approximately 16.9 °C, and never falls below freezing, therefore no icing is anticipated to occur at the intake structures.

During each operational mode, the raw water requirements vary. Therefore, the flow rates and intake velocities also vary. During power operation, both the CWS and the SWS require makeup water. Flow rates for all modes of operation are shown in Table 3.4-2.

3.4.2.2 DISCHARGE SYSTEM

The primary purpose of the discharge system is to limit the concentration of dissolved solids in the heat rejection systems and to disperse cooling tower blowdown into the Sevjur River.

3.4.2.2.1 ANPP Discharge Pipe

The ANPP Unit 3 discharge pipe meets with the pipe from Phase 1, which flows by gravity, eventually emptying into the Kosh-Ujan storm water drainage canal (Ref. [3.4-11]), which enters the Sevjur River approximately 0.8 km downstream of the plant intake

structure. During design of ANPP Unit 3, the need for replacement of the current discharge piping will be considered. To serve Unit 3, the plant discharge pipe will be extended to discharge directly into the Sevjur River.

In the event that levels of contaminants exceeding RoA limits are detected in the CWS and/or SWS cooling systems, the respective blowdown flow(s) can be diverted to the blowdown pond, described below.

3.4.2.2.2 Blowdown Pond

The blowdown pond is a pond with capacity to hold 24 hours of blowdown from the CWS. It is used only in the event of excessive contamination of the CWS or SWS cooling system by radioactive or other contaminants in excess of regulatory limits. The pond is an engineered structure with features to prevent seepage of the contents to the underlying soil. The capacity will allow for safe shutdown and cooldown of the plant without discharge directly to the Sevjur River. The combined capacities of the cooling water basins and the blowdown pond will allow the plant to reach and maintain safe shutdown conditions for thirty days or more without release of contaminated water to the Sevjur River.

If water directed to the blowdown pond can be processed or diluted to make it suitable for discharge, the pond contents will be pumped to the Sevjur River through the plant discharge pipe. If the water cannot be made suitable for discharge, it will be pumped to the Phase 1 sludge accumulation system (see description, below).

3.4.2.2.3 CWS Discharge

Blowdown from the Unit 3 CWS cooling tower(s) is directed to the plant discharge, as described above.

During each operational mode, the raw water requirements vary. Therefore, the discharge flow rates and velocities also vary. During power operation, the CWS is in operation and the discharge flow from Unit 3 CWS is 960 l/s. For startup and safe shutdown modes the flow is 960 l/s, with a possible maximum of 1,300 l/s. Flow rates for all modes of operation are shown in Table 3.4-2. The maximum blowdown temperature is assumed to be 38°C.

3.4.2.2.4 SWS Discharge

Blowdown from the Unit 3 SWS cooling pond/tower system is piped to the discharge pipe, as described above. Discharge flow from the Unit 3 SWS is 25 l/s, with a maximum of 69 l/s; a small fraction of the total discharge when CWS blowdown is operating.

3.4.2.2.5 Sludge Accumulation System

The ANPP Unit 2 Safety Analysis Report (Ref. [3.4-12]) describes the Sludge Accumulation System, as follows:

> Wastewater whose chemical composition does not comply with the requirements of Republic of Armenia water-protection law is drained into the sludge accumulation system, which is 100 m northeast of the cooling towers, behind the fence of the ANPP site.
>
> The sludge accumulation system originally consisted of four sludge collectors (two of which were not finished), a neutralizer pool and an evaporator pool.

Because of the small quantity of water drained, the sludge collectors were taken out of service by the relevant engineering solution, and the neutralizer pool and the evaporator pool are currently in service.

In the event that water cooling water discharges from ANPP Unit 3 exceed water discharge limits, they will be directed to the Blowdown Pond (described above) while the plant is placed in a safe shutdown condition. If the water in the Blowdown Pond cannot be processed or diluted to meet discharge limits, it can be pumped to the sludge accumulation system to be evaporated.

3.4.2.3 HEAT DISSIPATION

The CWS has one or two natural draft cooling tower(s), one mechanical draft wet cooling tower system, an air-cooled dry cooling tower system, or a hybrid wet/dry cooling tower system, as discussed above. Key parameters for possible heat dissipation systems are summarized in the Plant Parameter Envelope, Table 3.2A-1, section 2.

The SWS uses a spray pond or alternatively, one mechanical draft cooling tower with two cells to dissipate heat. Key parameters for possible heat dissipation systems are summarized in the Plant Parameter Envelope, Table 3.2A-1, section 3.

The SWS spray pond is an engineered concrete structure, providing two separate pond basins, each with rated cooling capacity of $1.4x10^5$ kW, sufficient to remove the maximum heat load from the SWS ($1.4x10^5$ kW or 140 MWth). Heat load on the SWS under normal conditions is $4.7x10^4$ kW, or 47 MWth. Water is pumped from the spray pond basins, at a normal flow rate of 1,300 l/s and maximum of 2,300 l/s, through the CSS and ESW heat exchangers, and to a return header leading to a network of vertical spray nozzles. Heat is dissipated by evaporation from the sprayed water and from the sprays and the pond surface by direct heat transfer to air.

If selected for the SWS in lieu of spray ponds, the mechanical draft cooling tower will be a stainless steel tower, consisting of a two cell arrangement, and a divided basin. The rated heat-dissipation capacity of the cooling tower is $1.5x10^5$ kW. For average monthly meteorological conditions, water enters the cooling tower at a temperature and flow rate of 45°C and 1,300 l/s and discharges at 35°C or less. The mechanical draft cooling tower uses fans to force convection within the cooling tower. The volumetric flow of air in the tower varies with the mode of operation. The power consumption for the fans is 120 kW for each cell's fan. Drift rate within the plume coming off the towers is approximately 0.5 l/s.

3.4.2.4 WATER TREATMENT

CWS and SWS chemistry is maintained by the turbine building and auxiliary building chemical feed systems. These systems inject the required chemicals into the CWS and SWS downstream of the system pumps. This maintains a noncorrosive, non-scale-forming condition and limits the biological film formation. Such film formation reduces the heat transfer rate in the condenser and the heat exchangers. Use of this treatment regime, though involving operating costs for the chemicals, eliminates the necessity for frequent shutdowns to clean the condensers and heat exchangers as is currently done for ANPP Unit 2

Treatment of water in the CWS and SWS is discussed in detail in section 3.6, including estimates of chemical usage and chemical content of effluents.

Table 3.4-1, Heat Transferred to the Environment for Each Mode of Operation

Modes of Operation	Total Heat Transferred SWS+CWS, kW	Heat Dissipated to Atmosphere by CWS [(a)] kW	Heat Released in Liquid Discharges by CWS [(b)] kW	Heat Dissipated to Atmosphere by SWS [(c)] kW	Heat Released in Liquid Discharges by SWS [(d)] kW
Power Operation	2.3E+06	2.1E+06	1.1E+05	4.6E+04	1.7E+03
Startup	2.7E+05	1.2E+05	1.1E+05	4.7E+04	9.6E+02
Hot Standby	1.4E+05			1.4E+05	6.8E+03
Safe Shutdown	1.4E+05			1.4E+05	6.9E+03
Cold Shutdown	4.8E+04			4.7E+04	9.6E+02
Refueling	4.8E+04			4.7E+04	1.4E+03

[(a)] Calculated as Condenser duty (PPE 2.3.2) less heat released in liquid - Power Operation 100%, Startup 10%

[(b)] Calculated based on blowdown flow and max temperature difference with Sevjur River, though some heat will be dissipated in discharge pipe

[(c)] Calculated as Heat Exchanger duty (PPE 3.2.2), less heat released in liquid

[(d)] Calculated based on blowdown flow and expected temperature difference with Sevjur River, though some heat will be dissipated in discharge pipe

Table 3.4-2, Water Withdrawn and Discharged for Each Mode of Operation

Modes of Operation	RWS Withdrawn (l/s)	CWS Withdrawn (l/s)	CWS Discharged (l/s)	SWS Withdrawn (l/s)	SWS Discharged (l/s)
Power Operation	1,900	1,900	960	49	25
Startup	1,100	960	960	140	25
Hot Standby	140			140	69
Safe Shutdown	140			140	69
Cold Shutdown	49			49	25
Refueling	49			49	25

Note: all values rounded to two significant figures.

Figure 3.4-1, Basic CWS system configuration

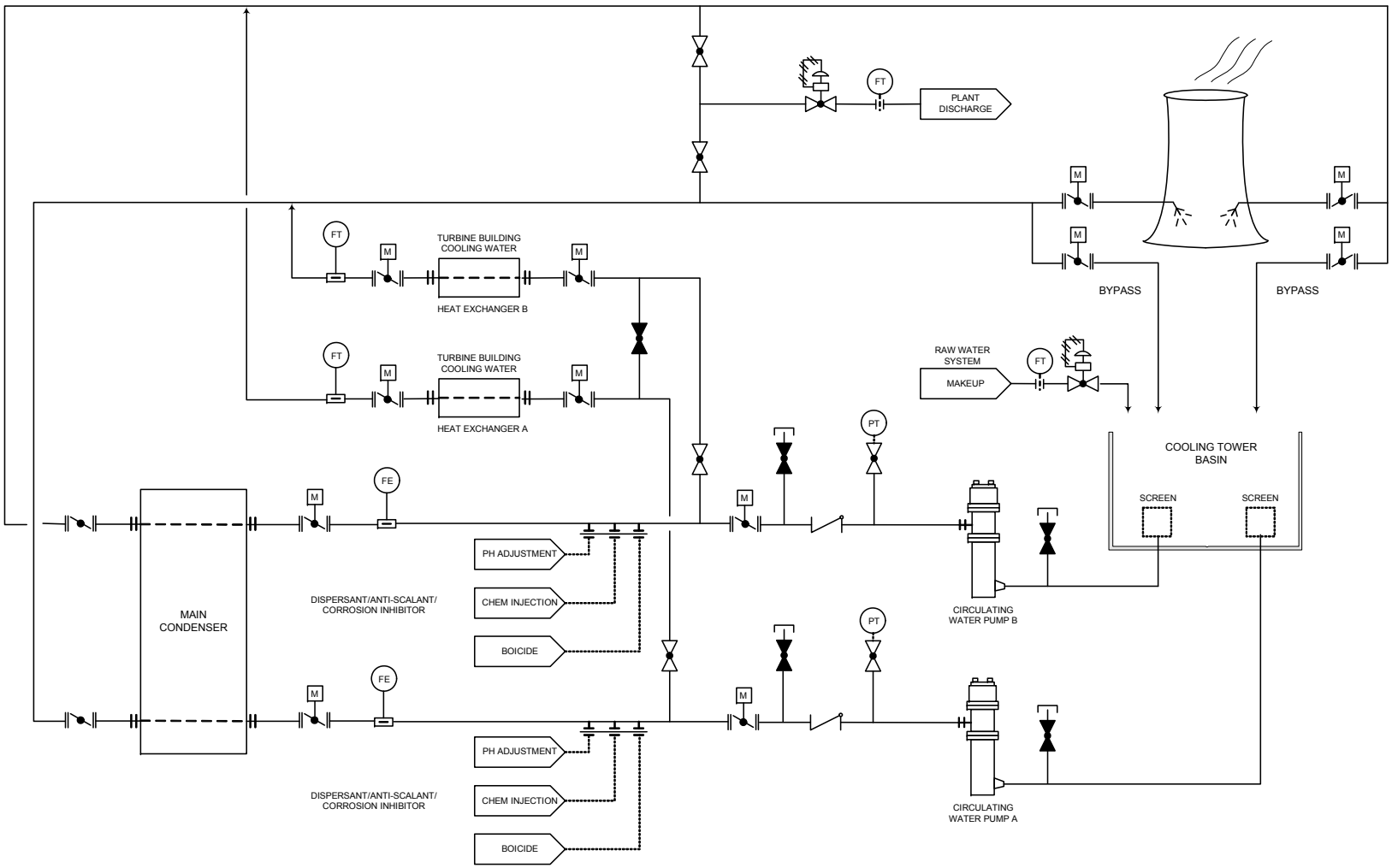


Figure 3.4-2a, Basic SWS Configuration (AP1000)

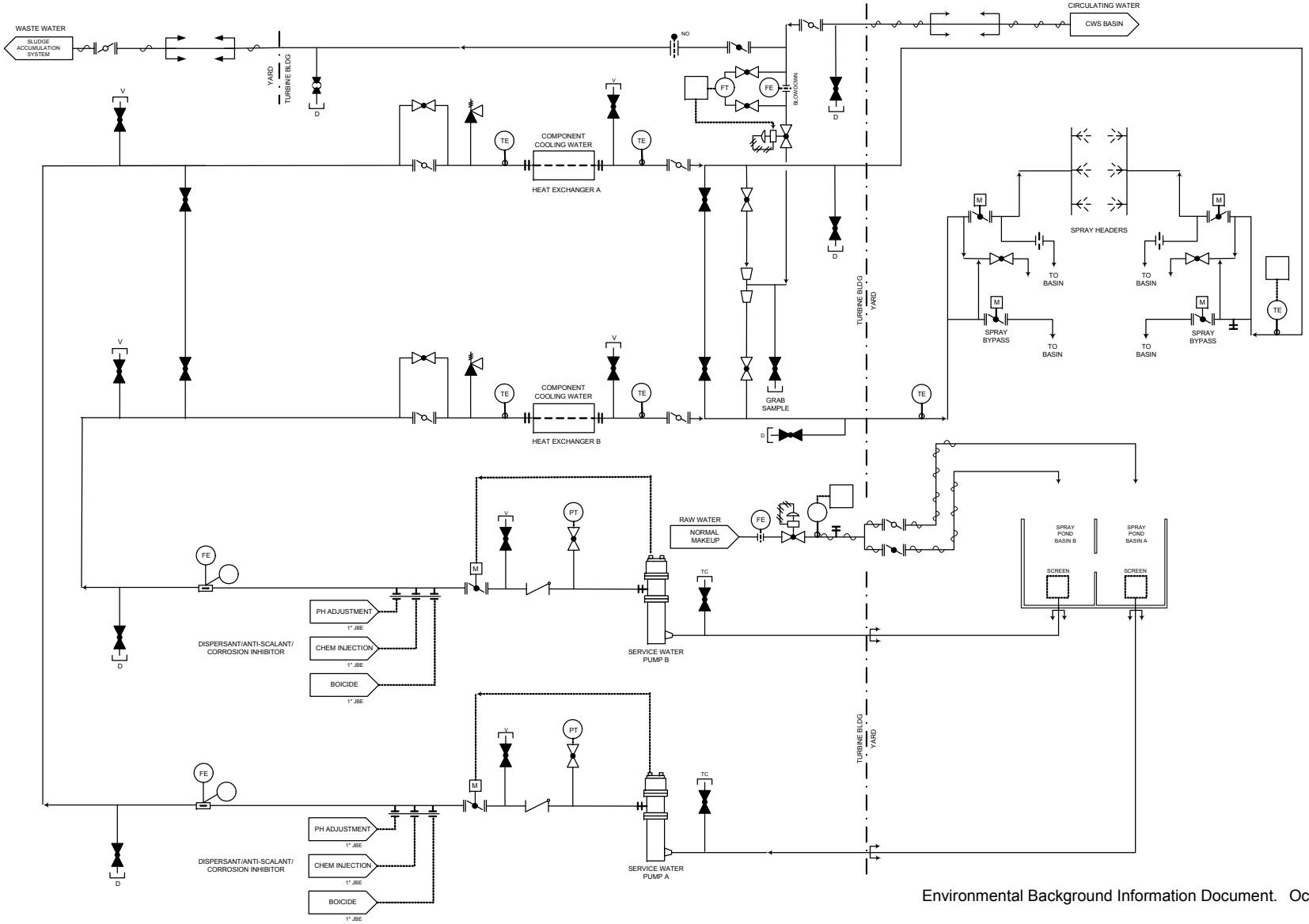
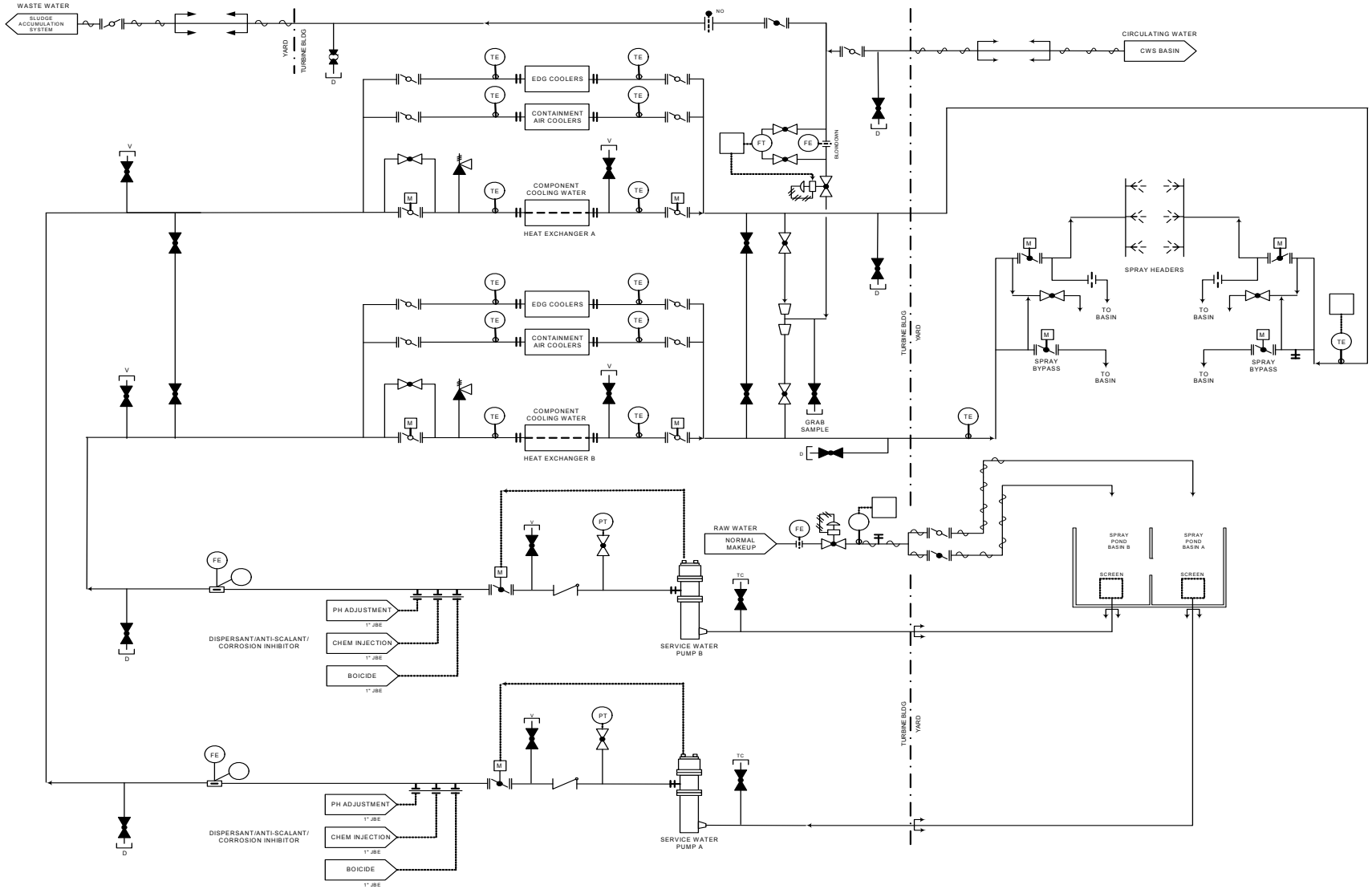


Figure 3.4-2b, Basic SWS Configuration (CANDU/ VVER)



References:

[3.4-1] Water Resources Management Agency of the Republic of Armenia, 2007, *Water Use Permit № 1442*.

[3.4-2] U.S. Environmental Protection Agency, 2001, *Technical Development Document for the Final Regulations Addressing Cooling Water Intake Structures for New Facilities, EPA-821-R-01-036,* Section 3.3.3.a, p 3-22.

[3.4-3] *EPA-821-R-01-036*, Section 4, pp 4-1, 4-2.

[3.4-4] *EPA-821-R-01-036*, Section 4.2.2, p 4-6.

[3.4-5] *EPA-821-R-01-036*, Table 4-3.

[3.4-6] EPA-821-R-01-036, Table 3-4.

[3.4-7] *EPA-821-R-01-036*, Table 3-14.

[3.4-8] CJSC "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Rev.1, 2007, Section 1.4.9.

[3.4-9] Water Resources Management Agency of the Republic of Armenia, 2007, *Water Use Permit № 1442*.

[3.4-10] CJSC "Armenian Nuclear Power Plant",, 1985, *Detail Design Armenian Nuclear Power Plant-II Phase Construction Part IV IV-A. Industrial/Technical Water Supply*, Chapter 3.

[3.4-11] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of the Armenian Nuclear Power Plant*, Section 2.3.

[3.4-12] CJSC "ANPP", 2007, *Safety Analysis Report on Power Unit №2 at the ANPP*, Section 1.4.14.

3.5 RADIOACTIVE WASTE MANAGEMENT SYSTEMS

Radioisotopes are produced during the normal operation of nuclear reactors, primarily through the processes of fission and activation. Fission products may enter the reactor coolant by diffusing from the fuel and then passing through the fuel cladding either through leaks or by diffusion. The primary cooling water may contain dissolved or suspended corrosion products and nonradioactive materials leached from plant components. These products and materials can be activated by the neutrons in the reactor core as the water passes through the core. These radioisotopes leave the reactor coolant either by plant systems designed to remove impurities (reactor water cleanup systems), by small leaks that occur in the reactor coolant system (RCS) and auxiliary systems, or by opening of systems for maintenance. Therefore, the plant generates radioactive waste that can be liquid, solid, or gaseous.

The description in this section of the EBID applies to the prospective ANPP Unit 3, unless noted otherwise, and therefore could have been written in the future tense. The description is based, in large part, on design details developed for the AP1000 plants to be built in the U.S. Although terminology and general technologies described may be specific to the AP1000, they are expected to be generally representative of what would exist with other candidate reactors, at least to the extent that this information is used for assessment of environmental impacts.

ANPP Unit 3 radioactive waste management systems are designed to minimize releases from reactor operations to values as low as reasonably achievable (ALARA). Design of these systems address the elements of pre-disposal management of radioactive waste identified in IAEA Safety Requirements No. WS-R-2 (Ref. [3.5-1]), including:

- Processing waste such that it fulfills acceptance requirements for safe handling, transport, storage and, ultimately, disposal;
- Processing wastes in a manner that ensures safety under normal conditions, prevents incidents and accidents, and incorporates provisions to mitigate any accidents or incidents that may occur;
- Processing wastes in such a way that the resulting waste can be safely stored and retrieved from the storage facility for disposal;
- Pretreatment of wastes (collection, segregation, chemical adjustment and decontamination) based upon appropriate characterization of the waste and with consideration of subsequent steps that will be taken in accordance with the Republic of Armenia's strategy for radioactive waste management;
- Treatment of wastes to remove radionuclides, reduce waste volumes, and change composition to safer forms;
- Conditioning of waste to produce packaged solid waste forms compatible with potential disposal options;
- Design of waste packages such that radionuclides are confined under both normal conditions and accident conditions that may occur during handling, transport, and disposal;
- Storage and processing of gaseous and liquid wastes such that they are suitable for discharge in accordance with Republic of Armenia laws and resolutions or are immobilized in a form suitable for long-term storage and eventual disposal;
- Placement of wastes in suitable facilities where appropriate isolation and monitoring are provided;

- Design and construction of storage facilities for the likely period of storage, consistent with the RoA strategy for radwaste management, with potential for degradation taken into account;
- Employment of multiple barriers to inadvertent release of radioactive materials; and
- Provisions for removal of heat generated by the waste, if necessitated by the nature of the waste.

A national radioactive waste management strategy should be defined for Armenia, based on IAEA waste management requirements and guidelines to define expected technologies and locations for storage and disposal of radioactive waste from ANPP Units 1, 2, and 3. When that strategy is established, this section should be reviewed for consistency with it.

Doses from radioactive waste management systems

Projected doses due to radioactive releases from radioactive waste management systems are provided in Section 5.4 of this EBID, including comparison of projected doses with dose limits specified in GoA Resolution 1219 (Ref. [3.5-2]) and those recommended in IAEA Safety Series No. SS-115 (Ref. [3.5-3]).

Doses due to radioactive releases are dependent on dispersion of isotopes in the environment. IAEA Safety Guide NS-G-3.2 (Ref. [3.5-4]) identifies parameters that should be provided to calculate dispersion of radioisotopes in air and water. To the extent that such parameters are available at this time, they are provided in the Plant Parameter Envelope (PPE) in Appendix 3.2A. Those parameters not provided in the PPE tables will be made available as part of the safety analysis report following selection of a reactor design.

Cost Benefit Analyses of Population Doses

Government of Armenia Resolution 1219 provides for justifying the expense of protective barriers and systems, assuming that collective effective dose of irradiation of 1 man-Sv causes potential loss that is equal to the life loss of population of 1 man/year, and assigning a monetary equivalent value to loss of life of 1 man/year as equal to the national annual income per a man. Ref. [3.5-2]

Since a specific plant design has not yet been chosen and decisions on radwaste system designs have yet to be made, it is not possible to define cost benefits of designs or design alternatives at this time. Once a reactor design has been chosen and specific radwaste system designs have been considered, a cost-benefit analysis can be provided in the facility safety analysis report.

3.5.1 Liquid Radioactive Waste Management System

The liquid radioactive waste management systems include the systems that may be used to process and dispose of liquids containing radioactive material. The liquid radwaste system is designed to control, collect, process, handle, store, and dispose of liquid radioactive waste generated as the result of normal operation, including anticipated operational occurrences.

The liquid radwaste system provides holdup capacity as well as permanently installed processing capacity of 4.7 l/s through the ion exchange/filtration train. This is adequate capacity to meet the anticipated processing requirements of the plant.

The liquid radwaste system design accommodates equipment malfunctions without affecting the capability of the system to handle anticipated liquid waste flows.

The liquid radwaste system includes tanks, pumps, ion exchangers, and filters. The liquid radwaste system is designed to process, or store for processing by mobile equipment, radioactively contaminated wastes in four major categories:

- Borated, reactor-grade, wastewater -- This input is collected from the RCS effluents received through the chemical volume and control system (CVS)[25], primary sampling system sink drains, and equipment leakoffs and drains.
- Floor drains and other wastes with potentially high suspended solids content – This input is collected from various building floor drains and sumps that are likely to contain radioactivity.
- Detergent wastes -- This input comes from the plant hot sinks and showers, and some cleanup and decontamination processes. It generally has low concentrations of radioactivity.
- Chemical wastes -- This input comes from the laboratory and other relatively small volume sources. It may be mixed hazardous and radioactive wastes or other radioactive wastes with high dissolved-solids content.

Since a specific plant design has not been selected, piping and instrumentation drawings of the liquid radioactive waste management systems are not available. The descriptions below are intended to be representative of the systems that will be included in the selected reactor plant design, with bounding parameters based on the PPE provided in Appendix 3.2A.

Characteristics of radioactive discharges to water during normal (non-emergency) plant operation are given in the Plant Parameter Envelope, Appendix 3.2A, Table 3.2A-8 (Average Annual Normal Liquid Release), and Table 3.2A-1 (Plant Parameter Envelope), Section 10. Table 3.5-1, which is based on Table 3.2A-8, includes a factor to account for anticipated operational occurrences.

Secondary-system effluent is normally handled by the steam generator blowdown processing system and by the turbine building drain system. Radioactivity can enter the secondary systems from steam generator tube leakage. If significant radioactivity is detected in secondary-side systems, steam generator blowdown is diverted to the liquid radwaste system for processing and disposal.

3.5.1.1 WASTE INPUT STREAMS

3.5.1.1.1 Reactor Coolant System Effluents

The effluent subsystem receives borated and hydrogen-bearing liquid from two sources: the reactor coolant drain tank and the CVS. The reactor coolant drain tank collects leakage and drainage from various primary systems and components inside containment. Effluent from the CVS is produced mainly as a result of RCS heat up, boron concentration changes, and RCS level reduction for refueling.

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[25] Also known in some designs as the reactor water cleanup and inventory control systems.

Input collected by the effluent subsystem normally contains hydrogen and dissolved radioactive gases. Therefore, it is routed through the liquid radwaste system vacuum degasifier before being stored in the effluent holdup tanks.

The liquid radwaste system degasifier can also be used to degas the RCS before shutdown by operating the CVS in an open loop configuration. This is done by taking one of the effluent holdup tanks out of normal waste service and pumping its contents to other tanks. Then normal CVS letdown is directed through the degasifier to the dedicated effluent holdup tank. From there, it is pumped back to the suction of the CVS makeup (charging) pumps with the effluent holdup tank pump. The makeup pumps return the fluid to the RCS in the normal fashion. This process is continued as necessary for degassing the RCS.

The input to the reactor coolant drain tank is potentially at high temperature. Therefore, provisions are made for recirculation through a heat exchanger for cooling. The tank is inerted with nitrogen and is vented to the gaseous radwaste system (WGS). Transfer of water from the reactor coolant drain tank is controlled to maintain an essentially fixed tank level to minimize tank pressure variation.

RCS effluents from the CVS letdown line or the reactor coolant drain subsystem pass through the vacuum degasifier, where dissolved hydrogen and fission gases are removed. These gaseous components are sent via a water separator to the WGS. A degasifier discharge pump then transfers the liquid to the in service effluent holdup tank. If flows from the letdown line and the reactor coolant drain tank are routed to the degasifier concurrently, the letdown flow has priority and the drain tank input is automatically suspended. In the event of abnormally high degasifier water level, inputs are automatically stopped by closing the letdown control and containment isolation valves.

The effluent holdup tanks vent to the radiologically controlled area ventilation system and, in abnormal conditions, may be purged with air to maintain a low hydrogen gas concentration in the tanks' atmosphere. Hydrogen monitors are included in the tanks vent lines to alert the operator of elevated hydrogen levels.

The contents of the effluent holdup tanks may be recirculated and sampled, recycled through the degasifier for further gas stripping, returned to the RCS via the CVS makeup pumps, discharged to the mobile treatment facility, processed through the ion exchangers, or directed to the monitor tanks for discharge without treatment. Processing through the ion exchangers is the normal mode.

The liquid radwaste system processes waste with an upstream filter followed by four ion exchange resin vessels in series. Any of these vessels can be manually bypassed and the order of the last two can be interchanged, so as to provide complete usage of the ion exchange resin.

The top of the first vessel is normally charged with activated carbon, to act as a deep-bed filter and remove oil from floor drain wastes. Moderate amounts of other wastes can also be routed through this vessel. It can be bypassed for processing of relatively clean waste streams. This vessel is somewhat larger than the other three, with an extra sluice connection to allow the top bed of activated carbon to be removed. This feature is associated with the deep bed filter function of the vessel; the top layer of activated carbon collects particulates, and the ability to remove it without disturbing the underlying zeolite bed minimizes solid-waste production.

The second, third, and fourth beds are in identical ion exchange vessels, which are selectively loaded with resin, depending on prevailing plant conditions.

After deionization, the water passes through an after-filter where radioactive particulates and resin fines are removed. The processed water then enters one of the monitor tanks. When one of the monitor tanks is full, the system is automatically realigned to route processed water to another tank.

The contents of the monitor tank are recirculated and sampled. In the unlikely event of high radioactivity, the tank contents are returned to a waste holdup tank for additional processing.

Normally, however, the radioactivity is well below the discharge limits, and the dilute boric acid is discharged for dilution to the circulating water blowdown. The discharge flow rate is set to limit the boric acid concentration in the circulating water blowdown stream to an acceptable concentration for local requirements. Detection of high radiation in the discharge stream stops the discharge flow and operator action is required to re-establish discharge. The raw water system, which provides makeup for the circulating water system, is used as a backup source for dilution water when circulating water blowdown is not available for the discharge path.

3.5.1.1.2 Floor Drains and Other Wastes with Potentially High Suspended Solid Contents

Potentially contaminated floor drain sumps and other sources that tend to be high in particulate loading are collected in the waste holdup tank. Additives may be introduced to the tank to improve filtration and ion exchange processes. Tank contents may be recirculated for mixing and sampling. The tanks have sufficient holdup capability to allow time for realignment and maintenance of the process equipment.

The wastewater is processed through the waste pre-filter to remove the bulk of the particulate loading. Next it passes through the ion exchangers and the waste after-filter before entering a monitor tank. The monitor tank contents are sampled and, if necessary, returned to a waste holdup tank or recirculated directly through the filters and ion exchangers.

Wastewater meeting the discharge limits is discharged to the circulating water blowdown through a radiation detector that stops the discharge if high radiation is detected.

3.5.1.1.3 Detergent Wastes

The detergent wastes from the plant hot sinks and showers contain soaps and detergents. These wastes are generally not compatible with the ion exchange resins. The detergent wastes are not processed and are collected in the chemical waste tank. If the detergent wastes activity is low enough, the wastes can be discharged without processing.

When sufficient detergent wastes are produced and processing is necessary, mobile processing equipment is brought into one of the radwaste building mobile systems facility truck bays provided for this purpose.

3.5.1.1.4 Chemical Wastes

Inputs to the chemical waste tank normally are generated at a low rate, approximately 8 liters per day. These wastes are only collected; no internal processing is provided. Chemicals can be added to the tank for pH or other adjustment. Because the volume of these wastes is low, they can be treated by the use of mobile equipment or by shipment off-site.

3.5.1.1.5 Steam Generator Blowdown

If leakage from steam generator tubes results in significant levels of radioactivity in the steam generator blowdown stream, this stream is redirected to the liquid radwaste system for treatment before release. In this event, one of the waste holdup tanks is emptied to prepare it for blowdown processing. The blowdown stream is brought into that holdup tank, and continuously or in batches pumped through the waste ion exchangers. The number of ion exchangers in service is determined by the operator to provide adequate purification without excessive resin usage. The blowdown is then collected in a monitor tank, sampled, and discharged in a monitored fashion.

3.5.1.1.6 Radioactive Releases

Liquid waste is produced both on the primary side (primarily from adjustment of reactor coolant boron concentration and from reactor coolant leakage) and the secondary side (primarily from steam generator blowdown processing and from secondary side leakage). Primary and secondary coolant activity levels are based on operating plant experience.

Except for RCS degasification in anticipation of shutdown, primary side effluents are not normally returned to the primary system. Primary effluents are discharged to the environment after processing. Fluid recycling is provided for the steam generator blowdown fluid which is normally returned to the condensate system.

The liquid waste is discharged from the monitor tank in a batch operation, and the discharge flow rate is restricted as necessary to maintain an acceptable concentration when diluted by the circulating water and service water blowdown discharge flows. The liquid waste is discharged into the plant discharge pipe and then to the Sevjur River.

The annual average release of radionuclides from the plant is given in Table 3.5-1. Table 3.5-1 is based on Appendix 3.2A, Table 3.2A-8, adjusted by 5.9 GBq/y to account for anticipated operational occurrences. The adjustment uses the same distribution of nuclides as the releases given in Table 3.2A-8.

3.5.2 Gaseous Radioactive Waste Management System

During reactor operation, radioactive isotopes of xenon, krypton, and iodine are created as fission products. A portion of these radionuclides may be released to the reactor coolant if there are any small fuel cladding defects. Leakage of reactor coolant thus results in a release to the containment atmosphere of the noble gases. Airborne releases can be limited both by restricting reactor coolant leakage and by limiting the concentrations of radioactive noble gases and iodine in the RCS.

Iodine is removed by ion exchange in the CVS. Removal of the noble gases from the RCS is not normally necessary because the gases do not build up to unacceptable levels when fuel defects are within anticipated ranges. If noble gas removal is required because of high RCS concentration, the CVS can be operated in conjunction with the liquid radwaste system degasifier, to remove the gases.

The WGS is designed to perform the following major functions:

- Collect gaseous wastes that are radioactive or hydrogen bearing.
- Process and discharge the waste gas, keeping off-site releases of radioactivity within acceptable limits.

In addition to the WGS release pathway, release of radioactive material to the environment occurs through the various building ventilation systems. The estimated annual release includes contributions from the major building ventilation pathways.

The WGS is designed to collect hydrogen bearing and radioactive gases generated during process operation. The radioactive gas flowing into the WGS enters as trace contamination in a stream of hydrogen and nitrogen.

WGS design inputs are as follows:

- Letdown[26] diversion for dilution, RCS with maximum hydrogen concentration.
- Letdown diversion for RCS degassing.
- Reactor coolant drain tank liquid transfer to maintain proper reactor coolant drain tank level.
- Reactor coolant drain tank gas venting.

3.5.2.1 WGS SYSTEM DESCRIPTION

Since a specific plant design has not been selected, piping and instrumentation drawings of the gaseous radioactive waste management system are not available. The descriptions below are intended to be representative of the systems that will be included in the selected reactor plant design, with bounding parameters based on the Plant Parameters Envelope (PPE) provided in Appendix 3.2A.

The WGS is a once through, ambient temperature, activated carbon delay system. The system includes a gas cooler, a moisture separator, an activated carbon-filled guard bed, and two activated carbon-filled delay beds. Also included in the system are an oxygen analyzer subsystem and a gas sampling subsystem.

The radioactive fission gases entering the system are carried by hydrogen and nitrogen gas. The primary influent source is the liquid radwaste system degasifier. The degasifier extracts both hydrogen and fission gases from the CVS letdown flow that is diverted to the liquid radwaste system or from the reactor coolant drain tank discharge.

Reactor coolant degassing is not required during power operation with fuel defects at or below the design basis level of 0.25 percent. However, the WGS periodically receives influent when CVS letdown is processed through the liquid radwaste system degasifier during RCS dilution and volume control operations. Because the degasifier is a vacuum type and requires no purge gas, the maximum gas influent rate to the WGS from the degasifier equals the rate that hydrogen enters the degasifier (dissolved in liquid).

The other major source of input to the WGS is the reactor coolant drain tank. Hydrogen dissolved in the influent to the reactor coolant drain tank enters the WGS either via the tank vent or the liquid radwaste system degasifier discharge.

The tank vent is normally closed, but is periodically opened on high pressure to vent the gas that has come out of solution. The reactor coolant drain tank liquid is normally discharged to the liquid radwaste system via the degasifier, where the remaining hydrogen is removed.

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[26] "Letdown" is the flow of primary coolant removed, or letdown, from the RCS in the process of inventory control and reactor water cleanup.

The reactor coolant drain tank is purged with nitrogen gas to discharge nitrogen and fission gases to the WGS before operations requiring tank access. The reactor coolant drain tank is also purged with nitrogen gas to dilute and discharge oxygen after tank servicing or inspection operations which allow air to enter the tank.

Influents to the WGS first pass through the gas cooler where they are cooled to about 7°C by the chilled water system. Moisture formed due to gas cooling is removed in the moisture separator.

After leaving the moisture separator, the gas flows through a guard bed that protects the delay beds from abnormal moisture carryover or chemical contaminants. The gas then flows through two 100-percent capacity delay beds where the fission gases undergo dynamic adsorption by the activated carbon and are thereby delayed relative to the hydrogen or nitrogen carrier gas flow. Radioactive decay of the fission gases during the delay period significantly reduces the radioactivity of the gas flow leaving the system. The activated carbon volume is twice the theoretical amount required.

The effluent from the delay bed passes through a radiation monitor and discharges to the ventilation exhaust duct. The radiation monitor is interlocked to close the WGS discharge isolation valve on high radiation. The discharge isolation valve also closes on low ventilation system exhaust flow rate to prevent the accumulation of hydrogen in the aerated vent.

3.5.2.2 WGS SYSTEM OPERATION

The WGS is used intermittently. During normal operation, the WGS is usually not in operation. When there is no waste gas inflow to the system, a small nitrogen gas flow is injected into the discharge line at the inlet of the discharge isolation valve. This nitrogen gas flow maintains the WGS at a pressure above ambient atmospheric (barometric) pressure, preventing the ingress of air during the periods of low waste gas flow.

When the WGS is in use, its operation is passive, using the pressure provided by the influent sources to drive the waste gas through the system.

The largest input to the WGS is from the liquid radwaste system degasifier, which processes the CVS letdown flow when diverted to the liquid radwaste system and the liquid effluent from the liquid radwaste system reactor coolant drain tank.

The CVS letdown flow is diverted to the liquid radwaste system only during dilutions, borations, and RCS degassing in anticipation of shutdown. The design basis influent rate from the liquid radwaste system degasifier is the full diversion of the CVS letdown flow, when the RCS is operating with maximum allowable hydrogen concentration. Because the liquid radwaste system degasifier is a vacuum type that operates without a purge gas, this input rate is very small, about 0.8 m^3/hr.

The liquid radwaste system degasifier is also used to degas liquid pumped out of the reactor coolant drain tank. The amount of fluid pumped out, and therefore the gas sent to the WGS, is dependent upon the input into the reactor coolant drain tank. This is smaller than the input from the CVS letdown line.

The final input to the WGS is from the reactor coolant drain tank vent. A nitrogen cover gas is maintained in the reactor coolant drain tank. This input consists of nitrogen, hydrogen, and radioactive gases. The tank operates at nearly constant level, with its vent line normally closed, so this input is minimal. Venting is required only after enough gas has evolved from the input fluid to increase the reactor coolant drain tank pressure.

The influent first passes through a gas cooler. Chilled water flows through the gas cooler at a fixed rate to cool the waste gas to about 7°C regardless of waste gas flow rate. Moisture formed due to gas cooling is removed in the moisture separator, and collected water is periodically discharged automatically. To reduce the potential for waste gas bypass of the gas cooler in the event of valve leakage, a float-operated drain trap is provided which automatically closes on low water level.

The gas leaving the moisture separator is monitored for moisture, and a high alarm alerts the operator to an abnormal condition requiring attention. Oxygen concentration is also monitored. On a high oxygen alarm, a nitrogen purge is automatically injected into the influent line.

The waste gas then flows through the guard bed, where iodine and chemical (oxidizing) contaminants are removed. The guard bed also removes any remaining excessive moisture from the waste gas. The waste gas then flows through the two delay beds where xenon and krypton are delayed by a dynamic adsorption process. The discharge line is equipped with a valve that automatically closes on either high radioactivity in the WGS discharge line or low ventilation exhaust duct flow.

The adsorption of radioactive gases in the delay bed occurs without reliance on active components or operator action. Operator error or active component failure does not result in an uncontrolled release of radioactivity to the environment. Failure to remove moisture prior to the delay beds (due to loss of chilled water or other causes) results in a gradual reduction in WGS performance. Reduced performance is indicated by high moisture and discharge radiation alarms. High-high radiation automatically terminates discharge.

3.5.2.3 WGS RADIOACTIVE RELEASES

Releases of radioactive effluent by way of the atmospheric pathway occur due to:

- Venting of the containment that contains activity as a result of leakage of reactor coolant and as a result of activation of naturally occurring Ar-40 in the atmosphere to form radioactive Ar-41. This discharge is via the plant ventilation stack.
- Ventilation discharges from the auxiliary building that contains activity as a result of leakage from process streams.
- Ventilation discharges from the turbine building.
- Condenser air removal system (gaseous activity entering the secondary coolant as a result of primary to secondary leakage is released via this pathway).
- WGS discharges via the plant ventilation stack.

These releases are on-going throughout normal plant operations. There is no gaseous waste holdup capability in the gaseous waste management system and thus no criteria are required for determining the timing of releases or the release rates to be used.

3.5.2.3.1 Estimated Annual Gaseous Releases

The annual average airborne releases of radionuclides from the plant are obtained from the experience of many operating pressurized water reactors. The expected annual gaseous releases for ANPP Unit 3 are presented in PPE Table 3.2A-6.

3.5.2.3.2 Release Points

Airborne effluents are normally released through the plant vent stack or the turbine building vent. The plant vent stack provides the release path for containment venting

releases, auxiliary building ventilation releases, annex building releases, radwaste building releases, and WGS discharge. The turbine building vents provide the release path for the condenser air removal system, gland seal condenser exhaust and the turbine building ventilation releases.

The plant vent stack discharges at an approximate elevation of 49 m above plant grade.[27] The turbine building vents are located at an approximate elevation of 37 m.

3.5.3 Solid Radioactive Waste Management System

ANPP Unit 3 operating procedures encourage plant operators to segregate wastes to keep mixed wastes at a minimum. However, the waste handling system is designed to allow handling and disposal of mixed waste, if it is created, as described below.

The solid waste management system (WSS) is designed to collect and accumulate spent ion exchange resins and deep bed filtration media, spent filter cartridges, dry active wastes, and mixed wastes generated as a result of normal plant operation, including anticipated operational occurrences. The system is located in the auxiliary and radwaste buildings. Processing and packaging of wastes are by mobile systems in the auxiliary building rail car bay and in the mobile systems facility part of the radwaste building. The packaged waste is stored in the auxiliary and radwaste buildings until it is moved to the near-site radwaste storage facility or shipped off-site to a licensed disposal facility.

The use of mobile systems for the processing functions permits the use of the latest technology and avoids the equipment obsolescence problems experienced with installed radwaste processing equipment. The most appropriate and efficient systems may be used as they become available.

This system does not handle large, radioactive waste materials such as core components or radioactive process wastes from the plant's secondary cycle. However, the volumes and activities of the secondary cycle wastes are provided in this subsection.

Since a specific plant design has not been selected, process drawings of the solid radioactive waste management system are not available. The descriptions below are intended to be representative of the systems that will be included in the selected reactor plant design, with bounding parameters based on the Plant Parameters Envelope (PPE) provided in Appendix 3.2A.

The WSS includes the spent resin system. The flows of wastes through the solid waste management system are shown in Figure 3.5-1. The radioactivity of influents to the system are dependent on the level of radioactivity in the reactor coolant and the decontamination factors of the processes in the CVS, spent fuel cooling system, and the liquid waste processing system.

The radioactivity of the dry active waste is expected to normally range from a low of 4 GBq per year to 300 GBq per year with a maximum of about 600 GBq per year during those years with major maintenance on the reactor plant[28]. This waste includes spent HVAC

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[27] Table 3.2A-1, section 9.4.2; bounding value is for the AP1000 – other designs are at higher elevations.

[28] These values are average design values for the AP1000 and should be representative of other reactors, as well; however, they are substantially less than the upper bound values given in

filters, compressible trash, non-compressible components, mixed wastes[29], and solidified chemical wastes. The radioactivity is produced by relatively long-lived radionuclides (such as Fe-55, Co-60, Cs-134 and Cs-137), and therefore, radioactivity decay during processing and storage is minimal. Thus, the indicated levels of radioactivity apply to the waste as generated and to the waste as stored.

Until Armenia has established a waste disposal site, all radwaste from Unit 3 is packaged and stored onsite. To facilitate movement and handling, radwaste is generally stored in containers that are ready for shipment. Volumes of radwaste processed for storage are estimated to be 160 m^3/yr[30] or less. Radionuclide content of the solid radwaste is estimated in PPE Table 3.2A-3.

The expected disposal volumes of wet and dry wastes are approximately 45 and 110 m^3/yr, respectively. The wet wastes volumes include 43 m^3/yr of spent ion exchange resins and deep bed filter activated carbon, 1.6 m^3 of volume reduced liquid chemical wastes and 1.4 m^3 of mixed liquid wastes. The spent resins and activated carbon are initially stored in the spent resin storage tanks located in the rail car bay of the auxiliary building. When a sufficient quantity has accumulated, the resin is sluiced into two 4.5 m^3 high-integrity containers. Liquid chemical wastes are reduced in volume and packaged into three 200 l drums per year (about 1.6 m^3) and are stored in the packaged waste storage room of the radwaste building. The mixed liquid wastes fill less than three drums per year (about 1.4 m^3/yr) and are stored on containment pallets in the waste accumulation room of the radwaste building.

The two spent resin storage tanks (7.8 m^3 usable, each) and one high integrity container in the spent resin waste container fill station in the rail car bay of the auxiliary building provide more than a year of spent resin storage at the expected rate, and several months of storage at the maximum generation rate. The <u>expected</u> radwaste generation rate is based upon the following:

- All ion exchange resin beds are disposed and replaced every refueling cycle.
- The WGS activated carbon guard bed is replaced every refueling cycle.
- The WGS delay beds are replaced every 10 years.
- All wet filters are replaced every refueling cycle.
- Rates of compatible and non-compatible radwaste, chemical waste and mixed wastes are estimated using historical operating plant data.

The <u>maximum</u> radwaste generation rate is based upon the following:

- The ion exchange resin beds are disposed based upon operation with 0.25 percent fuel defects.
- The WGS activated carbon guard bed is replaced twice every refueling cycle.
- The WGS delay beds are replaced every 5 years.
- All wet filters are replaced based upon operation with 0.25 percent fuel defects.

Table 3.2A-3. Table 3.2A-3 does not bound amounts reported for VVER plants that most likely include discharged spent fuel or reactor core components.

[29] Mixed waste is defined as radioactive waste that also contains non-radioactive toxic or hazardous substances – See Ref. [3.5-7].

[30] Appendix 3.2A, PPE Table 3.2A-1, section 11.2.3.

- The expected rates of compatible and non-compatible radwaste, chemical waste, and mixed wastes are increased by about 50 percent.
- Primary to secondary system leakage contaminates the condensate polishing system and blowdown system resins and membranes, which are replaced.

The dry solid radwaste includes 117 m^3/yr of compactable and non-compactable waste packed into about 40 boxes (2.6 m^3 each) and 30 drums (0.2 m^3 each) per year. Drums are used for higher activity compactable and non-compactable wastes. Compactable waste includes HVAC exhaust filters, ground sheets, boot covers, hairnets, etc. Non-compactable waste includes about 5 m^3/yr of dry activated carbon and other solids such as broken tools and wood. Solid mixed wastes occupy 0.6 m^3/yr (one drum). The low activity spent filter cartridges may be compacted to fill about 1.2 drums per year (0.25 m^3/yr) and are stored in the packaged waste storage room. Compaction is performed by mobile equipment or is performed off-site. High activity filter cartridges fill three drums per year (2 m^3/yr) and are stored in portable processing or storage casks in the rail car of the auxiliary building.

The total volume of radwaste to be stored in the radwaste building packaged waste storage room is 120 m^3/yr at the expected rate and 220 m^3/yr at the maximum rate. The compactable and non-compactable dry wastes, packaged in drums or steel boxes, are stored with the mixed liquid and mixed solid, volume reduced liquid chemical wastes, and the lower activity filter cartridges. The quantities of liquid radwaste stored in the packaged waste storage room of the radwaste building consists of 1.7 m^3 of chemical waste and 1.4 m^3 of mixed liquid waste. The useful storage volume in the packaged waste storage room is approximately 110 m^3. The packaged waste storage room provides storage for more than eight months at the expected rate of generation and more than four months at the maximum rate of generation. One four-drum containment pallet provides approximately three months of storage capacity for the liquid mixed wastes and the volume reduced liquid chemical wastes at the expected rate of generation and more than 1.5 months at the maximum rate.

A conservative estimate of solid wet waste includes blowdown material based on continuous operation of the steam generator blowdown purification system, with leakage from the primary to secondary system. The volume of radioactively contaminated material from this source is estimated to be 15 m^3/yr. Although included here for conservatism, this volume of contaminated resin is removed from the plant within the contaminated electro-deionization unit and not stored as wet waste.

The condensate polishing system includes mixed bed ion exchanger vessels for purification of the condensate. Should the resins become radioactive, the resins are transferred from the condensate polishing vessel directly to a temporary processing unit or to the temporary processing unit via the spent resin tank. The processing unit, located outside of the turbine building, dewaters and processes the resins as required for off-site disposal. Radioactive condensate polishing resin has very low activity. After packaging, the resins may be stored in the radwaste building. Based on a typical condensate polishing system operation of 30 days per refueling cycle with leakage from the primary system to the secondary system, the volume of radioactively contaminated resin is estimated to be 8.7 m^3/yr (one bed per refueling cycle).

Table 3.2A-3 lists the expected principal radionuclides in solid wastes. These values represent the radionuclide content in these wastes as packaged for storage/shipping.

3.5.4 Data for Calculation of Radioactive Source Term

The overall objective of this section of the EBID is to provide information to allow evaluation of radioactive releases and confirmation that such releases are maintained:

- within limits established in laws and resolutions of the Republic of Armenia;
- consistent with guidelines established by international bodies such as the IAEA; and
- as low as reasonably achievable (ALARA).

Radioactive source term calculations for pressurized-water reactors (PWRs) are typically based on the PWR-GALE Code given in NUREG-0017. The calculations performed with this code are based on (1) standardized reactor coolant activities; (2) the release and transport mechanisms that result in the appearance of radioactive materials in gaseous and liquid waste streams; and (3) the effectiveness of design features employed to reduce the quantities of radioactive materials ultimately released to the environment. Appendix B to US NRC Regulatory Guide 1.112 (RG 1.112, Ref. [3.5-6]) lists information to be submitted and summarizes the parameters the applicant should consider in performing PWR source term calculations.

Since the reactor type has not been selected, composite values for releases to the environment, as reflected in the Plant Parameter Envelope, Tables 3.2A-3 (Principal Radionuclides in Solid Radwaste), 3.2A-6 (Composite Average Annual Normal Gaseous Release), 3.2A-7 (Gaseous Release Source Term (Post-Accident)), and 3.2A-8 (Average Annual Normal Liquid Release) are used to predict doses and radiological impacts of normal operation and accidents involving radioactive materials. The releases indicated in the referenced tables are provided in lieu of information that would be needed to address RG 1.112, Appendix B. Other parameters necessary for dose projections are provided in the PPE, Table 3.2A-1, Sections 9, 10, 11, and 12.

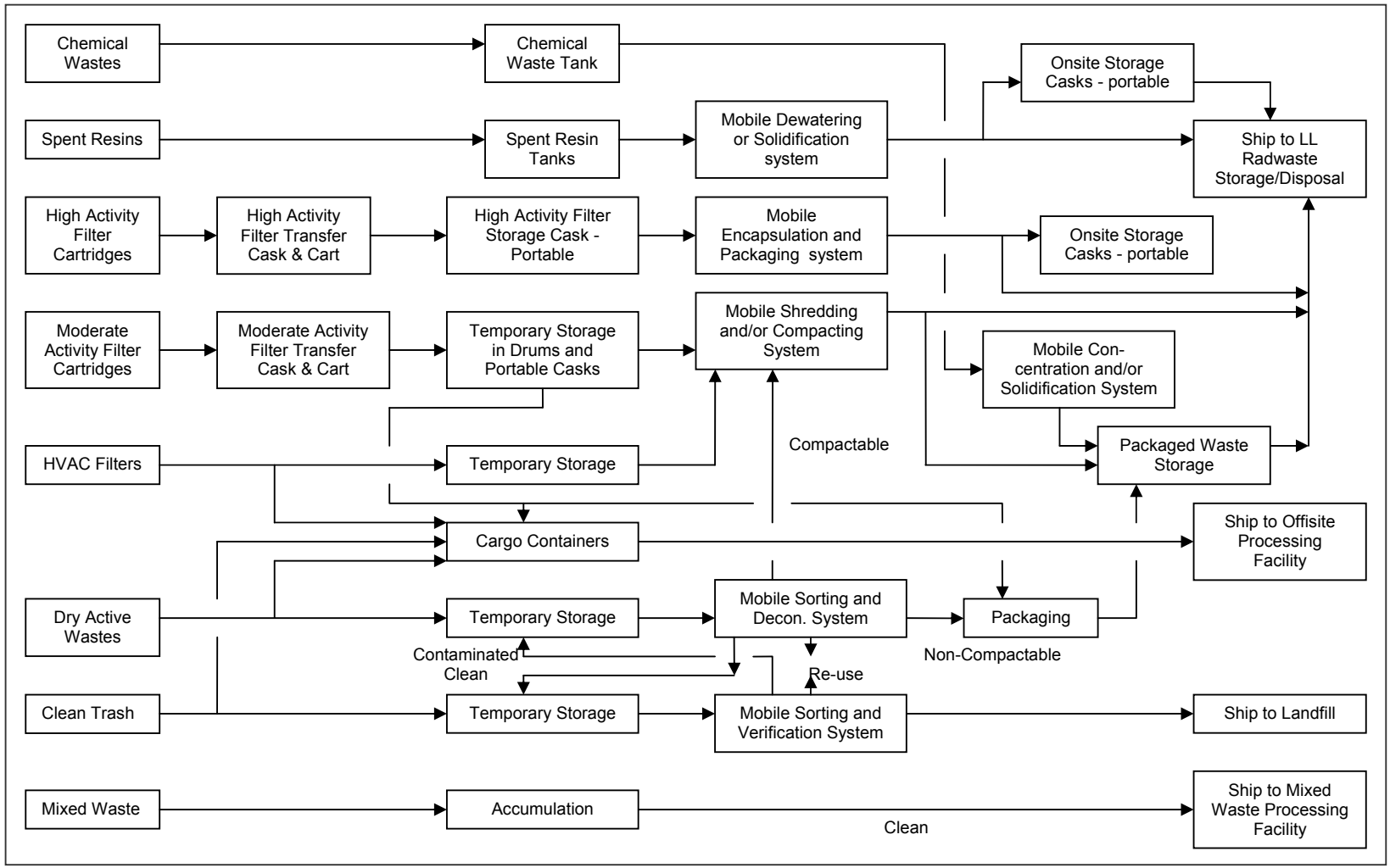
Results of the dose projections are given in this background document, Section 5.4 (Radiological Impacts of Normal Operation) and Chapter 7 (Environmental Impacts of Postulated Accidents Involving Radioactive Materials). Section 5.4 includes a comparison of projected doses with dose limits specified in GoA Resolution 1219 (Ref. [3.5-2]) and those recommended in IAEA Safety Series No. SS-115 (Ref. [3.5-3]).

Table 3.5-1 Average Annual Normal Liquid Release [1]

Isotope	Release - 1 unit GBq/yr	Isotope	Release - 1 unit GBq/yr
*C 14	2.16E-02	Ru 103	2.82E-01
Na 24	9.31E-02	Rh 103M	2.82E-01
P-32	5.14E-03	Ru 106	4.20E+00
*Cr 51	2.78E-01	Rh 106	4.20E+00
Mn 54	7.43E-02	Ag 110M	6.00E-02
Mn-56	1.09E-01	Ag 110	8.00E-03
Fe 55	1.66E-01	*Sb 122	1.17E-02
*Fe 59	1.45E-02	*Sb 124	5.09E-02
Ni 63	4.00E-03	*Sb 125	5.71E-03
Cu 64	2.15E-01	Te 129M	6.86E-03
Co 56	1.48E-01	Te 129	8.57E-03
Co 57	2.05E-03	Te 131M	5.14E-03
Co 58	1.92E-01	Te 131	1.71E-03
*Co 60	3.86E-01	I 131	8.09E-01
Zn 65	2.34E-02	Te 132	1.37E-02
W 187	7.43E-03	I 132	9.37E-02
Np 239	8.89E-02	I 133	3.83E-01
Br 84	1.14E-03	I 134	4.86E-02
Rb 88	1.54E-02	Cs 134	5.69E-01
Rb 89	1.26E-03	I 135	2.84E-01
Sr 89	5.71E-03	Cs 136	3.60E-02
*Sr 90	4.31E-04	Cs 137	7.60E-01
Sr 91	2.57E-02	Cs 138	5.43E-03
Y 90	8.89E-05	Ba 137m	7.11E-01
Y 91	3.14E-03	Ba 140	3.14E-01
Sr 92	2.29E-02	La 140	4.26E-01
Y 91M	5.71E-04	Ce 141	5.14E-03
Y 92	1.71E-02	Ce 143	1.09E-02
Y 93	2.57E-02	Pr 143	7.43E-03
*Zr 95	2.63E-01	Ce 144	1.81E-01
*Nb 95	5.57E-01	Pr 144	1.81E-01
Mo 99	3.26E-02	All others	1.14E-03
Tc 99M	3.14E-02	**Total	1.68E+01

[1] Includes an adjustment for anticipated operational occurrences.
* CANDU(S) bounds AP1000, ** Composite AP1000 & CANDU(S).

Figure 3.5-1 Solid Radwaste Processing



References:

[3.5-1] International Atomic Energy Agency (IAEA), 2000, Safety Standards Series, Safety Requirements No. WS-R-2, *Predisposal Management of Radioactive Waste, Including Decommissioning*, Paragraphs 5.9 through 5.30.

[3.5-2] GoA Resolution 1219, August 18, 2006, *On Approval of Radiation Safety Norms*, Appendix, Part II.

[3.5-3] IAEA, 1996, Safety Series No. 115, *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*.

[3.5-4] IAEA, 2002, Safety Standards Series, Safety Guide No. NS-G-3.2, *Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants*.

[3.5-5] CJSC "Armenia Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Revision 1, Section 1.4.16.

[3.5-6] U.S. Nuclear Regulatory Commission Regulatory Guide 1.112, Rev. 1, March 2007, *Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Light-Water-Cooled Nuclear Power Reactors*.

[3.5-7]IAEA, 2007, *IAEA Safety Glossary, Terminology Used in Nuclear Safety and Radiation Protection, 2007 Edition*.

3.6 NONRADIOACTIVE WASTE SYSTEMS

Section 3.6 describes the nonradioactive waste systems. The chemical and biocidal characteristics of each nonradioactive waste stream discharged from the unit are described in Section 3.6.1. Section 3.6.2 describes the sanitary effluent systems to identify anticipated volumes generated during construction and operation, the treatment systems to be employed, and points of discharge to surface waters. Section 3.6.3 describes miscellaneous gaseous, liquid, and solid effluents, including identification and quantification of these wastes and their proposed treatment and disposal methods.

Plant liquid discharges will be controlled to maintain constituents within limits established in the water use permit for ANPP Unit 3, as discussed in Section 1.2. The constituents in the makeup water supplied to Unit 3 from the Sevjur River are provided in Section 2.3.6. These parameters also represent the concentrations of natural materials present in the water stream (the Sevjur River) that receives plant discharge from Unit 3. Evaporation from the circulating water system (CWS) and service water system (SWS) cause the concentration of principal constituents in the makeup water to increase by a factor of 2.

3.6.1 Effluents Containing Chemicals or Biocides

3.6.1.1 INDUSTRIAL AND RAINWATER SEWAGE

ANPP Phase 1 (Units 1 & 2) includes an industrial and rainwater sewage system that receives uncontaminated drainage from the cooling of mechanisms and bearings that have no radioactive or other contaminants, blowdown water from cooling towers, rainwater from the roofs of buildings of Phase 1 that are equipped with internal drainpipes and rainwater from paved and soil surfaces of part of the plant site. A gravity-flow network consisting of cast-iron and reinforced-concrete pipe 300-800 mm in diameter, laid at a depth of as much as 6 m, receives industrial and rainwater sewage. Ref. [3.6-1] This system discharges to the Kosh-Ujan storm water drainage canal near Taronik Village which then empties into the Sevjur River downstream of the plant water intake. Volumes of discharge and chemical treatment are discussed below.

ANPP Unit 3 will use the same discharge path as that currently used by Unit 2; however the piping may be replaced. As part of the construction for Unit 3, the discharge pipe will be extended to drain directly into the Sevjur River.

During power operation and startup operations when the CWS is operating, ANPP Unit 3 discharges are estimated to total 992 l/s (3,571 m^3/hr) normally, 1,381 l/s (4,972 m^3/hr) maximum, comprised of:

- Main cooling tower (CWS) blowdown at 960 l/s (3,456 m^3/hr) average, 1,300 l/s (4,680 m^3/hr) maximum;[31]
- SWS cooling pond/tower blowdown at 25 l/s (89 m^3/hr) normally, 69 l/s (249 m^3/hr) maximum;[32]
- DWS discharges at 5.4 l/s (19 m^3/hr) average and 7.2 l/s (26 m^3/hr) maximum;[33] and
- Miscellaneous drains at 1.6 l/s (5.8 m^3/hr) normally, 5 l/s (18 m^3/hr) maximum.[34]

The blowdown systems of the Unit 3 CWS and the SWS are designed to maintain a cycle of concentration of approximately 2 over the constituent concentrations in the makeup water.[35] Expected blowdown constituents and those of the makeup water source (Sevjur River and/or groundwater collection pond) are provided in Appendix 3.2A, Table 3.2A-2.

During periods when the CWS is not in operation, the Unit 3 discharges will be reduced to a total of 32 l/s (114 m^3/hr) normally, 81 l/s (556 m^3/hr) maximum, comprised of:

- SWS cooling pond/tower blowdown at 25 l/s (89 m^3/hr) normally, 69 l/s (249 m^3/hr) maximum;[36]
- DWS discharges at 5.4 l/s (19 m^3/hr) average and 7.2 l/s (26 m^3/hr) maximum;[37] and
- Miscellaneous drains at 1.6 l/s (5.8 m^3/hr) expected, 5 l/s (18 m^3/hr) maximum.[38]

3.6.1.1.1 Circulating Water System

The operation of the Unit 3 CWS is described in sections 3.3 and 3.4. The operating cycle for this system for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the system are injected by the turbine building chemical feed system during the power operation and startup modes of operation. If necessary and the CWS is in operation, chemicals may be fed also during hot standby and safe shutdown modes of operation. The chemicals injected into the Unit 3 CWS, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1. The Unit 3 CWS blowdown is extracted from the circulating water tower basin and is discharged directly to plant discharge pipe.

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[31] Table 3.2A-1, section 2.4.4; values in section 2.5.4 (natural draft tower) are less.

[32] Table 3.2A-1, section 3.5.3; values in section 3.3.4 (mechanical draft tower) are less.

[33] Table 3.2A-1, section 6.1.1.

[34] Table 3.2A-1, section 8.1.

[35] Table 3.2A-1, sections 2.4.6/2.5.6, 3.3.6, and 3.5.5

[36] Table 3.2A-1, section 3.5.3; values in section 3.3.4 (mechanical draft tower) are less.

[37] Table 3.2A-1, section 6.1.1.

[38] Table 3.2A-1, section 8.1.

3.6.1.1.2 Service Water System

The operation of the Unit 3 SWS is described in sections 3.3 and 3.4. The operating cycle for this system for normal modes of operation is described in Section 3.4. The chemicals that are needed to maintain proper operation of the system are injected by the auxiliary building chemical feed system during all modes of operation, except during emergencies. The chemicals injected into the Unit 3 SWS, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1. The blowdown effluent is taken from the Unit 3 SWS pump discharges and sent to the plant discharge pipe.

3.6.1.1.3 Demineralized Water System

The operation of the Unit 3 DWS is described in Section 3.3. The DWS uses reverse osmosis and electro-deionization to purify water without the use of chemicals necessary for regeneration of traditional ion exchange resins. The capacity of the Unit 3 DWS is sufficient to supply the plant makeup demand during all modes of operation; however, operation of the DWS is on an as needed basis. The chemicals needed to maintain proper operation of the system are injected by the turbine building chemical feed system and are not dependent on the operating modes of the plant. The chemicals injected into the Unit 3 DWS, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1. The effluent from the Unit 3 DWS is discharged into the plant discharge pipe.

3.6.1.1.4 Steam Generator Blowdown System

The Unit 3 steam generator blowdown system removes a portion of the feedwater flow from the steam generators to maintain secondary chemistry within limits specified by the steam generator vendor and reduce the contaminants that are concentrated by the evaporation process in the steam generators. The blowdown passes through electro-deionization demineralizer units and is routed back to the condenser. In the event of high mineral content due to leakage of CWS water in the condenser, the blowdown can be directed to the plant discharge pipe. In the event of primary-to-secondary leakage above limits, steam generator blowdown can be routed to the Unit 3 liquid radwaste management system described in EBID Section 3.5.

The chemicals injected into the Unit 3 steam generator blowdown system, the amount used per year, the frequency of use and the concentration in the waste stream are shown in Table 3.6-1.

The Unit 3 steam generator blowdown system can be operated to drain the steam generator. During this mode of operation, the blowdown discharge is normally sent to the plant discharge pipe. This mode of operation is expected to occur only during a refueling outage where the discharge concentration to the plant discharge is shown in Table 3.6-1.

3.6.1.1.5 Contaminated Sewage Network

ANPP Phase 1 (Units 1 & 2) includes a network for industrial sewage contaminated by oil products. This network receives sewage from rotating mechanisms in the Unit 1 and Unit 2 turbine hall, drainage water and hydraulic-cleanup effluent, and rainwater and snowmelt from the gravel pits of transformers and oil circuit breakers. The continuous discharge of this sewage from ANPP Phase 1 amounts to 992 m^3/day. The capacity of the Phase 1 contaminated treatment structures is 200 m^3/hr (4,800 m^3/day). Treatment is performed by mechanical separation with an oil trap and flotation tanks and by adsorption in mechanical filters and beds of expanded perlite. The expanded perlite removes 100 % of

oil from the contaminated sewage. Ref. [3.6-1]. The cleaned effluent from the contaminated sewage network is reused in plant systems.

It is expected that the Phase 1 contaminated sewage network will also be used by Unit 3.

3.6.1.1.6 Miscellaneous Drains

Unit 3 will also have the potential for oil-contaminated drains from the turbine building, diesel generator buildings, auxiliary boiler, and transformers. A portion of the miscellaneous drains, estimated at 1.6 l/s (5.7 m^3/hr, 140 m^3/day) expected, 5 l/s (18 m^3/hr, 432 m^3/day)] maximum[39] could have oil contamination, and appropriate area drains will be routed to the Phase 1 contaminated treatment system. The Phase 1 system has more than sufficient capacity to accommodate this Unit 3 miscellaneous drain flow.

Wastes from the Unit 3 turbine building floor and equipment drains (which include laboratory and sampling sink drains, oil storage room drains, the main steam isolation valve compartment, auxiliary building penetration area and the auxiliary building HVAC room) are collected in two turbine building sumps. Drainage from the Unit 3 diesel generator building sumps, the non-radioactive auxiliary building sump and the annex building sump is also collected in the turbine building sumps. The turbine building sumps provide a temporary storage capacity and a controlled source of fluid flow to the contaminated sewage network. In the event radioactivity is present in the turbine building sumps, the wastewater is diverted from the sumps to the liquid radwaste system for processing and disposal, as discussed in section 3.5. A radiation monitor located on the common discharge piping of the sump pumps provides an alarm upon detection of radioactivity in the wastewater. The radiation monitor also trips the sump pumps on detection of radioactivity to isolate the contaminated wastewater. Provisions are included for sampling the sumps. The turbine building sump pumps route the wastewater from either of the two sumps to the contaminated sewage network for removal of oily waste. The diesel fuel oil area sump pump also discharges wastewater to the contaminated sewage network. The wastewater from the contaminated sewage network flows by gravity to the plant discharge pipe.

3.6.1.1.7 Fire Protection System

The fire protection system (FPS) provides the capability to extinguish fires in any plant area, to protect site personnel, limit fire damage, and enhance safe shutdown capabilities. The Unit 3 FPS normally operates in an active standby mode. The fire water supply piping is kept full and pressurized by operation of the jockey pump. If needed, water for fire suppression is supplied by pumps drawing from the three potable water tanks. The water in these tanks is untreated.

Depending on the location of any fire fighting activities, the area drains may be directed to the contaminated sewage network (if from areas with potential oil contamination) or to the plant discharge pipe.

3.6.1.2 SLUDGE ACCUMULATION SYSTEM

Phase 1 also included a sludge accumulation system where wastewater whose chemical composition does not comply with the requirements of the Republic of Armenia water use

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[39] Table 3.2A-1, section 8.1.

permit is drained into sludge accumulation system that is located 100 m northeast of the Phase 1 cooling towers. Ref. [3.6-2]

Should the water in any of the Unit 3 plant systems exceed discharge limits, the system discharges will be directed to the Unit 3 blowdown pond for isolation, as discussed in section 3.4. If water in the blowdown pond exceeds discharge limits, it will be directed to the Phase 1 neutralizer pool and evaporator pool for treatment. (The Unit 3 plant designers should evaluate the potential volumes that might be directed to the sludge accumulation system to determine if design changes are necessary for the sludge accumulation system to serve Unit 3.)

3.6.2 Sanitary System Effluents

Site preparation for ANPP Unit 3 will include completion of construction and commissioning of a new sewage waste water treatment facility to serve the ANPP site.

Construction of Unit 3 at ANPP will require treatment of sanitary wastes resulting from construction and operating personnel onsite. The PPE indicates a maximum sanitary discharge flow rate of 8 l/s (28 m^3/hr, 672 m^3/day) during plant normal operation.[40]

The Unit 3 potable water system continuously furnishes water for domestic use and human consumption. The operation of this system is not dependent on the modes of operation of the plant. The source of potable water for Unit 3 is the deep well pumping system as discussed in section 3.3. The water supplied by this system will meet applicable drinking water standards and, therefore, will not be treated. The water is discharged to the waste water treatment facility as discussed below.

Site preparation for construction of ANPP Unit 3 will include completion of the sanitary waste water treatment facility for waste generated during operation of Unit 3. It would be efficient to design such a system to also accommodate sanitary discharges from ANPP Phase 1 (Units 1 & 2), since that sanitary waste is currently untreated. The design could also take into account expected peak onsite labor for Unit 1 & 2 decommissioning unless that population will be served by portable toilets as is planned for the Unit 3 construction force.

3.6.2.1 ANPP PHASE 1 ORIGINAL WASTE WATER TREATMENT SYSTEM

According to the ANPP Phase 1 design, the site, Armavir Town, Metsamor Town, and Norapat village were served by collectors and a sewage pumping station that fed into a wastewater treatment plant and then by effluent pipeline/canal to the Sevjur River. The wastewater treatment plant was located 12 km from the ANPP site (Ref. [3.6-1]). These components were put into operation in 1980. The collectors received wastewater from household and industrial customers including ANPP. The pumping station and wastewater treatment plant were abandoned in 1989 due to energy shortages. The original wastewater treatment plant was designed under Soviet standards to process 24,000 m^3/day (average 1,000 m^3/hr). The pumping station had two pumps of capacity 680 m^3/hr each with a backup pump with capacity of 920 m^3/hr. (As of 2004, the pumping station was not operable.) Ref. [3.6-4]

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[40] Table 3.2A-1, Section 5.1.1.

3.6.2.2 ANPP WASTE WATER TREATMENT SYSTEM STUDY, 1995

The ANPP Unit 2 Safety Analysis Report (Ref. [3.6-1]) describes a waste water treatment system study in 1995 that included a proposed replacement design.

In 1995, the waste water treatment plant structures were not performing their intended functions and did not meet requirements. The location of the waste water treatment plant resulted in leaks in the sewer and contamination of the area that the sewer runs through. In addition, the remoteness of the treatment facilities resulted in a lack of monitoring of their operation and an inability to ensure reliable operation of the system facilities, which caused shutdowns and breakdowns in the system.

Based on an analysis of the existing system and the sewage-system configuration, a study produced by the Armpromproyekt (Armenian Industrial Planning) institute demonstrated the need to build a decentralized, gravity-flow sewage system for the ANPP as part of the wastewater drainage system, a treatment station and a drainage sewer of pretreated wastewater up to the irrigation canal, connecting the latter to the existing sewer that goes to the area of treatment structures in the settlement of Metsamor. As part of this study, a design was developed for a new sewer system, including a biological treatment system to be located in the southwestern part of ANPP's allocated territory. This system was designed for a capacity of 1,000 m^3/day, with a long-term plan to increase it to 1,250 m^3/day, so as to meet requirements for wastewater treatment that reduces basic pollutants in terms of BOD and suspended matter from 200 mg/l to 5 mg/l[41]. The total area allocated for the biological treatment system was 0.69 ha and the construction area totaled 0.27 ha.

Due to financial difficulties, however, the construction of this biological treatment system was suspended. This may be the system envisioned by the authors of the justification in the 2006 Environmental Passport (Ref. [3.6-3]).

Based on information in the PPE, the system designed in 1995 and partially constructed on the ANPP site should have sufficient capacity and its construction should be completed and the facility placed into operation as part of the site preparation for Unit 3. From the descriptions given above, it appears that the effluent from this facility would be directed to the existing sewage discharge pipe that eventually flows into the Sevjur River upstream of the plant intake.

3.6.2.3 ANPP AREA WASTE WATER TREATMENT PROPOSAL, 2004

As of 2004, the main collector from ANPP, Metsamor Town, Armavir Town, and Norapat discharged into a drainage canal and then to the Sevjur without treatment. The main collector and original pumping station were in need of rehabilitation. A second design proposal was developed for a new wastewater treatment plant with an anaerobic lagoon and a facultative lagoon to serve these communities. The proposed project included a first phase with two lagoons and a second phase to add a BIOLAK treatment facility. The design flow for the proposed facility, based on projected populations in 2016, was to handle 591 m^3/hr (14,200 m^3/day). Ref. [3.6-4]

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[41] The study described in Ref. [3.6-1] indicated that the treatment system effluent would be used for irrigation. During periods that liquid radioactive waste discharges are directed to the sanitary sewer system, use of this effluent for irrigation should be restricted.

The waste water treatment project was proposed to the German government for funding, but no action has been taken on the project because the local utility, Nor Akunk Closed Joint Stock Company, could not be assured that they would recover operational costs through tariffs[42]. (See discussion in the next subsection; it is expected that the description in the Metsamor Master Plan is based on this 2004 proposal.)

3.6.2.4 METSAMOR MASTER PLAN, 2007

The Metsamor Master Plan acknowledges the problems with the wastewater treatment for Metsamor Town and recommends reconstruction and operation of a treatment station with the capacity of 17,000 m^3/day that would provide ~98.5% cleaning of sewage from Armavir and Metsamor towns. Due to lack of financial resources, the proposed reconstruction would be done in two stages; first a mechanical filtration system, and second the biological treatment system. Ref. [3.6-5] Unfortunately, the Master Plan provides no schedule or assurance that the wastewater treatment reconstruction will take place.

3.6.3 Other Effluents

Operation of Unit 3 will involve effluents from operation of the auxiliary boiler, the standby diesel generators, and wastes from laboratories, maintenance workshops and plant offices.

3.6.3.1 AIRBORNE EFFLUENTS

Non-radioactive emissions to air will be controlled in accordance with a permit issued by the Ministry of Nature Protection, as discussed in Section 1.2.

The Unit 3 auxiliary boiler provides process steam needed for heating of buildings and systems when steam is not available from the main steam system. This boiler, fired with natural gas, releases particulate matter, sulfur and nitrogen oxides, and carbon monoxide from the boiler exhaust. The boiler exhaust is at 34 m above plant grade.[43] Estimated annual emissions, based on 30 days of boiler operation per year, are provided in Table 3.2A-4.

Unit 3 has a number of standby diesel generators (number and ratings depend on the selected plant design) to provide backup power in the event of loss of offsite power and/or during design basis events.[44] Although the standby diesels are only required during emergencies, they must be operated periodically for testing and maintenance. Diesel exhausts are approximately 10 m above plant grade.[45] The diesel exhaust includes particulate matter, sulfur and nitrogen oxides, and carbon monoxide. In addition, a small amount of hydrocarbons are released from the fuel tank vents for the diesels. Annual releases of these contaminants is estimated in Table 3.2A-5, based on operation of each diesel for four hours per month.

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[42] Armenia has established a unified tariff system for sewage treatment systems; it is not known if that system would have applied to the proposed system at the time of the Nor Akunk decision to not proceed.

[43] Table 3.2A-1, section 13.1.

[44] Bounding parameters in Table 3.2A-1, section 16.1.1.

[45] Table 3.2A-1, Section 16.1.2.

Cooling towers for the CWS and SWS may result in release of vapor plumes and entrained moisture, known as drift, that carries dissolved solids from the cooling water. The vapor plumes can cause icing or fogging in the plant vicinity. Also as entrained water (drift) evaporates, the dissolved solids are subject to deposition on surrounding land, resulting in mineralization. Reviews by the US NRC have revealed no instances where cooling tower operation has resulted in measurable productivity losses in agricultural crops. The impact of cooling towers on agricultural crops will therefore be of small significance. Cumulative impacts on crops are not a consideration because deposition from cooling tower drift is a localized phenomenon and because of the distance between nuclear power plant sites and any other facilities that may have large cooling towers. Ref. [3.6-6]

3.6.3.2 SOLID EFFLUENTS

ANPP Unit 2 currently sends their non-radioactive solid wastes to a landfill within the territory of Metsamor Town. The waste from ANPP territory is transported to the Metsamor landfill by two trucks, nine times per month. Five times out of nine it is a truck with capacity 7.5 m^3, and the remaining four times it is a truck with capacity 5.7 m^3. On average, garbage removed monthly amounts to 18-20 tonne. Ref. [3.6-7]

Non-radioactive solid wastes include typical industrial wastes, such as metal, wood and paper, as well as non-radioactive resins, filters and sludge. These wastes are disposed of in a permitted landfill.

The Metsamor Master Plan reports approximately 58 tonne/year of industrial waste is disposed of in the town landfill. Ref. [3.6-8] (Based on the waste volumes reported by ANPP, this does not include waste from ANPP.)

Table 3.6-1, Chemicals Added to Liquid Effluent Streams[46]				
System	**Chemical – type/specific**	**Annual amount (*l*)**	**Frequency**	**Concentration in waste streams**
CWS	Biocide/sodium hypochlorite (NaClO)	680,000	continuous	0.2 ppm residual chlorine or 0.36 ppm sodium hypochlorite
CWS	Algaecide/quarternary amine (ammonium chloride, NH_4Cl)	690,000	continuous	0.2 ppm residual chlorine or 0.3 ppm ammonium chloride
CWS	pH adjustment/sulfuric acid (H_2SO_4)	16,000	continuous	2.2 ppm H_2SO_4
CWS	Corrosion Inhibitor/ortho-polyphosphate	280,000	continuous	30 ppm ortho-polyphosphate
CWS	Silt Dispersant/polyacrylate	1.9×10^6	continuous	150 ppm polyacrylate
CWS	Antiscalant/phosphonate	200,000	continuous	20 ppm phosphonate
SWS	Biocide/sodium hypochlorite (NaClO)	7,800	~ 1 hr/day	0.2 ppm residual chlorine or 0.36 ppm sodium hypochlorite
SWS	Algaecide/quarternary amine (ammonium chloride, NH_4Cl)	7,900	~ 1 hr/day	0.2 ppm residual chlorine or 0.3 ppm ammonium chloride
SWS	pH adjustment/sulfuric acid (H_2SO_4)	140	~ 1 min/day	2.2 ppm H_2SO_4
SWS	Corrosion Inhibitor/ortho-polyphosphate	2,400	1.3% of time	30 ppm ortho-polyphosphate
SWS	Silt Dispersant/polyacrylate	16,000	9% of time	150 ppm polyacrylate
SWS	Antiscalant/phosphonate	1,700	0.9 % of time	20 ppm phosphonate
DWS	pH adjustment/sulfuric acid (H_2SO_4)	71	Intermittent	2.3-6.8 ppm H_2SO_4
DWS	Coagulant/Polyaluminum Chloride	450	Intermittent	5-15 mg/l
DWS	Anti-scalant/polyacrylate	8,500	Intermittent	150-450 ppm polyacrylate
SG BD	Oxygen Scavenging/Hydrazine (N_2H_4)	200	2.5 hr/yr or 1.25 hr/shutdown	200 ppm hydrazine (If steam generator is drained to the discharge pipe.)
SG BD	pH adjustment/ammonium hydroxide (NH_4OH)	780	21 hr/yr or 10 hr/shutdown	100 ppm ammonia (If steam generator is drained to the discharge pipe.)

[46] Currently ANPP Unit 2 uses only H_2SO_4 for treatment of treatment of circulating water. This table is typical for an AP1000 in the US.

References:

[3.6-1] CJSC "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, (Revision 1), Section 1.4.12.

[3.6-2] *Safety Analysis Report on Power Unit № 2 at the ANPP*, (Revision 1), Section 1.4.14.

[3.6-3] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of Armenian Nuclear Power Plant*, Appendix 12, p. 30 (of English translation by PA Armenia).

[3.6-4] Nor Akunk Closed Joint Stock Company and Kreditanstalt fur Wiederaufbau, 2004, *Communal Infrastructure Project, Design Report WWTP Armavir-Metsamor – First Phase, Wastewater Treatment Pond System*.

[3.6-5] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007, Section 6.5.

[3.6-6] USNRC, 1996, NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, section 4.3.4.

[3.6-7] CJSC "Armenian Nuclear Power Plant", 2008, ANPP Letter dated 05 May 2008, from S. Ghazaryan to A. Galstyan, Ministry of Energy, *Information on Garbage Removal from Territory of ANPP*.

[3.6-8] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007, Section 6.6.

3.7 POWER TRANSMISSION SYSTEM

This section describes upgrades and modifications to the power transmission system that will be necessary for ANPP Unit 3. The description includes the transmission system from the plant switchyard to its connections with existing systems.

The republic-wide transmission system capabilities and planned improvements that may facilitate transmission of power from Unit 3 within Armenia and to neighboring countries is discussed within the Initial Planning Studies, Chapters 3 and 4, both of which conclude that a new 400 kV line is needed, based on calculations of steady-state and transient stability.

The analysis in this EBID section assumes that concurrent operation of Units 2 and 3 must be accommodated by the high voltage electrical network. Although Unit 2 is expected to be shutdown once Unit 3 is operational, operation of both units may occur during the Unit 3 startup testing period, which can last several months before the unit is declared fully operational. It is not likely that both units will operate at full capacity at the same time, but for a conservative assessment, concurrent operation of both units at full power is assumed.

This section of the EBID addresses only the transmission system for transmission of power from the ANPP site switchyards to the nearest interconnecting substations.

3.7.1 Existing ANPP Transmission System

The backbone of the Armenian transmission and distribution network (high voltage electrical network) is formed at 220 kV and covers practically the entire territory of the country. There are fourteen 220 kV substations. Ref. [3.7-1]

Power from the operating ANPP Unit 2 generators is transmitted to this high voltage electrical network from the ANPP outdoor switchyard by five 220 kV overhead transmission lines, as follows (Ref. [3.7-2]):

- Line “Areg” to Ararat-2 substation;
- Line “Musaler” to Marash substation;
- Line “Ashnak-1” to Ashnak substation;
- Line “Ashnak-2” also to Ashnak substation; and
- Line “Sipan” to Shaumyan-2 substation.

The above five lines leave the plant vicinity in three separate transmission corridors: one for lines “Areg” and “Musaler”; one for “Ashnak-1” and “Ashnak-2”; and the third for “Sipan”, as illustrated in Figure 3.7-1. Details for the existing transmission lines are listed in Table 3.7-1.

Different transmission line capacity values, as listed in Table 3.7-1, are given for these lines. The combined capacities of the existing 220 kV transmission lines is between 675 MW (Ref. [3.7-3]) and 1200 MW (Ref. [3.7-4]). The output capacity of these lines is also given as 900 MW. Ref. [3.7-5]

Another information source (Ref. [3.7-6]) lists “maximum loads per active capacities” for each of the above substations that differ by one to three orders of magnitude from those given in Table 3.7-1; it is assumed that the values in this later reference do not relate to the transmission line capacities. However, the information does indicate that changes

may be necessary within these substations to accommodate the rated loads of the corresponding transmission lines. Analysis of the electric network components in 1998 indicated that many of them need urgent reconstruction and technical re-equipment due to physical degradation and expiration of their service lives, including replacement of all operating oil and air circuit breakers (Ref. [3.7-7]). (The scope of this EBID section is limited to the ANPP switchyard and transmission lines leaving that switchyard, out to the first offsite substation on each line. The EBID does not assess the impact of changes to the power transmission and distribution network.)

A number of generating facilities transmit over 110 kV lines. Ref. [3.7-1] Transmission lines of 110 kV are also used for more localized power distribution. Power is transmitted from ANPP Unit 2 over seven 110 kV overhead transmission lines, as follows (Ref. [3.7-2]):

- Line “Bzhni” to the Argel hydroelectric station in the Sevan-Hrazdan Cascade;
- Line “BNS” to the Sevjur and Pond substations that power pumps at the Sevjur River intake, the groundwater collection pond, and the household and drinking water supply (see descriptions of water supply systems in EBID section 3.4);
- Line “Anush” to the Ashtarak substation;
- Line “Shaumyan-2” to the Shaumyan-2 substation;
- Line “Echmiadzin” to the Echmiadzin substation;
- Line “Atomain-1” to the Armavir substation; and
- Line “Atomain-2” also to the Armavir substation.

The sum of capacities of the above transmission lines, as given in Table 3.7-1, is 180 MW to 540 MW.

Current and power ratings for transmission cables are given in Table 3.7-2, based on Ref. [3.7-8]. The power ratings from Table 3.7-2 are given in Table 3.7-1, corresponding to the conductor data given.

Combining capacities of the 220 kV connections to the Armenian high voltage electrical network and the 110 kV local distribution lines from the ANPP outdoor switchyard results in a total capacity of between 855 MW and 2,040 MW, with reliable capacity of approximately 1,380 MW. In any case, with the potential for concurrent operation of Units 2 and 3, the existing capacity would be insufficient.

3.7.2 Expansion of the Armenian Transmission and Distribution System

As noted in the previous section, additional capacity for transmission of power from the ANPP site is needed. A number of studies substantiate this need and forecast expansion of the Armenian high voltage electrical network to support increased generation capacity at the ANPP and other electrical power generation sites within Armenia, to improve electricity import and export capabilities, and to strengthen the overall electrical network stability.

3.7.2.1 ANPP PHASE 2 PLANNING

The original planning for ANPP Phase 2 (VVER-440 Units 3 and 4) included two new 330 kV transmission lines; one line to Hrazdan and one line to Shaumyan (see Figure 3.1-1). As reflected in the discussions that follow, these 330 kV lines are not part of current planning for the Armenian high voltage electrical network. Ref. [3.7-9]

3.7.2.2 FEASIBILITY STUDY REPORT - 1998

A feasibility study on development of the Armenian high voltage electrical network was conducted in 1998, accounting for additional nuclear production capacity. Ref. [3.7-10] This study included projections through 2010 and an estimation for 2020. The study assumed new nuclear production capacity of 640 MW and the report states that one additional 220 kV transmission line should be constructed to serve this new generation source. Ref. [3.7-5] The capacity of this line is given as 250 MW. Ref. [3.7-11]

The study concludes that, with consideration of the existing network of 110 kV lines, new generation capacity of 640 MW does *not* require construction of new 220 kV lines. Nevertheless, it recommends construction of a new 220 kV line from ANPP in the direction of the expected load – the city of Yerevan (specifically substation Shaumyan-2). Ref. [3.7-12]

3.7.2.3 PROSPECTIVE DEVELOPMENT SCHEME FOR DEVELOPMENT OF THE ARMENIAN POWER SYSTEM - 2006

A recent study of the Armenian high voltage electrical network offers perspective on its development through 2020. Ref. [3.7-13] This recent study assumes supply of 1000 MW from a new NPP, beginning in 2015. Ref. [3.7-14] The recommended development of the network in this report includes two new transmission lines in operation from ANPP by 2020 (Ref. [3.7-15]):

1. ANPP-Hrazdan TPP, 400 kV, 500 mm conductors x 2, length = 80 km; and
2. ANPP-Horasan (Turkey), 400 kV, 500 mm conductors x 2, length = 170 km.

One can infer from capacities reported for other lines that each of the above two-conductor transmission lines could carry from 580 to 1,000 MW. Ref. [3.7-16] This would be a total of 1,160 to 2,000 MW new transmission capacity from ANPP if the lines are operational at the time of Unit 3 completion in January 2016.

The two new 400 kV lines from ANPP are modeled in the system for analysis of the situation in 2020. Ref. [3.7-17] The report concludes that to ensure the maximum system capabilities in 2020 it is required to add about 500 MW new capacity to the system, and considering the requirement to have a reserve equal to the size of the maximum [generating] unit of the system, to also add 1000 MW of transmission capacity (the size of the new NPP). Ref. [3.7-18]

3.7.2.4 INITIAL PLANNING STUDIES FOR REPLACEMENT NUCLEAR UNIT - 2008

Initial planning studies (IPS) for a new nuclear unit in Armenia are being prepared in parallel with development of this Environmental Background Information Document. Chapter 3 of the IPS evaluates transmission capacities. The report states that currently the GoA is planning a significant expansion of the existing transmission network, including a 400 kV line between ANPP and the Hrazdan Thermal Power Plant. One can infer from capacities assigned to the proposed new 400 kV lines to Iran and Georgia, that the new line between ANPP and Hrazdan would have a total capacity of 1,000 MW. Ref. [3.7-19] From the 1998 Feasibility Study, we can infer that the new transmission line would have a capacity of 580 to 1,000 MW (see discussion above and Ref. [3.7-16]).

3.7.2.5 NEW TRANSMISSION CAPACITY FOR ANPP UNIT 3

The data discussed above are summarized in Table 3.7-3, which totals up minimum, expected and maximum capacities of the generators (Units 2 and 3), the existing

transmission lines, and proposed new lines. The minimum transmission capacities are the minimum values in the published references. The maximum transmission capacities are the maximum of the values given in the published reports and the conductor ratings given in Table 3.7-2. The assumed capacity of the possible generation resources is the mean value between the minimum and maximum values. Assumed capacity of transmission lines is the average of the published minimums, maximums, conductor capacities from Table 3.7-2 (power factor = 0.95), and conductor capacities from Table 3.7-2 corrected for a power factor of 0.80.

From Table 3.7-3, we can see that the existing lines *may* be adequate to transmit power from Unit 2 and a CANDU-6, but the transmission capacity is dependant on the 110 kV lines, is marginal, and considered inadequate from a reliability standpoint.

The existing lines, with addition of a single 220 kV line from ANPP to Shaumyan-2 substation, as proposed in the 1998 Feasibility Study, *could* be adequate to transmit power from Unit 2 and a CANDU, if the capacity of the 110 kV lines is included. It is possible that this configuration could accommodate the VVER-1000 or the AP1000, but with little margin and low reliability.

The existing lines with addition of just one two-conductor 400 kV line to Hrazdan *could* have capacity to transmit power from both Units 2 and 3 if Unit 3 has the capacity of the VVER-1000 or AP1000, but reliability may not be sufficient if both units are online at full capacity.

The existing lines with addition of the two two-conductor 400 kV lines discussed in the 2006 prospective development study would be sufficient to transmit power from both Units 2 and 3, without relying on the capacity of the 110 kV lines from the ANPP switchyard.

If, in addition to the two-conductor 400 kV line to Hrazdan, a single connector 400 kV line to Turkey is run from ANPP, the capacity of the existing 220 kV lines plus new 400 kV lines is sufficient to transmit power from both Unit 2 and Unit 3. If the line to Turkey is a two-conductor line, then the values for the 2006 Prospective Development Report are valid. However, since commissioning of a new line to Turkey requires a change in the political and diplomatic relations between Armenia and Turkey, the configuration with addition of only the new two-conductor 400 kV line to Hrazdan is considered the most likely scenario for 2016.

3.7.2.5.1 Conclusion Regarding Capacity Needed for ANPP Unit 3

The most likely scenario for development of new transmission capacity from ANPP is for a two-circuit connection between ANPP and Hrazdan-5.

- This will provide reliable capacity to allow full power operation of Unit 2 and a CANDU-6 plant without reliance on the 110 kV transmission capacities.

- Depending on the assigned reliable ratings of the existing and new transmission lines, this combination will also be capable of transmitting full power from Unit 2 and an AP1000 or VVER-1000; however some of the power may have to be carried by 110 kV lines. The total high voltage electrical network capacity should be evaluated against the expected total generation from Units 2 and 3 to determine if load limits should be placed on the combined generator output.

This evaluation accounts for expansion of the existing ANPP switchyard to house transformers, bus bars, and circuit breakers to serve one or more 400 kV transmission

line(s). The generator(s) for Unit 3 will be connected to the 400 kV, 220 kV and 110 kV busses to allow for maximum flexibility. It is assumed that only one new 2-conductor 400 kV transmission line will be built in connection with construction of Unit 3, that being between switchyards for ANPP and Hrazdan 5.

The routing and specific design for this line has yet to be determined (Ref. [3.7-20]), so specific impacts of the new transmission corridor cannot be evaluated at this time. {The Developer must assess the environmental impacts of the new transmission line construction and operation, once the corridor routing is defined.}

3.7.3 Characteristics of New 400 kV Switchyard and Transmission Line

The voltages, conductor sizes, and capacities of existing lines are given in Table 3.7-1.

Since the existing Armenian high voltage electrical network currently has no 400 kV transmission lines, there are no established Armenian standards for 400 kV transmission systems. Such standards are currently under development based on standards from other countries that use 400 kV systems. Ref. [3.7-20] Parameters expected to be in those standards, as they will apply to the 400 kV switchyard and connected transmission line are given below.

3.7.3.1 NEW 400 KV SWITCHYARD AT ANPP

Draft standards for 400 kV systems indicate the following parameters for the 400 kV switchyard at ANPP (Ref. [3.7-21]):

- conductor/busbar type and configuration – steel-aluminum wire of AC-500/27 type (cross section of aluminum 500 mm^2, steel – 27 mm^2), two wires per phase;
- minimum spacing between phases – 5500 mm;
- minimum distance to switchyard fence – 4550 mm; and
- minimum conductor clearances to ground – 14.5 m.

Armenian design standards do not specify electric field strengths or noise limits and those parameters are not measured at existing switchyards.

3.7.3.2 NEW 400 KV TRANSMISSION LINE, ANPP TO HRAZDAN 5

Draft standards for 400 kV systems indicate the following parameters for the 400 kV transmission line between ANPP and Hrazdan 5 (Ref. [3.7-21]):

- conductor type and configuration - steel-aluminum wire of AC-400/51 type (cross section of aluminum 400 mm^2, steel – 51 mm^2), two wires per phase;
- minimum spacing between phases – see Figure 3.7-2;
- minimum conductor clearances to ground – 8 m;
- standalone galvanized steel towers with factory-made or cast in place monolithic reinforced concrete foundations – see Figure 3.7-2;
- approximate length of line – 70 to 80 km;

- typical span length – from 350m to 450m, depending on climatic conditions of the towers;
- width of area of transmission line rights-of-way – 77.5m (30m each from each side of the edge-wires);
- conductor stringing – using hauling mechanisms through the rollers on the tower;
- access roads – envisaged for each foundation (for mountainous conditions new roads are designed).

As stated above, the corridor routing for the new transmission line has not been determined, so impacts of the new corridor cannot be evaluated at this time. Environmental expert reviews of new transmission lines typically require that new corridors not pass through forested areas or agricultural lands. Ref. [3.7-20]

Existing procedures for routing of transmission lines, which may also apply to 400 kV lines, provide guidance on corridor widths, distances to trees, etc. that will minimize impacts on the environment and prohibit the routing of lines over 110 kV through residential areas. Ref. [3.7-22]

Table 3.7-1, Existing Power Transmission Line Data

Name	Voltage (kV)	Length[(a)] (km)	Cross Section[(a)] (mm^2)	Capacity [(a)] (MW)	Conductors [(b)]	Capacity [(b)] (MW)	Capacity [(d)] (MW)	Destination
“Musaler”	220	53	400	135	400 x 1	250	300	Marash substation
“Areg”	220	86	400	135	400 x 1	250	300	Ararat-2 substation
“Sipan”	220	33	400	135	400 x 2	300	300	Shaumyan-2 substation
“Ashnak-1”	220	39	400	135	400 x 2	200	300	Ashnak substation
“Ashnak-2”	220	39	400	135		200	300	Ashnak substation
“Shaumyan-2”	110	33	150	30			90	Shaumyan-2 substation
“Bzhni” / “BNS”	110	43	150	30			90	Argel hydroelectric power station, Sevjur and Pond substations serving unit pumping stations
“Echmiadzin”	110	27	150	30			90	Echmiadzin substation
“Anush”	110	30	150	30			90	Ashtarak substation
“Atomain-1”	110	10	150	30			90	Armavir substation
“Atomain-2”	110	10	150	30			90	Armavir substation

[(a)] Ref. [3.7-3], [(b)] Ref. [3.7-4], [(c)] Ref. [3.7-12], [(d)] Ref. [3.7-8]

Table 3.7-2, Transmission Cable Ratings				
Voltage (kV)	**Conductor**	**Rated Current (A)**	**Power Factor**	**Rated Power (MW)**
110	AC-120	390	0.95	80
	AC-150	450	0.95	90
	AC-185	510	0.95	100
	AC-300	710	0.95	130
220	AC-300	710	0.95	260
	AC-400	825	0.95	300
	AC-500	945	0.95	350
	AC-500x2	1890	0.95	690
400	AC-500x2	1890	0.95	1250

Table 3.7-3, New Power Transmission Requirements

Name	Voltage (kV)	Size (mm)	Min Cap. (MW)	Assumed Cap. (MW)	Max Cap. (MW)	Notes
Unit 2 Generation			385	410	440	
CANDU-6 Generation			680	728	740	
VVER-1000 Generation			1000	1100	1200	
AP1000 Generation			1000	1100	1200	
Generation with CANDU			1065	1100	1180	
Generation with VVER			1385	1500	1640	
Generation with AP			1385	1500	1640	
Existing Transmission Capacities						
Existing Lines	220	400	675	1200	1500	
Existing Lines	110	150	180	340	540	
Existing Total			855	1540	2040	
Excess (Deficiency) w/CANDU			(210)	340	860	
Excess (Deficiency) w/VVER			(530)	40	400	
Excess (Deficiency) w/AP			(530)	40	400	
Phase 2 Preliminary Design [(a)]						
"Hrazdan"	330	n/s	n/s	280	n/s	Hrazdan TPP
"Shaumyan"	330	n/s	n/s	280	n/s	Shaumyan-2 Substation
1998 Feasibility study [(b)]						
Add "New Shaumyan"	220	400 x 1	250	260	300	Direction of Yerevan (Shaumyan-2 Substation)
Excess (Deficiency) w/CANDU			40	700	1,160	
Excess (Deficiency) w/VVER			(280)	300	700	
Excess (Deficiency) w/AP			(280)	300	700	
[(a)] Ref. [3.7-9], [(b)] Ref. [3.7-10]						
2006 Mode Calculations Report [(c)]						

Table 3.7-3, New Power Transmission Requirements

Name	Voltage (kV)	Size (mm)	Min Cap. (MW)	Assumed Cap. (MW)	Max Cap. (MW)	Notes
Add new Hrazdan Line	400	500 x 2	580	980	1250	to Hrazdan TPP
Add new Horasan Line	400	500 x 2	580	980	1250	to Turkey
Total new capacity	400	500 x 4	1160	1960	2500	
Excess (Deficiency) w/CANDU			950	2,400	3,360	
Excess (Deficiency) w/VVER			630	2,000	2,900	
Excess (Deficiency) w/AP			630	2,000	2,900	
2008 Initial Planning Study [d]						
Add new Hrazdan Line	400	500 x 2	580	980	1250	to Hrazdan TPP (size assumed)
Excess (Deficiency) w/CANDU			370	1,420	2,110	
Excess (Deficiency) w/VVER			50	1,020	1,650	
Excess (Deficiency) w/AP			50	1,020	1,650	

[c] Ref. [3.7-13], [d] Ref. [3.7-19]

Figure 3.7-1, Existing Power Transmission Systems

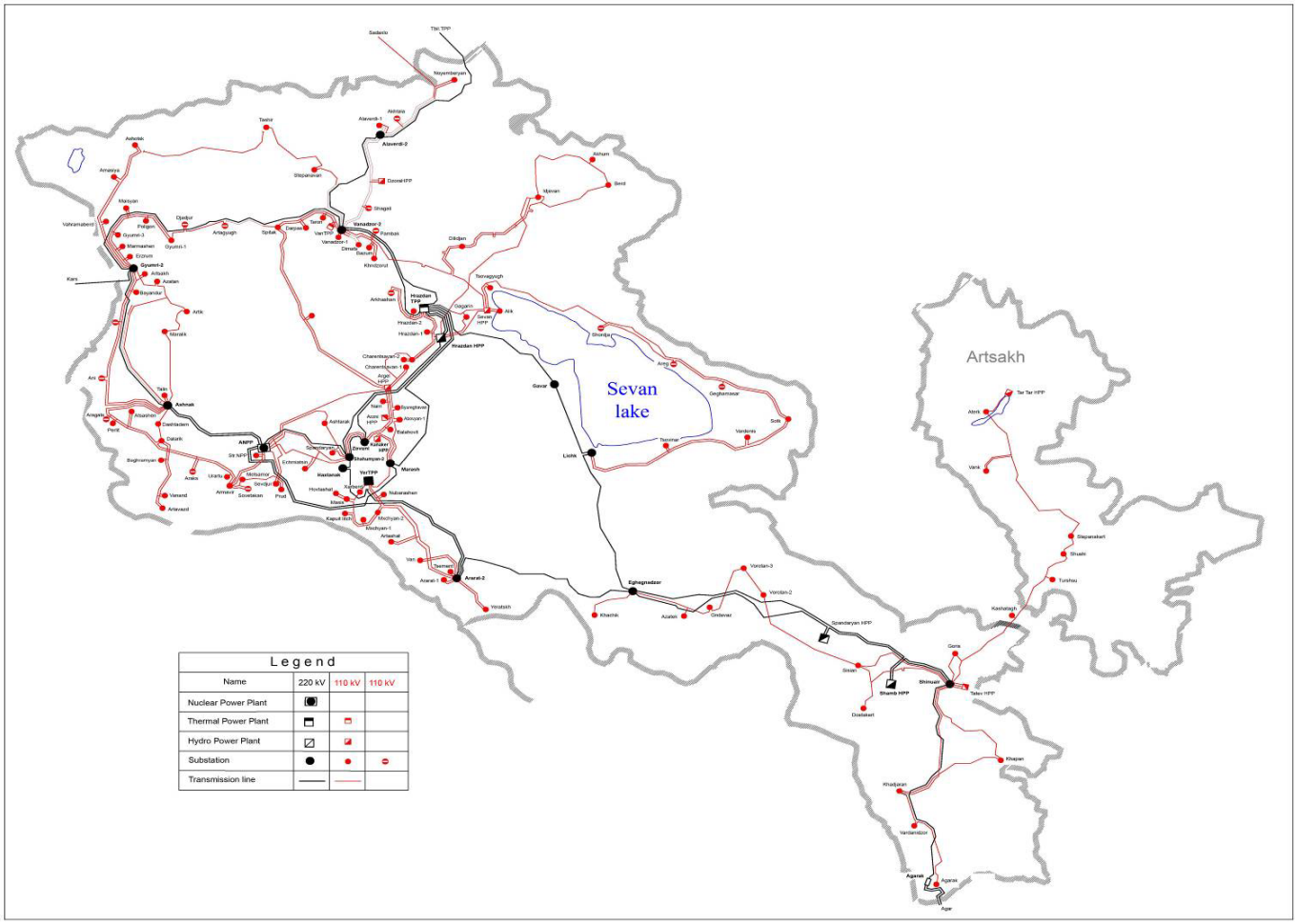
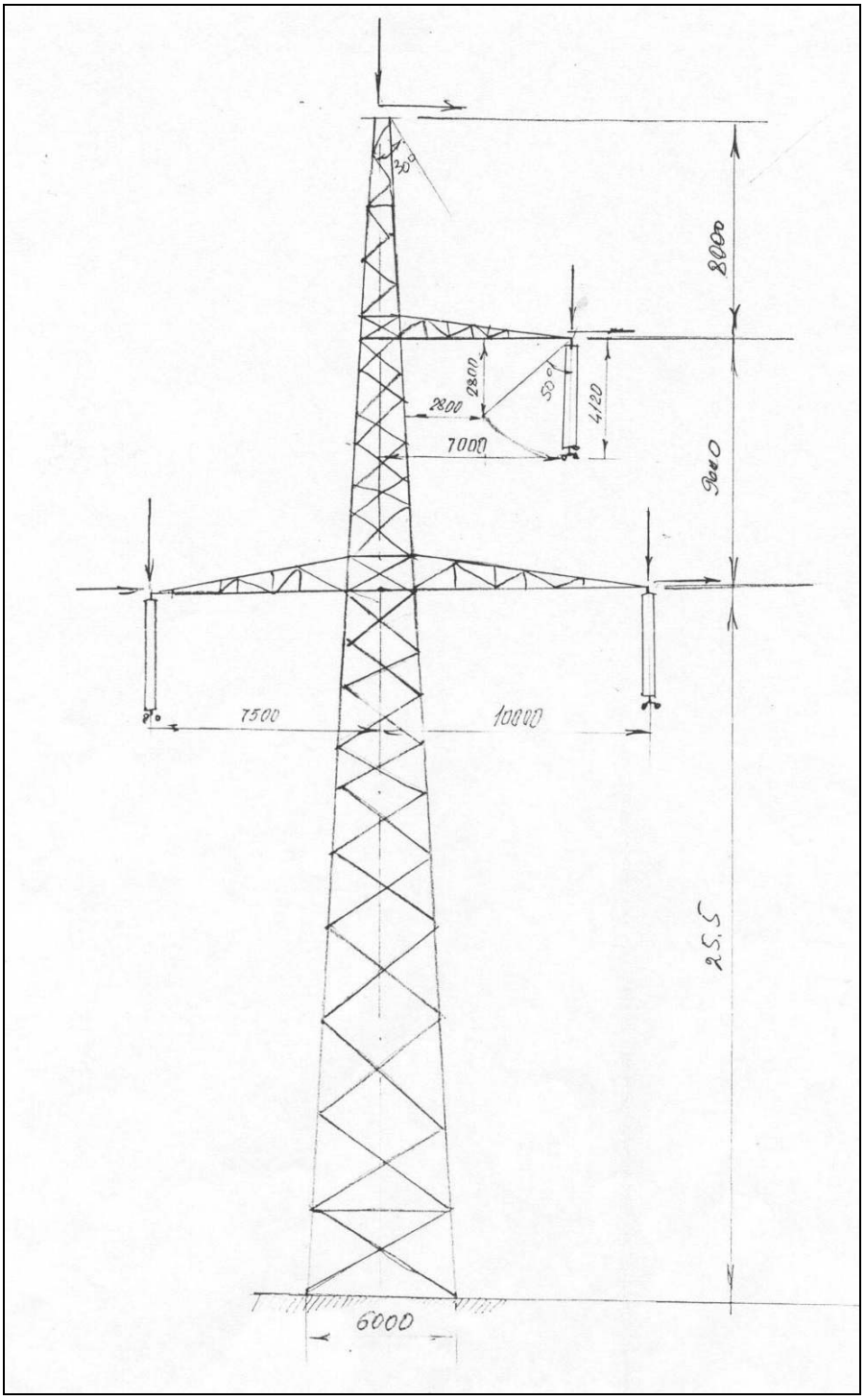


Figure 3.7-2, Design of 400 kV Transmission Tower



REFERENCES:

[3.7-1] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …* (see Ref. [3.7-10] for complete citation), Section 9, p 9-1.

[3.7-2] CJSC "Armenia Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Revision 1, Section 1.4.15.

[3.7-3] *Safety Analysis Report on Power Unit № 2 at the ANPP*, Revision 1, Section 1.5.3.1 and Table 1.5.3-7.

[3.7-4] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …*, Table 9.3, pp 9-5 – 9-6.

[3.7-5] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …*, p 9-4.

[3.7-6] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme of the RoA Power System for 2010, 2015, and 2020*, Section 1.3, Table 1.3.

[3.7-7] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …*, p 9-6.

[3.7-8] Energy Strategy Centre, 2008, e-mail from Vahan.Sargsyan@energinst.am to Albina.Tevosyan@paarmenia.am dated 13 March 2008.

[3.7-9] "TermoPowerProject" Design Institute, Gorki Division, 1975, *Armenian Nuclear Power Plant, Second Phase, Preliminary Design*, Part I, I-A General Explanatory Note.

[3.7-10] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report, Prospective Development of Power System of Armenia Including Nuclear Energy until 2010 with Estimation for 2020*, (complete report)

[3.7-11] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …*, Table 9.6.

[3.7-12] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report …*, p 9-8.

[3.7-13] CJSC "Research Institute of Energy", 2006, *Prospective Development Scheme of the RoA Power System for 2010, 2015, and 2020*, (Complete report).

[3.7-14] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme …*, Tables 3.2 and 3.3.

[3.7-15] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme …*, Section 3.2.2.

[3.7-16] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme …*, Table 3.6, lines 1, 2, 8, and 9.

[3.7-17] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme …*, Figures 4.8, 4.17, 4.18, 4.19, and 4.20.

[3.7-18] CJSC "Energy Network Design Institute", 2006, *Prospective Development Scheme …*, Conclusion 5.

[3.7-19] PA Consulting Group (PA), 2008, *Initial Planning Studies to Assess Feasibility of a Replacement Nuclear Power Unit in Armenia*, Chapter 3, "Review of the Regional Export Possibilities and Grid Requirements", Section 3.3.

[3.7-20] Meeting with CJSC "Energy Network Design Institute", April 9, 2008.

[3.7-21] E-mail from CJSC "Energy Network Design Institute", 25 April 2008.

[3.7-22] GoA Resolution № 961, "On Approval of Technical Procedure Related to Power Transmission and Distribution," July 12, 2007, Articles 47 and 48.

3.8 TRANSPORTATION OF RADIOACTIVE MATERIAL

Section 3.8 describes transportation of radioactive material associated with ANPP Unit 3.

NRC evaluated the environmental effects of transportation of fuel and waste for light water reactors in the Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Plants in WASH-1238 (Ref. [3.8-1] AEC 1972) and Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants, Supplement 1 of NUREG-75/038 (Ref. [3.8-2] NRC 1975) and found the impacts to be SMALL. These analyses provided the basis for Table S-4 in 10 CFR 51.52 (Ref. [3.8-3]), which summarizes the environmental impacts of transportation of fuel and radioactive wastes to and from a reference reactor. The conditions establishing the applicability of Table S-4 are reactor core thermal power, fuel form, fuel enrichment, fuel encapsulation, average fuel irradiation, time after discharge of irradiated fuel before shipment, mode of transport for unirradiated fuel, mode of transport for irradiated fuel, radioactive waste form and packaging, and mode of transport for radioactive waste other than irradiated fuel.

The following subsections describe the characteristics of the ANPP Unit 3 relative to the requirements for use of Table S-4.

3.8.1 Transportation of Un-irradiated Fuel

!0 CFR 51.52 requires fuel be shipped by truck, with provisions for rail shipments. Shipment of new fuel to ANPP Unit 3 is most likely to be by air transport, and thus is not enveloped by the generic assessments done by the U.S. NRC.

The specifics of transportation of un-irradiated reactor fuel will have to be assessed when the specific reactor is selected and the potential fuel vendors identified, along with transportation means available from those vendors. Although road or rail shipments would be preferred, restrictions of countries through which the fuel may have to pass must be taken into account, and at this time, air transport cannot be ruled out as a possibility. If air shipments are considered, the size of the shipments may need to be set based on the potential impacts of transportation accidents.

3.8.2 Transportation of Irradiated (Spent) Reactor Fuel

The fuel for ANPP Unit 2 will be of sintered UO2, clad with Zircalloy or ZIRLO, consistent with the limits of U.S. NRC regulations, however, the Uranium-235 enrichment could be as high as 4.45 percent, which is above the 10CFR51.52 limit of 4 percent. In addition, fuel burnup could be as high as 62,000 MWD/MTU, in excess of the limits for applicability of Table S-4. However, NUREG 1555 states that the NRC has generically considered the environmental impacts of spent nuclear fuel with U-235 enrichment levels up to 5 percent and irradiation levels up to 62,000 MWD/MTU and found that the environmental impacts of spent nuclear fuel transport are bounded by the impacts listed in Table S-4 provided that the more than 5 years has elapsed between removal of the fuel from the reactor and shipment of the fuel off-site.

Spent reactor fuel will be stored in the ANPP Unit 3 spent fuel pool for a minimum of five years before being placed in canisters designed for dry storage. Transportation between Unit 3 and the ANPP dry fuel storage pads will occur totally on special roads with specialized transport vehicles within the ANPP site boundaries. Therefore, the environmental impacts of transportation of spent reactor fuel from Unit 3, within the bounds of the ANPP site should be bound by the conditions assumed in formulation of

Table S-4 of 10 CFR 51.52 which concluded that environmental impacts of spent fuel storage are acceptable.

As discussed in IPS Chapter 5, it is expected that spent nuclear fuel from ANPP Unit 3 will be shipped to a site for processing and disposal of the resulting high-level radioactive waste in a manner and location consistent with international agreements, but that have not yet been determined.

Once international facilities are available and requisite provisions have been established in laws and regulations, the Unit 3 spent nuclear fuel will be shipped out of the country. Without details of the packaging and transportation methods to be used, a suitable assessment of impacts is not possible. Environmental assessments related to these future arrangements must take into account the impacts of accidents during transportation of the spent nuclear fuel.

3.8.3 Transportation of Radioactive Waste

To meet the conditions of 10 CFR 51.52 Table S-4, radwaste shipped from the reactor must be in solid form and packaged for transport.

Liquid radwaste exceeding concentrations suitable for release will be concentrated and solidified in accordance with available technologies within Unit 3 buildings.

Solid radioactive waste from Unit 3 will be packaged for transport and disposal inside Unit 3 buildings. Onsite transportation of packaged radioactive waste will be performed in special vehicles on engineered roads over very short distances (the site is less than 3 km at its widest point).

REFERENCES:

[3.8-1] US Atomic Energy Commission, 1972, *Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants*, WASH-1238.

[3.8-2] US Nuclear Regulatory Committee (US NRC), 1975, *Supplement 1 to WASH-1238, "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants Supplement 1"*, NUREG-75/038

[3.8-3]US NRC, 1984/1988/2007, Title 10 Code of Federal Regulations, Section 51.52 (10 CFR 51.52), *Environmental effects of transportation of fuel and waste--Table S-4*.

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Chapter 4: ENVIRONMENTAL IMPACTS OF CONSTRUCTION

October 2008

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4. ENVIROMENTAL IMPACTS OF CONSTRUCTION

Chapter 4 presents the potential environmental impacts of construction of Armenian Nuclear Power Plant Unit 3 (ANPP Unit 3). The impacts are analyzed, and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of "small," may be negligible.

The definitions of significance are as follows:

SMALL	Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, those impacts that do not exceed permissible levels in RoA laws and regulations are considered small.
MODERATE	Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE	Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

This chapter is divided into six sections:

- Land-Use Impacts (Section 4.1).
- Water-Related Impacts (Section 4.2).
- Ecological Impacts (Section 4.3).
- Socioeconomic Impacts (Section 4.4).
- Radiation Exposure to Construction Workers (Section 4.5).
- Measures and Controls to Limit Adverse Impacts during Construction (Section 4.6).

These sections present potential ways to avoid, minimize, or mitigate adverse impacts of construction to the maximum extent practical. For the purposes of this EBID, the site, vicinity, and region are defined in Section 2.1.

4.1 LAND-USE IMPACTS

Construction has the potential to cause land-use impacts on and off of the site. Impacts can be considered in four categories:

- Impacts on the value of neighboring properties due to a radical change in the use of the site for power production
- Impacts due to the destruction of cultural or natural resources on the site
- Visual impacts of the new power plant on neighboring land use
- Temporary land use impacts resulting from construction activities

Unit 3 will require a large construction effort extending over five or more years. Construction activities will extend over a large portion of the site. In addition to the land occupied by structures, land will required to support construction activities including placement of material excavated for grading, foundations and footings. Land will be occupied temporarily by a batch plant for mixing concrete, by vehicle repair and maintenance facilities, by temporary laydown of construction materials and plant components, by buildings for warehousing of critical safety components, storage of parts and material for welders, pipefitters and electricians, by construction offices, by toilet facilities and cafeterias and by other support facilities for workmen, by parking lots for construction workers, equipment suppliers and vendors.

Additional work will take place at the water supply intake and discharge locations. This work will be limited. The intake structure modifications, if any, will be at the Units 1 and 2 intakes. The discharge pipeline currently serving Unit 2 will be extended from its current discharge point to the main channel of the Sevjur River.

One new transmission line will be needed to support operation of units 2 and 3. Routing of this line is not yet available; therefore construction impacts cannot be assessed at this time. {The final Environmental Report should address the impact of construction of this new transmission line.}

Most of the construction will be done during daylight hours. To minimize the duration of construction it is likely that two construction shifts will be used. Occasionally an activity, for example a large concrete pour, will go nonstop around the clock for several days.

A large number of trucks and automobiles will be arriving at the site daily. The number of construction workers will vary during the course of the project, reaching a maximum of 2500 to 3500 during peak construction. In addition to the need to transport workers to the site each day, all of the material required to build the unit will be transported to the site by truck.

Water must be provided to support construction activities and there will be some amount of waste generated for disposal. Noise and dust are inevitable consequences of construction.

As an example, the nominal construction schedule proposed by the AP1000 vendor is shown in Table 4.1-1. Construction begins with 18 months of site preparation work. The 36 month duration of construction is the time interval between the first pour of concrete to the time of loading fuel into the reactor. This schedule was proposed in the USA for applicants for a combined construction and operating license. This is comparable to the licensing situation in the Republic of Armenia. Attainment of this schedule is dependent on all actions being well planned and on certain procurement actions being initiated even before the site preparation work begins [4.1-2]. This schedule is also based on construction techniques which Westinghouse may believe is optimal.

Table 4.1-1, Westinghouse Construction Schedule for the AP1000 (Ref [4.1-1])

Activity/Milestone	Duration of Activity, months	Lapsed Time, months
Break Ground	0	0
Site Preparation	18	18
Construction	36	54
Startup	6	60

The construction schedule developed for the Unit 3 may be different from the example. However the use of the nominal schedule is helpful in assessing the major transient impacts associated with the large construction project.

Table 4.1-1 was developed for the power block which includes the reactor, steam generators, turbines and condensers along with essential components. Other construction, which will be done concurrently, may include an administration building, warehouses, maintenance and paint shop, a cooling tower, and switchyard and transformer facilities. The schedule does not include details on the construction of a reactor control room simulator [4.1-1]. The extent of these support facilities cannot be known until the detailed design of the new unit is complete. However it is believed that they are adequately accounted for in the design envelope.

The 18 months of site preparation includes time for mobilization of equipment and personnel, and time for building facilities to support the construction of the permanent facilities. Site preparations for permanent structures include grading and excavation activities. The dimensions of excavations will vary among the reactor designs.

Site preparation involves extensive grading, excavation, and placement of excavated material. For the AP1000, the schedule includes 4.5 months to prepare the 12-meter-deep nuclear island excavation and 3 months to install drains, sumps, a working slab, and rebar for the nuclear island basemat. The CANDU would require excavation to a depth of up to 22 meters.

Later site preparation activities will allow uninterrupted plant construction that starts with pouring the nuclear island basemat. These activities include placing working basemats, fabricating rebar modules, placing basemat rebar modules, and the on-site fabrication of the containment vessel's bottom head.

Underground utilities are installed early in the site preparation process to allow the completion of plant roads, crane access areas, and other activities.

During site preparation numerous temporary and permanent buildings will be constructed. Construction of these buildings will extend over a several month period.

During the 36 month construction period large quantities of concrete will be used. Plant construction starts with a 2-day (30-hour) continuous pour of the nuclear island basemat with about 6,000 cubic meters of concrete poured using four concrete pumps. This is based on an on-site concrete batch plant and transit trucks with the capacity to deliver the concrete. Mixing and pouring structural concrete will then continue for the duration of construction. The schedule includes 142 concrete placement activities in the nuclear island that place approximately 41,000 cubic meters of concrete. This translates into approximately 200 cubic meters/day of concrete poured over 200 days.

Some of the concrete placements will require around the clock activity. Noise may be significant during these activities. Dust will also be produced, but perhaps to a lesser extent than during site preparation.

The overall estimated quantities of concrete for each of the major buildings and the duration of concrete placement activities are tabulated below:

Table 4.1-2, Quantities of concrete for permanent structures

Building	Quantity of Concrete, m^3	Duration of pour
Nuclear Island Basemat	6,000	2 days
Shield Building	24,000	27 months
Auxiliary Building	11,000	27 months
SubTotal for Nuclear Island	41,000	
Turbine Building	11,000	14 months
Annex Building	4,000	17 months
Radwaste Building	750	11 months
Diesel Generator Building	400	10 months
Total Concrete	57,150	

Material for construction of the unit will be arriving by truck and stored in a controlled manner to be available as needed. The larger volume items may include: 3,100 tons of reinforcing bar for the reactor building alone; 2,000,000 meters of cable; 80,000 yards (73,150 meters) of piping of greater than 6 cm diameter [4.1-3].

Placement of major components is a small part of the schedule. Reactor and power generation components are modular in design. Setting of modules typically takes 2 days within the schedule. 18 working days are allowed to set the plant's two steam generators, and 20 working days are planned for setting the plant's reactor vessel. Piping and wiring and completion of structures will fill out the construction schedule.

Activities during the startup period may include piping integrity checks, hydrostatic pressure tests, and electrical checks along with other testing of components.

4.1.1 Impacts on Neighboring Land Values Due to Changing The Land Use On The Site

Unit 3 will be built on the site of an operating nuclear power plant. The site has been committed to electrical generation for about thirty years. Thus, construction of the new unit does not constitute a change in land use. Rather, it extends the commitment to use the site for power generation for another fifty years or more.

Figure 2.1-4 shows a plan of the site. The boundary of land controlled by the ANPP is shown. The total area is 360 hectares. Additional land controlled includes a utility access corridor between the plant and the Sevjur River. This corridor includes pipelines for water supply and discharge. The corridor includes the eastern access road controlled by the ANPP that provides access to the plant from highway M-5. There is a western access road through Metsamor town. This road is not on property controlled by the ANPP. It is expected that all truck traffic will be directed to use the eastern access road. Additional land being transferred to the ANPP CJSC will border the site as it is shown in Figure 3.1-1 (see Section 2.2.3.2). This addition will serve as a sanitary buffer zone. The existing site is adequate to support the construction and operation of Unit 3 and the new land need not be used to support construction activities for Unit 3. This analysis is based on all construction activities occurring within the current 360 ha site.

The site plan shows the existing Unit 1 and 2 structures. The structures and paved areas occupy about 75 hectares. This includes the switchyard and other structures which may be shared with the new unit. The balance of the site will accommodate the new Unit 3. After startup of Unit 3, plans for the Unit 1 and 2 structures may make additional space

available. Unit 1 is no longer operational. For now it is planned that the new unit will be built and made operational without disrupting the operation of Unit 2.

A number of buildings were built on the site to support the construction of the originally planned four units. Some buildings have been converted to support operation of Unit 2. Some of these buildings may be removed or renovated to accommodate the new unit construction.

Figures 3.1-2, 3.1-3, and 3.1-4 show conceptual layouts of the Unit 3 permanent buildings on the site for three different reactor options. The permanent buildings for any option would occupy a small portion of the site. All of the construction activities will be within the area disturbed for construction of the earlier units. All three conceptual layouts have the permanent structures placed within the area previously committed to the originally planned Units 3 and 4 (VVER 440).

The new Unit 3 will require 25 ha for permanent buildings and paved areas. An additional 34ha will be used to support construction. Figures 3.1-2 through 3.1-4 show possible placements of the reactor building, the turbine generator building, the cooling tower and essential cooling spray ponds, and maintenance and support buildings. Figure 2.1-4 shows estimated limits of built-up and construction support areas.

Most buildings will be built at grade. The deepest excavation will be required for the nuclear island. Other buildings may require excavation. The area filled with material excavated during the earlier construction is shown on the site plan, Figure 4.1-1. The excavated material was used to fill this area prior to the construction of Building 84, which is a Construction Administrative Base. The fill was graded to produce a level surface.

It is expected that the excavated earth will be placed on site adjacent to the previously filled area. The slope of the ground at this location will allow a fill as high as 14 meters. The site is large enough to accommodate the excavated material. Hauling of excavated material offsite for disposal should not be necessary.

Construction support areas are used for equipment laydown, temporary warehousing of components and equipment, a concrete batch plant, temporary office space, and employee cafeteria and restroom areas. At peak of construction as many as 2500-3500 workers will be on site. This will require a parking area of as much as 15 hectares. It is anticipated that many of the workers will use the railroad to get to the site from Armavir. Others will carpool or use vans or buses. This will reduce the pressure on the access road and on the parking requirement.

The existing pumping stations on or near the Sevjur River were designed and constructed to support four VVER 440 units. The total installed pumping capacity is 4.2 m^3/s through the two 1-meter pipelines. This capacity is adequate to support the new Unit, including the startup period with Unit 2 also in operation. The discharge line from the circulating water and service water system also is within the utility corridor. If the engineers designing the new unit find the need for repair or replacement of the water supply system, it is likely that construction activities will be confined to the utility corridor.

Growth of population in the site vicinity has to a great extent been influenced by the existing power plant. The community of Metsamor provides housing for a number of power plant employees (about 60%). The power plant is recognized in the recent Master Plan for Metsamor. The power plant will continue to be an important factor in local planning. Construction of additional housing for construction workers may leave a mark on nearby communities, lasting after construction is completed.

As shown on the sketch of possible placement of structures on the site and on land requirements of construction activities, the site is large enough to accommodate the new unit without encroaching on neighboring lands.

Because the use of the site for nuclear power generation has dominated neighboring land use activities and because various construction activities have occurred on the site during its operating life, the impact of construction of Unit 3 on neighboring land use will be SMALL.

4.1.2 Impacts Resulting from Destruction of Existing Values on the Site

Figure 2.1-4 shows the land to be occupied by new structures. The figure also shows land to be used temporarily for construction activities. New facilities and newly paved areas will occupy as much as 25 ha. An additional 34 ha will be required temporarily for construction support activities.

It was noted in Section 2.5.6 that there are no historic properties within the boundaries of the site. The Ministry of Culture stated that numerous investigations of cultural sites in the vicinity of ANPP raised no concerns regarding potential construction in the area. Construction of the new unit will not prevent access to any historic or cultural site currently accessible.

There will be no impacts resulting from destruction of historic or cultural values on the site.

4.1.3 Offsite Land Use Impacts

The settlement closest to the plant is the town of Metsamor. The closest residence is 3.7 kilometers from the construction zone. The balance of the land surrounding the site is used for agricultural purposes.

There are a number of impacts associated with major construction projects. Construction activities will have the greatest impacts on the workers on the site. Nearby residents will be impacted to a lesser extent. Impacts to visitors to the site area will be even less significant. Any impacts on use of neighboring lands will be temporary and will disappear when construction is completed.

4.1.3.1 AIR QUALITY

Engine emissions and fugitive dust from operation of earth-moving and material-handling equipment are sources of air pollution from construction activities. Operation of other equipment for hauling debris, equipment, and supplies on unpaved roads would produce additional fugitive dust. Motor vehicles entering and leaving the site will add to the emissions.

There may be the need for use of fossil fuels for heating during winter months. Burning of construction wastes may result in additional emissions, although this practice should be discouraged.

Vehicle emissions are not a current air quality issue in the Metsamor area. Construction management practices should be adopted to ensure that vehicles are adequately maintained to minimize emissions. Some degradation of air quality will be a temporary problem for the duration of construction.

Because dust has been acknowledged as an air pollutant of concern at the existing site, dust is likely to be the more significant concern during construction. Good construction management practices should be adopted to minimize dust emissions.

The neighboring land is used for agriculture. The land to the west of the site is not currently irrigated. With exception of the parcel being transferred to the ANPP CJSC as a sanitary buffer, most of the land is in private ownership. At certain times of the year this land may be suitable for grazing of livestock. Construction dust may temporarily disrupt grazing practices.

The land to the east of the site is irrigated for raising cultivated crops. The nearest irrigated land is approximately 3 km from the site boundary. These cultivated lands may be impacted by dust but agricultural practices should be insensitive to noise.

Dust was recognized as an existing air quality issue in Section 2.7. Residents of Metsamor may be impacted by dust during the earlier stages of construction when grading and excavation are occurring.

The impact of dust can be mitigated by prescribing that certain construction practices be used. This can be part of a formal plan to mitigate the impacts of emissions from construction activities. Potential measures others have found effective to mitigate impacts include the following (see References [4.1-2] and [4.1-3]):

- limit the speed of construction equipment on unpaved roads
- remove dirt spilled onto paved roads on the construction site
- cover haul trucks during unloading and loading activities
- cease grading and excavation activities during periods of high wind speeds or extreme air pollution episodes
- phase construction activities to minimize daily emissions
- phase grading to minimize the area of disturbed soils
- perform proper maintenance activities on construction vehicles to minimize emissions
- re-vegetate road medians and slopes in accordance with the site redress plan

The impact of construction activities on air quality in neighboring areas will be SMALL.

4.1.3.2 NOISE

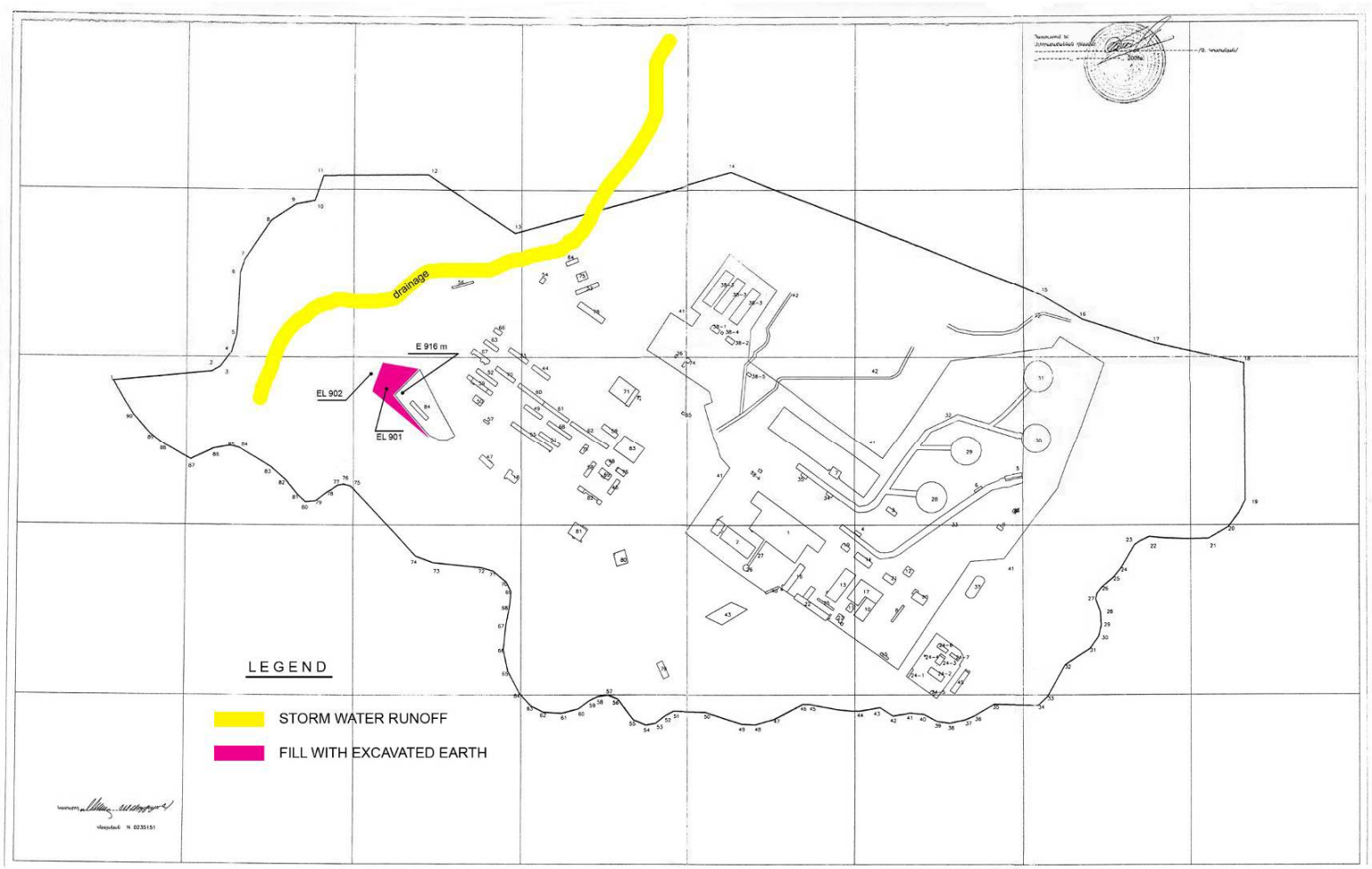
Noise will be noticeable for the duration of the construction. However, it will be greatest during site preparation. Noise from the concrete batch plant will be noticeable for a longer period of time. Section 4.4 looks in detail at the impact of construction noise on nearby residents. The conclusion reached is that the noise levels during construction will result in small to moderate impacts in outdoors at the nearest residence.
Because of the short duration of the construction a moderate impact due to noise should not impact neighboring land use.

Section 2.5.6 identifies a number of historic sites within ten kilometers of the site. At times during the construction of the new unit, visitors to the historic sites nearest the construction area may be aware of construction noise. Because the visits to the historic sites are voluntary, there may be a decrease in visits during construction.

Locations near Taronik where there may be construction or modification of intake and discharge facilities may be most vulnerable to construction impacts. If a decision is made to dredge the settling basin at the second intake location, or if work at the primary cooling water intake location becomes extensive, access to some historic sites may be disrupted temporarily.

The impact of construction noise on neighboring land use will be SMALL.

Figure 4.1-1, Construction impact area



REFERENCES

[4.1-1] Leanne M. Crosbie/ Kerry Kidwell, September 24, 2004, *DOE NP2010 Construction Schedule Evaluation*, MPR-2627, Revision 2, Prepared for the U.S. Department of Energy under contract DE-AT01-020NE23476.

[4.1-2] United States Department of Energy, "*Volume 1, Study of Construction Technologies and Schedules, O&M Staffing and Cost, Decommissioning Costs and Funding Requirements for Advanced Reactor Designs*," May 27, 2004, Prepared by Dominion Energy Inc., Bechtel Power Corporation, TLG, Inc., and MPR Associates under Cooperative Agreement DE-FC07-03ID14492 Contract DE-AT01-020NE23476

[4.1-3] North Anna 3 Combined License Application, Part 3: Applicants' Environmental Report - Combined License Stage, p. 10-7.

4.2 WATER-RELATED IMPACTS

This section describes site preparation activities, plant water supply, hydrological alterations that could result from plant construction activities, and the physical effects of hydrological alterations on other water users. Subsection 4.2.1 addresses hydrologic alterations, Subsection 4.2.2 addresses water-use impacts of plant construction activities and Subsection 4.2.3 addresses impacts to water quality.

Water-related impacts involved in the construction of a nuclear power plant would be similar to impacts that would be associated with any large industrial construction project. At other projects site grading and excavation activities have altered water courses or changed site drainage patterns. Construction activities adjacent to water courses and at intake and discharge structures are known to have the potential to produce hydrological alterations.

Water must be provided to support the plant construction. There must be assurances that adequate water is available and that impacts of providing water during construction are considered.

Changes in the quality of surface and ground water can result from certain construction activities.

During periods when site areas have been exposed by clearing, excavating, and grading, erosion can occur during rain storms. Runoff from the un-vegetated, unpaved construction carries excessive silt and could potentially impact neighboring watercourses. Certain other construction activities produce waste streams that must be treated and disposed of. Use and storage of fuels, lubricants, and chemicals must be done in such a manner as to minimize wastes reaching surface or ground water.

Impacts to water are effectively controlled by the use of good construction practices. A compilation of construction practices is included in reference [4.2-1].

4.2.1 Hydrological Alterations

There are no surface water bodies directly on the site. The southern and eastern boundary of the site is formed by the Hoktemberyan Channel. This channel intercepts site drainage during periods of heavy rainfall. The water follows downhill paths through the Lower Zanga Channel and the Hoktemberyan Channel joining together again just west of Metsamor Town. The flow then proceeds to a point where it enters through the Channel Talish Selav into the Sevjur River. The point where the Channel Talish Selav enters the Sevjur River is about 7 kilometers upstream of the cooling water intake. The Hoktembrian and Lower Zanga Channels have substantial gradients and are likely to be dry except during periods of heavy rainfall.

Excavation, filling, and grading operations at the site can be done without altering the Hoktemberyan Channel. The site was graded for the planned Units 3 and 4 (VVER-440). The terrain at present is no longer level due to remaining mounds of construction debris. A topographic map of the site is not available. Design studies are necessary to

determine whether additional grading of the site will eliminate the passage of stormwater through the construction area or whether a subsurface drain should be installed. This would not affect the location at which drainage leaves the site and will not produce hydrologic alterations beyond the site.

As reported in Section 2.7, precipitation in the vicinity of the site is low. Low precipitation minimizes concerns over silt being carried to surface streams during periods of excavation and grading. Much of the precipitation falling on the site is absorbed into the ground or evaporated, reducing runoff potential.

The groundwater elevation at the site is approximately 64 to 94 m below grade. The basemat for the nuclear island will be at most 22 m below grade. This is the excavation depth for the ACR-700 unit. It is not anticipated that dewatering of foundations will be necessary to construct Unit 3.

Two intake structures and pumping stations were built to serve the ANPP site. Each of these facilities was designed to support operation of four VVER 440 units. The pumping station currently providing water to Unit 2 is located on the Sevjur River approximately 7 km from the site on the pool created by an agriculture diversion dam near the village of Taronik. This station provided water to Units 1 and 2 while both were operating and could have supported the additional two VVER-440 units. Detailed engineering studies may show that some refurbishment of the existing cooling water supply system is required, to ensure reliability. Because the intake structure in place was designed to serve the four unit plant, this refurbishment should be accomplished without hydrological alterations at the intake.

The second cooling and service water supply intake and pumping station is located on a settling pond about one kilometer upstream of the diversion dam. This pond at one time was fed by springs and discharged to the Sevjur River. When an intake pumping station for the plant was built on the pond and put into service, water from the Sevjur also flowed into the pond. It was expected to act as a settling pond. The sediment would settle out to provide clearer water to condenser cooling water system. This station was taken out of service when the pond became overloaded with silt.

Unit 2 discharges into the Kosh-Ujan Storm-Water-Drainage Canal about 7km from the site. The canal discharges into the Sevjur River about 1 kilometer away. When there is no storm-water, most of the flow in the canal is from the Unit 2 discharge. Data were not available on flows in the canal during rainstorms. The discharge flow from the Unit 3 will be approximately two to three times greater than the Unit 2 discharge. Although the capacity of the existing pipeline may be adequate, the discharge should be piped directly to the Sevjur River. If this is done, it will be necessary to build a permanent outfall structure to anchor the discharge pipeline.

Design studies are needed for the water supply and discharge facilities to determine whether the Sevjur River channel will be altered. If so, the resulting impacts must be assessed.

4.2.2 Water-Use Impacts

Water will be necessary for the construction work force and for construction activities. The larger water demands are normally for concrete production and for spraying of roads to control dust. Table 4.2-1 lists typical water requirements for the duration of construction of a large nuclear power plant (Ref. [4.2-2]).

The typical water use averages 145,200 m^3/year for four years. This estimate was based on 280 days of construction per year.

Unit 2 obtains water from 2 sources. The current plant draws about 0.98 m^3/sec or 85,000 m^3/day for cooling water and for other technical water requirements. The construction water requirement is therefore about 0.1% of the unit 2 cooling and service water flow requirement. The capacity of the existing water supply system is adequate to provide water needs for concrete production, dust control, cleanup and other construction activities.

Unit 2 draws water from the Upper Zeiva springs to use for potable water and for producing high purity water for steam generator makeup. The capacity of the pumping system is 300 m^3/hr. The water use by construction workers will be 110 m^3/day during the first year of construction and 330 m^3/day during the remaining construction period. This is a significant demand on the potable water system. This system is not adequate for continued operation of Unit 2 and for the requirements of construction of Unit 3. Section 3.3 of this EBID indicates that the high quality water supply can be supplemented by drilling wells on site. This would have to be done prior to construction.

Because the systems in place for Unit 2 are adequate to provide water for construction needs, and because the Unit 3 construction needs are small in comparison to Unit 2 needs, and because the ANPP has been planning to supplement the Zeiva Springs potable water, there will be no water-use impacts caused by construction activities.

4.2.3 Water-Quality Impacts

Water-quality impacts for the construction activities would be similar to those associated with other large industrial construction projects. During construction there are no sewers available for collection of waste flows. Wastes come from diverse unrelated activities scattered across the construction site. Rather than rely on waste water treatment, good construction practices should be specified to ensure that storm water runoff, discharge from worker support facilities and from accidental spills will have minimal impact on surface water and groundwater quality. Good practices can ensure that other construction processes do not impact surface or ground water quality.

Unit 2 discharges sanitary waste into a waste water system shared with Metsamor and Armavir wastewater treatment system. This system is not functioning and therefore does not provide treatment of wastewater for Unit 2. In the absence of a working treatment system, human wastes are discharged to the Sevjur River untreated. As indicated in EBID Section 4.4, the sanitary treatment plant serving Armavir, Metsamor, and Norapat will rehabilitated (as discussed in the Metsamor Master Plan). The plant will be sized to serve the predicted populations of these communities and renovation will

be completed prior to or early in the construction of Unit 3. The volume of wastewater generated by construction work forces will be about equal to the volume of water required for worker support as shown in Table 4.2-1.

Portable toilets will be provided for construction workers. Waste from the temporary toilets must be discharged into a working treatment system.

Building drains and drainage from paved areas at Unit 2 are carried to the Sevjur River through the same discharge pipe that carries cooling tower blowdown. As areas at Unit 3 are prepared for construction support, additional storm water flow will be generated. Where possible building and storm water drains from paved areas can be discharged along with Unit 2 storm water.

Storm water from unpaved areas should be treated to remove silt before discharging to storm drains or surface water bodies. Treatment may be as simple as a settlement pond or filtration of flow through hay bales.

Drainage from work areas will be collected separately and measures taken to prevent the discharge of oils, lubricants, and other construction chemicals. Provisions to collect oil from vehicle maintenance areas will be included in construction management practices guidelines. Procedures will ensure proper disposal of this oil.

The concrete batch plant will be a major source of wastewater. This will come primarily from washing of concrete trucks. Procedures will be developed to prevent this wastewater from being discharged directly into drains or canals without treatment. Standards for control of impacts of batch plants are given in References [4.2-3] and [4.2-4].

Prior to startup of Unit 3 for testing, it will be necessary to flush all piping systems and certain other plant components. Procedures will be developed to monitor this waste and to determine the proper means of treatment and disposal.

In view of the ability of standard engineering construction practices to limit water quality impacts and the localized and temporary nature of any impacts, water-quality impacts caused by construction activities will be SMALL and further mitigation is not warranted.

Table 4.2-1, Estimated Cubic Meters of Fresh Water by Construction Year Required for Construction of Unit 3[(f)] (Ref. [4.2-3])

Construction Year	1	2	3	4	5	6
People	31,000,[a)]	94,000[(b)]	97,000[(b)]	97,000[(b)]	97,000[(b)]	
Concrete Mixing and Curing[(c)]	8,400	8,400	8,400	8,400	8,400	
Dust Control[(d)]	42,750	42,750	42,750	42,750	42,750	
Sub-Total	82,000	145,000	145,000	145,000	145,000	97,000[(e)]

Notes:

(a) Estimated at 1,000 persons using 110 l/day for 285 days per year.
(b) Estimated at 3,000 persons using 110 l/day for 285 days per year.
(c) Estimated at 5,000 m^3 per month using 140 l/m^3 concrete and 12 months per year.
(d) Estimated at 150,000 l/day for 285 days per year.
(e) Estimated at two-thirds of the amount used in any year 2 through 5.
(f) Water for concrete mixing and for dust control would largely come from the Unit 2 cooling water intake pipeline. Water for people would come from the Upper Zeiva Springs.

REFERENCES

[4.2-1] Atomic Industrial Forum, Inc, February 1974, *General Environmental Guidelines for Evaluating and Reporting the Effects of Nuclear Power Plant Site Preparation, Plant and Transmission Facilities Construction,* AIF/NESP-003.

[4.2-2] Constellation Generation Group, UniStar Nuclear Operating Services, 2007, *Applicant's Environmental Report, Combined License Stage, Calvert Cliffs Nuclear Power Plant Unit 3, Rev 0* p.4.2-18

[4.2-3] State of California, January 2003, *California Best Management Practices for Stormwater,* California BMP Handbook NS-16 Construction - Temporary Batch Plants, available at www.cabmphandbooks.com

[4.2-4] Government of South Australia Environmental Protection Agency, Re-issued September 2003, *Guidelines, Concrete batching*, EPA 427/03.

4.3 ECOLOGICAL IMPACTS

This section describes the potential impacts of construction on the ecological resources of the Unit 3 site and vicinity. Construction of Unit 3 will have a direct ecological impact in terms of environmental values lost when site preparation work begins. Floral species are usually tolerant to all but direct destruction. Most impacts to flora and fauna will occur on site areas specifically cleared and graded for construction. Faunal species can be impacted beyond the work areas. Other construction activities that may impact flora and fauna include mismanagement of chemicals, dust and noise. Imposition of the structures into the natural habitat also poses a hazard to certain species. Other than for the direct loss of habitat, impacts associated with construction are temporary and minor.

4.3.1 Terrestrial Ecosystems

The major impacts of construction to terrestrial ecosystems are due to temporary or permanent alterations or destruction of vegetative cover, loss of habitat, increased erosion, and increased interaction between humans and wildlife.

The 360 ha site controlled by the CJSC “ANPP” is in the semi-desert landscape zone. It is noted in Section 2.2 that 10% of the land in Armenia, or 297,426 ha are in the desert or semi-desert landscape zone. As stated in Section 2.2, 80 to 90 % of the semi-desert landscape zone is cultivated. This means that only about 30,000 to 60,000 ha of uncultivated desert landscape zone remains in Armenia. The land under the control of the CJSC “ANPP” represents about one per cent of the remaining landscape zone type.

The RoA has indicated their intent to give the CJSC “ANPP” control over an additional 289 ha of adjoining property. When this transfer is completed, the CJSC “ANPP” will control about 2% of the remaining desert landscape zone. This addition has been described as a sanitary buffer. A buffer area around the plant is helpful in maintaining plant security. It is also helpful in reducing exposure on neighboring properties. At one time the 289 ha parcel had been identified as being proposed for reforestation. The loss of desert habitat will depend on the planned use of the remainder of the plant site.

With an emphasis on environmental planning, the use of the site for the power plant could serve to preserve most of this large portion of the vanishing desert landscape compensating for the direct unavoidable losses. Limiting disturbance of natural habitat on the site during construction and restoration of disturbed portions after the completion of construction would allow for preservation of some of the semi-desert habitat for the life of the plant.

Fragmentation of the desert and semi-desert habitat may occur as land is developed for irrigation and industrial or residential use. Parcels of the original habitat are left scattered within developed areas. Such fragmentation impedes the migration of wildlife through the zone and hastens the loss of species diversity. Fragmentation extends impacts to wildlife well beyond the plant boundary. ANPP site is in the midst of an area of recognized agricultural potential and future fragmentation may be inevitable. However the placement of Unit 3 on the ANPP site does not result in fragmentation of the desert habitats.

Construction of Unit 3 will require the use of about 59 ha. Permanent structures and paved areas of Units 1 and 2 occupy about 75 ha. The 59 ha to be used for Unit 3 are within the part of the site cleared for construction of Units 3 and 4. Thus it is not pristine. Nevertheless, the loss of these 59 ha will reduce the habitat available to mammals, birds, and other fauna. Good construction practices should be adopted to limit the impacts to the 59 ha area. Construction limits should be well marked and controls should be used to prohibit the movement of vehicles in site areas beyond the construction area boundary.

Approximately 25 ha of the 59 ha affected area will contain permanent structures including paved lots. The remaining 34 ha could be allowed to re-vegetate following construction.

Figure 2.1-4 depicts one possible layout of construction areas on the ANPP property. Most of the area to be used for construction as shown in the figure was cleared and graded during previous construction. The surface soil structure described in Section 2.2 as existing prior to the start of construction of units 3 and 4 was disrupted by grading and construction activities. Construction activities of Units 3 and 4 were abandoned and the site was restored to approximately the original elevations. The description of the geology of the site, or at least the soil structure closer to the surface is no longer applicable. However, new vegetation similar in appearance to the vegetation in the surrounding semi-desert habitat has crept back in to cover the earlier construction areas.

It will be necessary to clear and grade the area for a second time. Removal of the new vegetative layer will be necessary to provide suitable surfaces for construction activities. Because this land was cleared recently and because the 25 ha area to be built over or paved is a small portion of the available habitat type, this impact is small.

The Sevjur River will provide cooling water for the Unit 3. The Sevjur River provides a ribbon of wetland habitat through the desert area. Engineering design for Unit 3 will identify work needed to modify or refurbish the water supply intake and discharge structures. Because the cooling water intake system was designed for a larger project, work at the shoreline of the Sevjur river may not be necessary. If shoreline work is determined, an environmental review of construction plans should be performed to ensure that the wetland habitat is protected from construction impacts.

It is proposed that the discharge point be moved from the Kosh-Uian storm water drainage canal to a location on the Sevjur River. The station design engineers will determine the optimum location. It is expected that this would be close the point where the Kosh-Uian canal enters the Sevjur. Some shoreline work will be necessary to firmly anchor the discharge conduit in place. When the engineering of the outfall is done, an inventory should be made of the flora and fauna at the proposed location. Constructing this new outfall should have a very small impact. However care should be taken to avoid any large stands of important floral species in the selected location.

The work at the intake and discharge sites will be limited in areal extent and damage to ecosystems is not likely. Rather, care must be given to specific important species.

4.3.2 Impacts to Flora

Although ecosystem impacts will be small, destruction of some individuals of several species will occur. A determination must be made of whether these individual losses result in a significant impact. This might occur, for example, if the species is already threatened or endangered or is of particularly high value for other reasons.

Tables 2.4-1 and 2.4-2 characterize the features of the desert and semi-desert habitats that influence the species found there. The tables also list examples of distinctive species found in the two habitat types. In the desert zone, most plants are specific to deserts and relatively rare elsewhere in Armenia. Distinctive vegetation structure and composition in the desert is associated with saline and chalk substrates in the Ararat Valley. The Semi-deserts are often covered by ephemeral plants in spring; xerophytes occur in these habitats (both plants and bushes); flowering vegetation occurs in some lowland sites.

Although the site does not represent pristine desert or semi-desert habitat, it is likely that the distinctive vegetation listed in Tables 2.4-16 and 2.4-17 constitutes a major part of the site vegetation. There are a number of other less abundant species that can be found in desert habitats. As part of the EIA process, an inventory of species present at or near the site should be taken. The analyses below are not based on site specific information.

The transition to steppe habitat occurs to the north of the site. Impacts on flora are not expected to extend much beyond construction areas. Therefore impacts to flora of the steppe landscape are not discussed here.

An inventory of the species at the site will determine whether species of special importance will be destroyed. The Unit 3 site is in the Yerevan floristic district. Thirteen (13) endemic species are found at low elevations in the Yerevan floristic district. Endemic fungi have been reported in desert and steppe zones. The site inventory of species on the land under the control of the CJSC “ANPP” will show whether any endemic species occur.

No relict plant species have been identified in desert landscape zones.

Table 2.4-5 presents a list of protected plant species in the Metsamor community area. Of the fourteen species listed, two may find suitable habitat on or near the site: Bienertia cicloptera Bunge favors salty depressions in the desert, and Ferula persica Willd favors dry slopes of the desert region. Two other protected species may find suitable habitat along the Sevjur: Acorus Calamus L. is a wetland species, and Linum seljukorum Davis is found in salt marshes of the Ararat Valley. The habitat preferences of the other species make it unlikely that they would be found at the site.

Of the species of potential medicinal value, Artemisia and Rhamnus are likely to be found on the site. These two species are listed as examples of distinctive species found in the desert habitats. The site inventory will establish whether other species of potential medicinal value are present.

Construction activities at the intake and discharge locations will take place in the wetland adjacent to the Sevjur River. The species composition in wetland habitats is more diverse and varies with the location and physical characteristics of each particular wetland. As noted in Section 2.4, the Sevjur wetland provides habitat for a number of unique biota. At least two protected species may be found in the Sevjur wetlands. The inventory of flora along the Sevjur can be limited to the Intake and discharge locations.

Once site clearing and grading activities begin, fugitive dust will be carried beyond the construction area boundary and will be deposited on vegetation in the neighboring area. The rate of dust deposition will decrease with distance from the construction boundary. Airborne dust is known to occur often in the site vicinity. It is not likely that the increase in dust emissions will affect native flora. Dust may be of concern if it should be carried into the cultivated areas. Good construction management practices should be used to control dust at the construction site.

4.3.3 Impacts to Fauna

Some destruction of faunal habit will occur. Because of the previous construction activities the habitat that will be lost in constructing Unit 3 may not be typical of desert faunal habitat. Ecosystem impacts will be small. Destruction of some individuals of several species will occur. A determination must be made of whether these individual losses are a significant impact.

An inventory of faunal species at the site has not been made. Section 2.4 present information on species likely to be found on or near the site. Tables 2.4-1 and 2.4-2 list examples of distinctive species found in the two habitat types. The species listed as distinctive to the desert habitat are insects, and are classified as invertebrates. None is endemic to Armenia and none is currently listed as endangered.

Table 2.4-2 includes 42 species finding habitat in the Semi-desert region. Among the 12 invertebrates listed are seven species endemic to Armenia. This includes 5 insects, a gastropod and a mollusk. None of the 23 vertebrates is endemic. The list includes a toad and a frog species. Lizards, skinks, snakes, and a tortoise are included in the 18 reptilians.

The Metsamor planning report identified shrews, hamsters, voles and a fox species among the most common wild animals known to the area. A site inventory, when taken, may identify other less common species at the site. Over 50 avian species have been recorded in semi-desert habitat.

Table 2.4-5 lists 15 protected species of fauna known in the vicinity of the town. The four bat species (*R. eurales, R. mehelyi, M. natteri, M. schrieibersi*) are not expected at the site because of the absence of typical cave habitat. The Armenian Mountain Viper (*V. raddei Boettger*) is known on the southern slope of Mt. Aragats but is not likely in the semi-desert. The site inventory will determine whether there is suitable habitat for the hedgehog (*E. auritas Gmelin*) or the Marbled polecat (*V. peergusna peregusna Guld*). Five of the seven avian species are likely to be found close to the Sevjur and Araks rivers but not likely to be found feeding or nesting near the Unit 3 construction area. The short toed eagle (*C. golllicus collicus Gmelin*) and the Red footed falcon (*F. vespertinus*

vespertinus) may be occasional visitors to the site but the absence of trees makes it likely that they are not permanent residents.

The heavy equipment used in clearing, grubbing, and grading may result in the incidental killing of some smaller, less mobile fauna such as the, shrews, voles, and hamsters. The burrowing vertebrates are especially vulnerable to construction activity. Densities of burrowing species at the Unit 3 site are unknown. Burrowing animals are mobile and it is expected that those that can will flee construction areas. Avoidance behavior of fauna in areas surrounding construction sites partially offsets the risk of wildlife colliding with equipment or vehicles. Nevertheless, there will be some mortality to the burrowing animals in the cleared and graded area. These species are not limited to the disturbed area but are common to the broad desert zone. The limited area of disturbance should limit affects to populations of the burrowing species.

Larger, more mobile fauna will voluntarily move quickly to adjoining terrestrial habitats. Because population density in the construction area is expected to be low, it is very unlikely that migration from the construction area will increase populations in adjoining areas to the point where it exceeds the carrying capacity of those habitats.

Studies by the US Federal Highway Administration have shown that wildlife typically avoids roadways where activity and noise increase (Ref. [4.3-1]). However, construction machinery and personal vehicles occasionally collide with wildlife on construction sites, or while traveling to and from these sites. Wildlife species that are particularly vulnerable to collisions with vehicles are the inconspicuous, slow-moving, or nocturnal species such as polecats, turtles, snakes, amphibians, and birds. To reduce collision occurrences vehicles should be confined to roadways and authorized areas.

4.3.3.1 IMPACTS OF COOLING TOWERS ON AVIAN SPECIES

The cooling tower, other smaller structures, vehicles, and transmission towers and lines present the potential for bird collisions. The reasons for the bird collisions are not well understood and attempts to prevent the collisions have not met with success. One study of a large cooling tower built in a bird migration pathway found that the collisions were not random but large numbers of collisions occurred in a few events during the year (Ref. [4.3-2]). The study continued for a number of years. A later report on the same study indicated that the majority of the impacts were songbirds rather than migratory waterfowl (Ref. [4.3-3]).

The U.S. Nuclear Regulatory Commission did a review of published studies of avian mortality resulting from collisions with transmission lines and other man-made objects (Ref. [4.3-4]). NRC was concerned whether collision mortality is large enough to cause long-term reductions in bird populations. NRC found that existing literature suggests that total collision mortality (cumulative impacts) associated with all types of man-made objects is not reducing bird populations significantly.

The NRC also reviewed monitoring studies conducted at six nuclear plants and found that local bird populations are apparently not being significantly affected by collision with cooling towers. Waterfowl and other birds that are commonly present as permanent or summer residents around nuclear plants do not frequently collide with the towers.

Instead, a very high percentage of the collision mortalities occur during the spring and fall bird migration periods and involve primarily birds migrating at night. They determined that overall avian mortality is low (Ref. [4.3-5]).

It is concluded that the impact of the cooling towers and other on site structures is SMALL.

Transmission line impacts, including the potential impact of bird losses along transmission lines are discussed in Section 5.6.

4.3.3.2 IMPACT OF NOISE

Noise is expected to displace mobile species beyond the actual construction area. Levels of noise expected are reported in Section 4.4. It has been noted above that mobile species will leave the site area because of construction noise.

A literature review in 1971 summarized existing studies of the effects of noise on domestic and wild animals (Ref. [4.3-6]). The literature at that time was primarily laboratory studies where animals were subjected to noise levels well in excess of noise levels to be expected outside of the Unit 3 construction area. Studies of domestic farm animals pastured near airports showed that responses to noise appeared to be temporary and no long term impacts on productivity could be seen. The studies did serve to provide a better understanding of the various physiological mechanisms by which species are impacted by noise.

A follow up study in 1980 reviewed literature published since 1971. The study found that the research to date was not sufficient to allow quantitative criteria to be proposed (Ref. [4.3-7]).

A 1996 literature review of research into the impact of noise generated by military activities was also unable to define criteria for protection of domestic animals and wildlife (Ref. [4.3-8]). The review found that noise from human activities can affect wildlife by inducing physiological changes, nest or habitat abandonment, and behavioral modifications, or it may disrupt communications required for breeding or defense. The summary noted that the research includes a preponderance of small, disconnected, anecdotal or correlational studies as opposed to coherent programs of controlled experiments. Comparability among studies is complicated by terms lacking generally-accepted definitions (e.g. “disturbance”) and by species differences.

The US Department of Transportation, Federal Highway Administration, did the most recent literature review (Ref. [4.3-9]). They reported that small birds showed behavior changes as much as 3000 m from noise sources. Small mammals showed no similar changes.

Noise levels will diminish with distance from the source of the noise. Damaging noise levels will not extend far beyond the boundaries of the Unit 3 construction area. Section 4.4 notes that noise levels will generally be below 65 decibels at the site boundary. Noise above this value will be temporary. No damage to wildlife should occur at these

levels. The only expected effect beyond the site boundary may be the abundance of the small birds.

Construction of Unit 3 would be adjacent to the existing operating Unit 2. Noise measurements for Unit 2 are not available. However, noise levels at operating nuclear plants are in the range of 50-60 decibels. The assemblage of fauna at the site may already be influenced by noise. Species occupying the site may represent those tolerant of noise or those that have become accustomed to typical existing operating facility.

Construction noise will occur over most of the construction period. Levels should return to existing levels when construction is completed. Although noise-related impacts during construction will be small, good construction practices should include measures to minimize noise. Such measures would include sound barriers around especially loud stationary equipment such as the batch plant. Good construction practices should also include measures to ensure that mufflers on transient equipment are properly maintained.

Because construction noise will be temporary will be temporary and because species will move back in when construction ends, the impact of noise will be SMALL.

4.3.4 Aquatic Ecosystems

There are no surface water bodies within the Unit 3 construction area. The intake and discharge areas are about 7 km from the site. With the use of best management practices to control potential release of chemicals, fuels and lubricants, construction on the site should not impact aquatic ecosystems at that distance. However the final engineering design may show that construction modifications are required for either the intake or discharge.

The intake and discharge structures are located about 7 km away on the Sevjur River. The detailed design and construction plans will determine the work at this river areas. Although construction at the intake and discharge will impact a very small area, the Sevjur River is bordered by a ribbon of wetland. The species composition in wetland habitats is more diverse and varies with the location and physical characteristics of each particular wetland. As noted in 2.4 the Sevjur wetland provides habitat for a number of unique biota, including both flora and fauna.

The major impact of the construction will be clearing of a small area and then temporary increases in the silt content of the river. The intake is in a pool created by an irrigation diversion dam. Pools are not abundant along the river. If the detailed engineering design indicates extensive work is required at the intake structure, then an inventory of aquatic species in that location should be conducted. An assessment of impact can be made based on species present and on construction design. A significant impact might occur if major portions of important habitat type would be eliminated. Important habitat for fisheries might be areas of emergent aquatic vegetation which provide spawning or nursery areas for certain fish species.

Usual shoreline construction impacts also include temporary increases in silt content of the river and siltation of silt downstream from the construction location. Turbidity of the

Sevjur River is typically high. It is not likely that the temporary increases in turbidity will be significant.

Construction impacts on aquatic ecosystems will be SMALL.

REFERENCES:

[4.3-1] U.S. Department of Transportation, *Synthesis of Noise Effects on Wildlife Populations*, FHWA-HEP-06-016, September 2004.

[4.3-2] Edward J. Rybak, William B. Jackson, and Stephen H. Vessey, 1973, *Impact Of Cooling Towers On Bird Migration*, Department of Biology, Bowling Green State University, Bowling Green, Ohio 43403, Internet Center for Wildlife Damage Management, Bird Control Seminars Proceedings, University of Nebraska – Lincoln, p. 188. This paper is posted at DigitalCommons@University of Nebraska – Lincoln, http://digitalcommons.unl.edu/icwdmbirdcontrol/120

[4.3-3] Manfred Temme and William B. Jackson, 1979, *Cooling Towers As Obstacles In Bird Migrations*, Bowling Green State University, Bowling Green State University, Internet Center for Wildlife Damage Management, Bird Control Seminars Proceedings, University of Nebraska – Lincoln. This paper is posted at DigitalCommons@University of Nebraska – Lincoln, http://digitalcommons.unl.edu/icwdmbirdcontrol/16

[4.3-4] USNRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Vol. 1**,** Final Report, Section 4.5.6.2.

[4.3-5] USNRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Vol. 1**,** Final Report, Section 4.3.5.2.

[4.3-6] Memphis State University, December 31, 1971, *Effects Of Noise On Wildlife And Other Animals*, CONTRACT 68-04-0024 for the U.S. Environmental Protection Agency Office of Noise Abatement and Control, Washington DC 20460, p 46.

[4.3-7] Patrlcla A. Dufour, July 1980**,** *Effects of Noise on Wildlife and Other Animals Review of Research since1971*, Informatics, Inc., 801 Executive Blvd. Rockville, MD 20852 for the US Environmental Protection Agency, Washington, DC, Report No. 550/9-80-100, p 71.

[4.3-8] Larkin, R. P. 1996. Effects of Military Noise on Wildlife: A Literature Review. USACERL Technical Report 96/21. U.S. Army Construction Engineering

Research Lab. Champaign, Illinois. http://nhsbig.inhs.uiuc.edu/bioacoustics/noise_and_wildlife.txt

[4.3-9] US Department of Transportation, Federal Highway Administratioin, September 2004, *Synthesis of Noise Effects on Wildlife Populations*, Publication No. FHWA-HEP-06-016.

4.4 SOCIOECONOMIC IMPACTS OF CONSTRUCTION

Subsection 4.4.1 describes physical impacts of station construction on the community. Subsection 4.4.2 describes the social and economic impacts of station construction on the surrounding region. Subsection 4.4.3 describes environmental justice impacts as a result of site construction.

A description of the ANPP site, vicinity, and region, and surrounding community characteristics is provided in Sections 2.1, 2.2, and 2.5. Chapter 3 describes the proposed facility including its external appearance.

The ANPP site is designated land of special importance and dedicated to the production of electricity. No changes are required to zoning or land use in order for Unit 3 to be constructed.

All construction activities would occur within the ANPP site boundary as described in Section 2.2, except for extension of the plant discharge pipe to the Sevjur River. Offsite areas that would support construction activities (such as borrow pits, quarries, and construction debris disposal sites) would already be permitted and operational. Therefore, impacts on those facilities from constructing new units would be small incremental impacts associated with their normal operation.

Section 2.1 defines the *Station Region* as the area within 50 km of the station. In Section 4.4, socio-economic impacts are anticipated to be the greatest, and primarily contained, within Armavir marz and Yerevan City; therefore for the purposes of this section, the area within Armavir marz and Yerevan City is defined as the *region of influence*.

4.4.1 Physical Impacts

Construction activities can cause temporary and localized physical impacts such as noise, odors, vehicle exhaust, and dust. This section addresses potential construction impacts that may affect people, buildings, roads, and aesthetics.

4.4.1.1 WORKERS AND THE LOCAL PUBLIC

Detailed descriptions of the ANPP site, vicinity, and region are provided in Sections 2.1 and 2.2 of this EBID. The site is largely developed, with construction support buildings in place from past activities. Within the boundaries of the existing site, new construction and rehabilitation of existing support buildings is necessary.

Beyond the immediate site boundary, the area is primarily rural, bound by undeveloped reforestation land, agricultural land, and desert landscape. The towns of Metsamor and Armavir are nearby, as are a number of villages. As shown in Table 2.5-1, the 2006 population for the area within 16 km is 204,245. Population distribution details are given in subsection 2.5.1.

For the purposes of this analysis, construction is assumed to begin in 2010, with the peak phase of construction targeted for three years later, in 2013. (Such a schedule is necessary to have an operational generation resource to replace ANPP Unit 2 prior to its scheduled shutdown in 2016.) As shown in Table 2.5-2, the low (pessimistic) projection of population for these communities in 2013 is 198,937. The estimated on-site construction workforce during the peak construction is 2500 to 3000, and then diminishes until completion of the construction phase in 2015.

People who work at or live near the ANPP site will be subject to physical impacts resulting from construction activities. Onsite construction workers will be impacted the most, with workers at the existing adjacent operating unit subject to slightly reduced, yet similar impacts. People living or working near the site will be impacted significantly less due to site access controls and distance from the construction site where most activities will occur. Transient populations (tourists and recreationists) will be impacted the least for similar reasons and the limited exposure to any impacts of construction.

Construction workers within the site boundary experience the most physical impact due to plant construction activities. Workers have training and personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care is available at the construction site, and regular health and safety monitoring is conducted during construction. These activities are performed in compliance with regulations of the RoA, and site-specific permit conditions. Reasonable efforts are made to ensure that transient populations are aware of the potential impacts of construction activities.

A settlement identified by the State Committee of the Real Estate Cadastre as the Collective Gardening Society of State Farm Maisyan, population approximately 150 people, is located near the western boundary of the site with its nearest residence approximately 3,000 m from the construction area. This settlement also contains garden plots and dachas owned primarily by personnel who work at the site and live in Metsamor town.

Aknalich village is located 4 km to the south of the site, across Highway M-5, and the town of Metsamor is located 4.6 km southwest of the site, spanning across Highway M-5. Potential impacts and mitigation measures on aesthetics, noise and air quality in these two communities are addressed in Subsections 4.4.1.2, 4.4.1.3, 4.4.1.4, 4.4.1.5 and 4.4.1.6, below.

As discussed in Section 3.7, one new transmission line is required to support concurrent operation of Units 2 and 3. The routing and design details of the transmission corridor have yet to be determined (Ref. [4.4-1]), so impact assessment is not possible at this time. The new 400 kV line to Hrazdan Thermal Power Plant will likely parallel the 110 kV line to the Argel Hydroelectric Station as it leaves the ANPP switchyard. In the vicinity of ANPP, the new line will also parallel the 220 kV Shaumyan-2 transmission line. {The Developer should include an assessment of transmission line construction impacts to support the final environmental assessment.}

4.4.1.2 BUILDINGS

Construction activities are not anticipated to affect any off-site buildings, primarily due to distance. The nearest residence is outside of the site boundary. The nearest business, a window and door manufacturing enterprise, is approximately 4 km from the site on the western plant access road. In the event that pile driving is necessary, the building(s) most vulnerable to shock and vibration are those associated with the plant and located within the ANPP site.

The closest commercial enterprises are in Metsamor town. Significant industrial and commercial facilities located within the vicinity of the ANPP site are located in Armavir town.

As illustrated in Figure 2.5-7, the nearest historic and culturally significant sites are in and near Taronik village, approximately 7 km from the site. Extension of the plant discharge pipe and upgrade of raw water pumping facilities (see Subsection 3.4.2) will occur in this area, but are not expected to disturb the cultural sites.

Construction activity to extend the plant discharge pipe to the bank of the Sevjur River should be no greater impact on local buildings than the use of equipment to periodically dredge the Kosh-Ujan storm water drainage canal that currently carries plant discharge water to the river.

4.4.1.3 TRANSPORTATION

Transportation is described in Section 2.5. No public transportation routes are located within the site boundary. Existing and new roads will be constructed inside the ANPP site. Physical impacts due to site road construction will be limited to plant construction workers. The eastern plant access road may be upgraded to facilitate delivery of equipment, but since this will use an existing right-of-way passing through agricultural land, impacts are expected to be minimal.

A railroad spur enters the site on its western boundary, extends across the south half of the site, and ends near Units 1 and 2. Upgrading this existing rail spur and/or extension of a spur within the site boundaries into the construction support area may necessary to support equipment delivery. No reconstruction of the rail line spur is expected outside the site boundary, but in the event such upgrading is necessary, since the rail line makes use of a pre-existing right-of-way, construction impacts are expected to be minimal.

Plant construction at the ANPP site increases traffic on local roads. Traffic access to the site is described in Subsection 2.5.2. {Since traffic patterns will change in the two or more years before start of construction, traffic flow studies have not been done in the area to support this EBID. A traffic flow study should be performed by the Developer to support the final environmental assessment and allow quantification of the impacts and support decision making regarding mitigation measures for increased traffic in the area.} Both construction workers and truck deliveries access the site via Republican Highway M-5 and one of two site access roads: the eastern access road from M-5, passing through uninhabited agricultural land; and the western access road from M-5, passing

through Metsamor town. Some workers and equipment will be transported over the rail spur from Armavir, as is the case with many of the existing ANPP staff.

During the peak construction period, two staggered shifts of 10 hours each are scheduled, with a combined workforce of 2,500 to 3,500 (mean value of 3,000). A conservative estimate of 100 daily truck deliveries is assumed for this analysis with all deliveries occurring during daytime hours. It is assumed that most workers will arrive by train or van. This analysis assumes all construction workers arrive by van or bus, with an average of six (6) persons per vehicle. The total number of vehicles, including deliveries, on the access road during the peak construction period is projected at 600 during the workday. Since many, if not most, construction workers will arrive by train, this value is conservative.

Impacts to transportation from construction workers and deliveries are considered a temporary SMALL to MODERATE impact during the peak construction period. Potential mitigation measures include: establishing a centralized parking area away from the site and shuttling construction workers to the site; encouraging use of train transport from Armavir and Metsamor; staggering work starting times; installing traffic control lighting and directional signage at the intersection of the access roads with Highway M-5; and routing most traffic over the eastern access road rather than through Metsamor town.

4.4.1.4 AESTHETICS

There are no parks or recreation areas nearer to the site than those in Metsamor town, over 3.5 km away. Large equipment and structures, such as construction cranes, the containment structure, and the cooling tower, will be clearly visible from Highway M-5 and nearby villages to the east and south of the site (villages Aknalich, Arshaluys, Haytagh, Ferik, and Tsaghkalanj). The site is also clearly visible from Nor Yedesia to the north of the site. Except for the natural draft cooling tower, which will be approximately 170 m tall[1], all structures will be less visible than the existing four cooling towers, which are 110 m in height.

Figures [3.1-6, -7, -8, and -9] illustrate the visual impact of the new structures, including a natural draft cooling tower.

Residents of the region are generally supportive of ANPP and many residents work or have family members who work at ANPP. The existing facility is looked upon as a beneficial influence in the region and construction of a new unit is welcomed. Based on existing structures and the topographic layout of the vicinity, the impact of construction at the ANPP site on aesthetics is considered to be SMALL and requires no mitigation efforts.

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[1] See Table 3.2A-1, Section 2.5.8.

Should opposition to the construction be raised on the grounds of aesthetics, the condenser cooling water could use mechanical draft cooling towers, which at 18 m high[2] would be smaller and less visible than major structures of the existing Units 2 and 3 and other new structures of Unit 3.

4.4.1.5 NOISE

{Since construction will not start for two or more years, ambient noise levels at and around the ANPP site were not measured during the preparation of the EBID. Nor has a detailed field survey been conducted to identify all specific receptors in the vicinity. Such surveys should be conducted by the Developer to support a more thorough analysis of noise impacts when the final environmental assessment is prepared.}

Nevertheless, the potential impacts of noise from ANPP site construction have been analyzed by projecting noise levels at the site and vicinity from various construction-related sources. Projected levels are compared to RoA and USNRC noise level guidelines. The results of these comparisons are then used to determine the magnitude of noise impacts at identified receptors.

The RoA Ministry of Health (MoH) has established noise impact limits for non-constant noise in residential areas based on equivalent sound levels ($L_{a\ eq}$) and maximal sound levels ($L_{a\ max}$). Ref. [4.4-2]

The most limiting values are those for wards in sanatoriums and hospitals given as:

- $L_{a\ eq}$ = 35 dBA and $L_{a\ max}$ = 50 dBA between 0600 and 2200;
- $L_{a\ eq}$ = 25 dBA and $L_{a\ max}$ = 40 dBA between 2200 and 0600.

The values for rooms in flats, residential areas, etc. are set as:

- $L_{a\ eq}$ = 40 dBA and $L_{a\ max}$ = 55 dBA between 0600 and 2200;
- $L_{a\ eq}$ = 30 dBA and $L_{a\ max}$ = 45 dBA between 2200 and 0600.

As can be seen from these values, the sound level limits have a 10 dB penalty between the hours of 2200 and 0600. For the purpose of this EBID, noise impacts are assessed using the $L_{a\ max}$ of 50 – 55 dBA as the level below which noise levels would be considered generally acceptable for residential and outdoor recreational uses; however maximum expected noise levels are also assessed against the limiting values indicated above. Using the Ministry of Health Order № 138 limits, noise levels below 50 – 55 dBA will be considered to be of SMALL significance (hereafter, referred to as “MoH Order 138 guideline levels”). These values are 10 dBA lower than those accepted by the U.S. NRC as noise levels of small significance (60 – 65 dBA – hereafter referred to as “acceptable levels”), which this analysis will consider a MODERATE impact. Ref. [4.4-3]

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[2] See Plant Parameter Envelope, Table 3.2A-1, Section 2.4.8.

Typical construction noise is generated by internal combustion engines (front end loaders, tractors, scrapers/graders, heavy trucks, cranes, concrete pumps, generators, etc.), impact equipment (pneumatic equipment, jack hammers, pile drivers, etc.) and other equipment such as vibrators and saws. The amount of impact construction noise has on the surrounding environment depends on numerous factors including sound intensity, frequency, duration, location on site, the number of noise sources, time of day, weather conditions, wind direction, time of year, etc.

Nuisance noise can be caused by the operation of heavy equipment, particularly vehicle and machine backup-alarms. Equipment noise can also be categorized as being either continuous or impulse in nature. Stationary equipment is considered to operate in one location for one or more days at a time; pumps, generators, compressors, screens, are typical examples of stationary equipment. In addition, pile drivers and pavement breakers are sometimes categorized as stationary equipment. Mobile equipment includes machinery that performs cyclic processes such as: bulldozers, scrapers, loaders, and haul trucks. The equipment type, age of equipment, specific model, equipment condition and the operation performed influence equipment noise.

Noise levels as generated by typical equipment are given in Table 4.4-1 using equipment noise levels from Ref. [4.4-4]. In some cases, the noise levels from equipment in use in Armenia may exceed those given in Table 4.4-1, which were typical in the US a number of years ago. Table 4.4-1 also provides the results calculations of attenuated noise levels at various distances from the equipment. {The Constructor for ANPP Unit 3 should survey noise levels from construction equipment to be used, compare with those in Table 4.4-1, and prepare mitigation plans where noise levels could exceed the guidelines of MoH Order 138.}

Attenuated noise levels given in Table 4.4-1 are considered maximum noise levels for single pieces of equipment. Construction equipment generally do not operate at maximum levels continuously, therefore actual noise levels are expected to be less than those predicted at the fence line. Utilization of modern equipment, mufflers, hydraulic systems, etc. should reduce these noise levels further. For the majority of the construction activities, noise levels would be considered to be comparable to or below the MoH Order 138 guideline levels of 50 – 55 dBA. As indicated by colored text in Table 4.4-1, the only equipment causing levels at the nearest residence in excess of these levels is bulldozer. All calculated noise levels at structures off site are below the 60 – 65 dBA acceptable levels. {It is recognized that the noise levels will increase with multiple pieces of equipment operating at the same time. For example, a bulldozer creates a noise level of 54 dB at 4,000 m, but if two bulldozers are working in tandem, the noise level would be approximately 57 dB. This should be evaluated further by the Constructor when performing the noise surveys of Armenian construction equipment.}

Those construction activities that generate noise above 60 – 65 dBA levels at the site boundary would be temporary. Generally, most construction activities would occur during normal daylight hours between 0800 and 1800. There are occasions when construction activities must be scheduled during night time hours. Typical instances include continuous concrete pours to ensure homogeneity and strength of the structures. At these times the noise level remains upwards of 60 – 90 dB at a distance of 100 ft. from the equipment, but should be attenuated to below the acceptable 65 dBA at the site

boundary, depending on the location of the continuous pour. The level at the nearest residence should be attenuated to below the MoH Order 138 guideline level of 50 dBA.

The nearest residences are located less than 100 m from the western site border (but more than 2.5 km from the area where construction will occur). Construction noise would be attenuated with distance by natural insulators (ground cover, earthen berms, grass, etc.). If construction activities occur within 120 m of the western site border or noise levels become excessive, the nearby residences could be temporarily impacted by construction noise above the acceptable and MoH Order 138 guideline levels (60 – 65 dBA and 50 – 55 dBA, respectively). Altering terrain during construction activities in this location could increase or decrease impact offsite noise levels. Common practices to mitigate noise include, but are not limited to: noise reduction devices on heavy equipment (mufflers), limiting driving speeds, restricting use of engine brakes[3], prohibiting tail-gate slamming, constructing earthen berms, placement of foliage, ground cover, etc. between the noise sources and receptors.

Based upon the projected noise levels at various site and local vicinity buildings and the duration of construction activities, noise impacts from the ANPP site construction are expected to be SMALL for the surrounding communities, and SMALL to MODERATE for the nearest residents.

The MoH Order 138 also specifies limits for constant noise in specific octave bands which may be lower than the guideline levels discussed above. As noted above, if stationary equipment is operating over a period of days, the noise is considered constant noise. The construction organization will compare noise levels from stationary equipment, such as concrete batch plants, water pumps, etc. against these MoH limits and take mitigating actions if sound levels could exceed MoH Order 138 limits.

Metsamor town is the closest major population center near the site (centered 4.6 km from the reactor location – see Section 2.5) with the nearest residential structures at a distance of 3.9 km from the construction zone. The Master Plan of Metsamor Town assesses noise levels in Metsamor. Ref. [4.4-5] The Plan identifies noise sources for the town as the Yerevan-Armavir highway (M-5), local streets, and industries in the industrial district of the town. Noise level in the streets of the town is 57 dBA (and 63 dBA in the industrial zone), where the standard applied by the plan is 70 dBA. Noise levels in hospital areas are equal to or less than the standard of 35 dBA. From

Table 4.4-1, it can be seen that the noise level standard for streets will not be exceeded in Metsamor. If a noise level reduction of 10 dBA for green areas is applied (see Table 4.3.5-1 and 6.8-1 of Ref. [4.4-5]), the standard of 35 dBA for hospital zones is met for all but one piece of construction equipment (bulldozer). (A limit of 35 dBA is also specified by MoH Order 138 for wards inside hospitals, Ref. [4.4-6].) Since, at the location of the

[3] An engine brake (sometimes called “Jake brake” or “Jacobs brake”) is a braking system, used primarily on semi-trucks or other large vehicles, that modifies engine valve operation to use engine compression to slow the vehicle.

hospital, terrain and other structures obstruct the view of the site, construction noise from all equipment will be reduced and in all likelihood will meet the noise standard for hospital zones. {A more complete survey and assessment of noise abatement features of the local terrain should be completed by the Constructor to determine if additional measures, such as earthen berms, should be employed near the construction site.}

Construction activity to upgrade the raw water supplies and to extend the plant discharge pipe to the bank of the Sevjur River should be no greater noise impact on local residences than that of equipment used to periodically dredge the Kosh-Ujan storm water drainage canal that currently carries plant discharge water to the river.

4.4.1.5.1 Traffic Noise due to Construction

Noise related to traffic along the access road to the ANPP site and the connecting Republican Highway M-5 was considered. Construction work force traffic, and especially the delivery of heavy equipment, is a temporarily imposed noise impact to receptors along the access road between M-5 and the ANPP entrance. Noise impacts along M-5 increases only slightly because the highway is currently utilized by tractor trailers, machinery transports, automobiles, etc.; however, the tractor trailer and machinery traffic on M-5 may increase significantly as a result of the construction. {A survey of traffic on M-5 and resulting noise levels should be conducted by the Developer to support the final environmental assessment of the impacts of traffic noise due to construction.}

Traffic noise levels along the access roads will increase during construction. Much of the traffic during the construction period will be at the beginning and end of the work shift. Peak hour traffic will result in an increase in traffic noise levels along the access road from about 51 dBA at 30 m to about 58 dBA. Traffic noise during the peak hours could be noticeable at nearby residences. Heavy truck traffic would be the most bothersome and could approach levels of 70 to 90 dBA at 15 m from the road. Peak traffic noise during construction is expected to have a SMALL impact along the eastern access road because there are no residences along that road, and off-peak traffic would have a SMALL impact to surrounding communities. Peak traffic noise along the western access road could be MODERATE, due to the fact that this road passes through the town of Metsamor, past nearby residences and businesses. Noise mitigation measures include, but are not limited to: routing construction traffic on the eastern access road (through un-populated areas) and restricting traffic on the western access road (through Metsamor); enforcing low speed limits; maintaining good road conditions; minimizing engine-braking; maintaining equipment with noise reduction devices (mufflers); and controlling the time of day the peak traffic would occur.

Construction activity to renovate and upgrade raw water pumping facilities and to extend the plant discharge pipe to the bank of the Sevjur River will involve a slight but transitory increase in traffic noise on the roads in the area of Taronik village.

4.4.1.6 AIR QUALITY

Temporary and minor impacts to local ambient air quality could occur as a result of normal construction activities. In the vicinity, those impacted could include the settlement identified by the State Committee of the Real Estate Cadastre as Collective Gardening

Society of State Farm Maisyan, which is located immediately west of the site (see Section 2.2). Fugitive[4] dust and fine particulate matter emissions are generated during earth-moving and material-handling activities. Construction equipment and off-site vehicles used for hauling debris, equipment, and supplies also produce emissions. The pollutants of primary concern include fugitive dust, reactive organic gases, oxides of nitrogen, carbon monoxide, and, to a lesser extent, sulfur dioxides. Variables affecting construction emissions (e.g., type of construction vehicles, timing and phasing of construction activities, and haul routes) cannot be accurately determined until the project is initiated. Actual construction-related emissions cannot be effectively quantified before the project begins. General estimates are available and the impacts on air quality can be minimized by compliance with RoA regulations that govern construction activities and emissions from construction vehicles.

Required construction permits, obtained from the Republican and local government agencies, are expected to be in place prior to the commencement of construction. Air pollutant control measures, which may include limits for noted pollutants, will be part of the controls prescribed in these permits (see Subsection 1.2.3).

While emissions from construction activities and equipment are unavoidable, a mitigation plan minimizes impacts to local ambient air quality and the nuisance impacts to the public in proximity to the project, particularly the residents living in Metsamor town. The mitigation plan includes, at a minimum:

- Phased construction to minimize daily emissions; and
- Proper maintenance of construction vehicles to maximize efficiency and minimize emissions.

Specific mitigation measures to control fugitive dust are identified in a dust control plan, or similar document, prepared by the constructor prior to project construction. These mitigation measures could include any or all of the following:

- Stabilizing construction roads and spoil piles;
- Limiting speeds on unpaved construction roads;
- Watering unpaved construction roads and grading and excavation areas to control dust;
- Performing housekeeping (e.g., remove dirt spilled onto paved roads);
- Covering hauling trucks when loaded or unloaded;
- Minimizing material handling (e.g., drop heights, double-handling);
- Ceasing grading and excavation activities during high winds and during extreme air pollution episodes;

[4] In this usage, “fugitive” means transient or temporary, lasting only a short time.

- Phasing grading to minimize the area of disturbed soils; and
- Using temporary or permanent vegetative road medians and slopes.

Impacts to air quality from construction are considered to be SMALL and do not warrant mitigation beyond these measures.

4.4.2 Social and Economic Impacts

This subsection evaluates the demographic, economic, infrastructure, and community impacts to the vicinity and region as a result of constructing a single new nuclear unit at the ANPP site. The evaluation assesses impacts of construction related activities and of an in-migrating construction workforce on population, regional labor, tax revenues, infrastructure and community services, housing, education and recreational activities within the vicinity and region. As discussed in the introduction to Section 4.4, all social and economic impacts are assumed to take place in the *region of influence*, which is taken to be the area of Armavir marz and Yerevan City.

A challenge for the Republic of Armenia in dealing with the social and economic impacts of construction of the new unit is to use this opportunity to: 1) prepare the region for the impacts of resources needed to decommission ANPP Units 1 and 2; 2) improve the standard of living in the *region of influence*; and 3) improve the living conditions (standards of housing, community cleanliness, and sanitary conditions) for the residents of the area in a such a way that they become positive examples for improvements in other regions of Armenia.

Since the Ministry of Energy/IAEA study of resources is not yet completed, in order to evaluate the social and economic impacts of construction, certain basic assumptions must be made regarding the construction workforce and ANPP Unit 3 staff. {The Developer should compare the results of the MoE/IAEA resource study and expected residences planned for relocating workers with these assumptions and determine if predictions must be revised for the final environmental assessment.}

Assumptions for this analysis are as follows:

- The ANPP Unit 3 staff at the peak construction period will number between 200 and 300 (see Table 2.5-4) and consist of personnel transferred from the Unit 2 staff and new staff from within Armenia;
- ANPP Unit 3 staff will reside in locations consistent with the residences of the existing ANPP staff (see Subsection 2.5.1 and Table 2.5-4);
- The peak construction workforce in 2013 will number between 2500 and 3500 (see Tables 2.5-4 and 4.4-2);
- The construction workforce will reside:
    - 60 % in Armavir town;
    - 20 % in Metsamor town;
    - 20 % in Yerevan.

- Of the construction craft labor and craft supervisors, 50 % will be Armenian citizens, half of which already reside in the region with their families;
- 90 % of the site indirect labor, quality control inspectors, and state inspectors will be Armenian citizens already residing in the region with their families, the remaining 10 % are Armenians relocating to the region with their families;
- The NSSS vendor and contractor staff will be 100 % from outside Armenia;
- The EPC contractor staff and startup personnel will be 80 % from outside Armenia, the remaining being Armenian citizens already residing in the region;
- Of the foreign workers and Armenians from outside the region, 80% will relocate temporarily without their families, living in dormitories or communal apartments (consistent with statistics for Sizewell B construction – Ref. [4.4-7] – and the predictions for Loviisa-3 - Ref. [4.4-8]);
- For those relocating to dormitories or communal apartments, there will be an average of four persons per living unit;
- For those workers relocating with their families, the family size will average 4 persons, 20% of which (0.8 persons) will be school-age (based on statistics in Ref. [4.4-9]).

The values in Table 2.5-4 assume that ANPP Unit 3 will require 120% of the personnel indicated in US DOE Report NP2010 (Ref. [4.4-10]). Table 4.4-2 and Figure 4.4-1 illustrate the affect on total number of workers of varying the multiple from 120% (the Table 2.5-4 value) to 200%. This results in a range of peak construction workforce from 2,880 to 4,800. The smaller number is comparable to that predicted for construction of Loviisa-3 in Finland (Ref. [4.4-8]) and new units at the Grand Gulf ESP site in the U.S. (Ref. [4.4-11]). The larger number is comparable to the peak workforce for construction of Sizewell B in the U.K. (Ref. [4.4-7]). Current nuclear power plant projects are based on improved construction techniques, such as modular construction, intended to reduce construction costs and schedules, making the Sizewell B a somewhat outdated example for assessing workforce impacts. For the balance of this analysis, it will be assumed that the construction workforce for ANPP Unit 3 will be between 120% and 150% of the values in NP2010.

4.4.2.1 DEMOGRAPHIC IMPACTS

Population estimates and projections for the region are discussed in Subsection 2.5.1. Industry and unemployment data are discussed Subsection 2.5.2.

During the peak construction, there is an on-site construction workforce of 2,880 to 3,600 (including 2,616 to 3,270 construction workers, plus engineering, and management, etc.). The estimated temporal distribution of workers is illustrated in Figure 4.4-2 (normalized to a peak workforce of 3000 people). This distribution assumes a 60-month construction schedule (Ref. [4.4-12]) and 12 month startup phase during which the number of construction trades onsite steadily decreases and are replaced by startup personnel and permanent plant operating staff.

Some of the different trade skills represented in the labor pool include electrical workers, welders, pipe fitters, etc. Many of these highly skilled workers will likely come from outside Armenia. The rest will come from skilled tradesmen working in other industries of Armenia or from Armenian training programs. The Ministry of Energy of Armenia (MoE) is currently conducting a study with IAEA regarding manpower and training needs to support construction and operation of a new ANPP unit. {The final environmental report for ANPP Unit 3 should reflect the results of that study.}

The construction workforce would approximately double the number of people involved in construction within Armavir marz in 2005 (see Table 2.5-15). If the construction labor pool is considered to be Armavir marz and Yerevan city, the construction workforce for ANPP Unit 3 would be less than 15% of the population employed in that sector in 2005. Given the large amount of building construction taking place in Yerevan, construction at ANPP could create stress on the construction labor market, especially in skilled trades such as concrete and steel workers, electrical workers, and construction equipment operators. The degree of stress on the labor market will be better assessed following completion of the MoE/IAEA study mentioned above.

The assumptions regarding percentage of foreign workers and Armenian workers who relocate to the site vicinity are listed above. The family size of workers is consistent with that indicated for Armenians in Ref. [4.4-9]. Since workers relocating their families are likely to be older and without school-aged children (primarily foreign workers) or newly trained, young workers without school-aged children, the assumptions for family size and number of school children are considered to be conservative.

Table 4.4-3 gives the calculated numbers of new residents and new students in the *region of influence* as a result of relocating workers. The table also includes a calculation of percentage increase in population, based on the community populations in 2013 as given in Table 2.5-7, and percentage increase in number of general education students, based on the number of students in these communities in 2006 as shown in Table 2.5-18.

If 60% of relocating workers reside in Armavir town, this would result in a population increase of 9% to 11%, an increase of 7% to 9% in the number of students, and would require 730 to 910 housing units. If 20% of relocating workers reside in Metsamor town, this would result in a 10% to 12% increase in population, a 10% to 12% increase in number of students, and would require 240 to 300 housing units. Based on the school capacities listed in Table 2.5-18, both Armavir and Metsamor schools have adequate capacity for the additional students. Based on housing statistics in Table 2.5-16, the required number of housing units represents from 9% to 12% of available housing stock in both Armavir and Metsamor towns. Based on the given assumptions, impacts on Armavir and Metsamor are considered MODERATE. The Metsamor Master Plan states that the maximum possible population of Metsamor is 15,000 (Ref. [4.4-13]); the predicted population in Metsamor (see Table 2.5-3), with addition of relocating construction workers and families (see Table 4.4-3) will not exceed that value.

If 20% of the relocating workers reside in Yerevan, it will represent less than a 0.2% increase in students, a 0.11% population increase, and require 240 to 300 housing units.

The required housing represents 0.10% to 0.12% of the housing stock available in Yerevan. Using the given assumptions, the impacts on Yerevan are SMALL.

The workforce for ANPP discussed above must be compared with the results of the MoE/IAEA study. Should the peak workforce be as high as 200% of the NP2010 numbers, and the assumptions regarding relocating workers remain valid, the stress on Armavir and Metsamor would be even greater, with town and school populations increasing as much as 16% and requiring over 1600 housing units. If all relocating workers reside in Yerevan, however, the approximately 8,000 new residents would represent an increase on the order of 1%, but this would represent a greater impact on transportation than would housing in Armavir or Metsamor from where the workers could be transported by train.

{A survey of vacant housing stock in Armavir and Metsamor towns should be conducted by the Developer to support the final environmental assessment.} If this survey indicates that insufficient housing is available in those communities, or it is desired to reduce the impacts on these communities, relocating workers should be encouraged to locate in Yerevan, as the stress on housing and schools will be substantially less. Incentives such as subsidized rents and provided transportation can be used to encourage workers to reside in Yerevan.

The most efficient solution to the housing of temporarily relocating workers may be for the Government of Armenia or the project Developer to build or procure a structure in Armavir or Metsamor to serve as a dormitory or hostel such as was done to support construction of Sizewell B in the United Kingdom (Ref. [4.4-7]). Such a development later could be converted into a hotel, residential flats, or accommodation for workers for decommissioning of ANPP Units 1 and 2. Arrangements for housing of workers should be started as early as possible after the decision to build a new unit.

4.4.2.2 ECONOMIC IMPACTS

The economy of the ANPP station's *region of influence*, including industries and employment, is described in Subsection 2.5.2.

The construction of a new power plant is a significant project locally and regionally; it will affect the business activities and employment in the region in many ways. The capital costs of the new plant are estimated to be approximately USD 2.3B (Ref. [4.4-14]) to USD 6.3B (Euro 4B - Ref. [4.4-15] @ 1.57 USD/EUR). Using a value of USD 4.3B and an assumption of 40% for the Armenian domestic share of economic investment (see Ref. [4.4-15]), this means USD 1.7B will be added to the Armenian economy over the five year construction period, or an average of USD 0.34B per year. The National Statistical Service of Armenia reports a GDP of USD 6.4B in 2006 (Ref. [4.4-16]); this indicates that the new ANPP unit would contribute approximately 5% to the GDP of Armenia. This represents a <u>beneficial</u> impact on Armenia's economy, which would extend beyond the *region of influence* to other portions of Armenia.

4.4.2.2.1 Direct Employment

The construction workforce levels illustrated in Figure 4.4-2 result in approximately 10,000 man-years of direct labor over the six-year construction and startup period, which compares favorably with the estimate for construction of Loviisa-3 in Finland (Ref. [4.4-17]). Construction labor during the peak year of construction (months 13 through 16), amounts to approximately 2.8 thousand person-years. From Table 2.5-15, the annual employment in the construction industry in *region of influence* during 2005 was 21.1 thousand persons. The ANPP Unit 3 peak annual construction labor represents a 12% increase over the 2005 construction employment. This is a moderate beneficial impact on construction employment in the region.

Little detail was collected for this EBID regarding the heavy construction industry in Armenia beyond that available from the National Statistical Service. Table 2.5-14 provides some indication of the location of construction industry resources – the number of businesses involved in construction. The vast majority of the construction firms (1,225 of 2,090 in marzes of the 50 km zone) are located in Yerevan. It is expected that the majority of the local (Armenian) construction management will come from existing heavy construction firms in Yerevan.

The state construction organization responsible for construction of ANPP Units 1 and 2 and for significant construction projects at the site was privatized in 2004 as Closed Joint Stock Company HAEK-i SHINARARUTIUN and is headquartered in Yerevan. The Director of this company was interviewed as part of the MoE-IAEA manpower study scheduled for completion in December 2008 and by authors of this EBID. The company has approximately 200 employees who are employed in construction of hydro-power, thermal power, industrial and civil construction. An adequate number of construction engineers should be available in Armenia because local universities graduate about 400 new engineers each year and past graduates have gained experience through extensive new construction in Armenia. Ref. [4.4-18]

Armenia has a low number of skilled laborers at present, with critical needs in the areas of welding, electrical installation, and mechanical installation. At the time ANPP Units 1 and 2 were constructed, technical training institutions existed throughout the Soviet Union to train personnel for such highly skilled construction jobs. Since the breakup of the Soviet Union and Armenian independence, such training institutions in Armenia have been shutdown. Training of Armenian workers must now be done by on-the-job training of young workers by older, more experienced workers. Specialized training programs are needed to prepare the Armenian construction workforce to support construction of Unit 3. Ref. [4.4-18]

Without a source of trained construction labor, a large percentage may have to be imported from outside Armenia; thus, the above stated assumption that 50% of the construction labor comes from outside the country. If a larger percentage of the construction workforce is foreign workers, the housing and economic impacts will be greater than those discussed in this section of the EBID.

To the extent that skilled workers from elsewhere in Armenia relocate permanently in the *region of influence*, or that existing residents take advantage of opportunities for training

to become skilled workers, the overall level of employment, wages, and standards of living will be improved – resulting in a beneficial impact on the *region*. Ref. [4.4-19] reports the beneficial impact of establishing local recruitment and training centers in the vicinity of nuclear plant construction; such centers should be established in Metsamor and Armavir towns and Yerevan City.

Because Armenia has a single nuclear station and has no mobile workforce to support plant outages, it must keep a relatively large number on staff year round; thus the ANPP operating staff is much larger than NPPs in other locations (see Table 2.5-4). A portion of the more than 1,700 people on the ANPP staff may be available to support construction of Unit 3, especially if they have critical skills. In evaluating demographic impacts of construction, however, no credit is taken for potential transfer of personnel from the ANPP Unit 2 operating staff to the construction organizations. Such transfer would reduce the demographic impacts from those predicted above in Subsection 4.4.1.

4.4.2.2.2 Indirect Employment

Presence of the construction workforce will result in indirect employment to provide services and support to the construction workers. The Loviisa-3 EIA assumes 560 indirect workers for each 1,000 construction workers (Ref. [4.4-17]). The Environmental Report for Bellefonte Nuclear Plant Units 3 and 4 in the U.S. uses a figure of 423 indirect jobs per 1,000 construction workers migrating to the area (Ref. [4.4-20]). Comparing the total number of construction workers to the number of relocating workers in Table 4.4-3, we calculate that 65% of the construction workforce will be relocating to the region. Using a ratio of indirect to direct employment for ANPP Unit 3 of 500 indirect jobs per 1,000 relocating workers predicts another 3,300 man-years of indirect labor in the region. Assuming this employment is in the sectors of transport and communications and trade in the *region of influence*, this would be approximately 4% employment increase over the employment in those sectors in 2005 (as shown in Table 2.5-15) – a small to moderate beneficial impact. If, however, the majority of this new employment is concentrated in Armavir marz, it could mean as much as a 30% increase in employment in those sectors. Table 2.5-15 reports 3,900 unemployed persons in Armavir marz during 2005, indicating that a majority of the unemployed in the marz could find employment as a result of the relocating workers – a large beneficial impact. (It is possible that some people filling this employment need may relocate from other regions of Armenia, placing additional stress on housing and social services of Armavir marz.)

4.4.2.2.3 Taxes

Taxation is discussed in Subsection 2.5.4.2. Property and land taxes for the ANPP site are paid into the local budget of Metsamor Town. Enterprise profit and value added taxes go into the state budget of Armenia.

The actual monetary value of revenues generated by construction of Unit 3 cannot be precisely estimated because the type of reactor has not been selected and the portion of required labor and materials to come from within Armenia are unknown. The specific methods of determining taxes owed were not determined during preparation of this EBID; therefore, no calculation of tax revenues is provided. It is also unknown what tax incentives might be offered by the Government to encourage participation of Armenian

and foreign enterprises in the construction of Unit 3. Although the taxes cannot be quantified at this time, the impact of increased business volumes and property values should be beneficial to the site vicinity and to the Government of Armenia.

Since construction of Unit 3 will substantially increase the asset value of the site and its structures, property and land taxes paid into the budget of Metsamor Town should also increase substantially and provide a beneficial impact to the town. The Metsamor Master Plan (ref. [4.4-21]) reflects plans for improvement of existing housing, development of additional residential areas, and for improvement of utilities and other infrastructure within the town. This opportunity may be offset to a small degree by needs to increase police and social services in the town to serve the workforce relocating to Metsamor from other regions of Armenia.

Enterprise profit and value added taxes of the enterprises directly involved in construction and material supply will increase revenue flowing into the state budget of Armenia. In addition, taxes paid by enterprises and individuals indirectly involved in support of the construction workforce will further increase state revenues during the construction period. Although the tax revenues are not quantified, it is clear that there will be a beneficial impact on the state budget. The beneficial impact of increased tax revenues will be partially offset by the necessary increase in Government of Armenia employment to provide for licensing and inspection of the new unit during construction.

4.4.2.2.4 Cost of Housing

The influx of construction workers from outside the *region of influence* is likely to result in an increase in cost of rented flats and houses. Since a survey of vacant housing has not been conducted, the degree of this increase cannot be predicted. The pressure for increases in housing can be mitigated if the Government of Armenia or the project developer provides housing for the temporarily relocating construction workers, as discussed above.

4.4.2.3 IMPACT ON SOCIAL SERVICES AND GOVERNANCE

The increases in population due to the construction workforce will have an impact on social services and governance in the *region of influence*.

4.4.2.3.1 Police and Traffic Control Services

Major construction projects can lead to an increase in levels of crime and other behavioral problems in the host locality (Ref. [4.4-22]). The police forces in Metsamor and Armavir will have increased stress due to the influx of workers from outside the region and the country. Ref. [4.4-22] reports a significant increase in arrests for drink-driving and drunkenness in the construction zone and that the construction workforce was the source of the bulk of the increase. By the time of peak employment at the site, however, arrests for these offences had decreased, in large part because of the following mitigation measures, which should be considered by the project developer for ANPP Unit 3:

- site induction procedures for all new employees, which stressed the need for employees to be sensitive to the local community – these procedures included involvement from the local police;
- a free shuttle minibus service operated in the evenings between the site hostel and the local town center;
- provision of attractive facilities on site, such as the site hostel bar, reducing the need for residents to travel to town in the evening;
- regular monitoring of behavior by developers' staff in town during the evenings, especially around the town's pubs; and
- police targeting of certain offences during the course of the construction program including speeding and drink-driving.

Establishment of traffic signals and signage at the intersections of Highway M-5 with the eastern and western access roads will improve traffic control and reduce highway speeds; thereby mitigating the need for the authorities to respond to traffic violations and accidents. This will also mitigate the impacts of traffic noise on the town of Metsamor and villages in the vicinity of the stretch of M-5 near these intersections.

4.4.2.3.2 Potable and Fire Water Supplies and Sanitary Waste Treatment

Water supplies and sanitation in the station region (50 km zone) are discussed in Subsection 2.5.2.4, with statistics in Table 2.5-19. Potable water supply to ANPP and Metsamor are discussed in Subsection 3.3.1.4, and further in this section. Sanitary waste water treatment for the ANPP site, the towns of Metsamor and Armavir and village of Norapat are discussed in Subsection 3.6.2 and further in this section.

<u>Potable and Fire Water Supplies for Metsamor</u>

Potable water supplies for Unit 3 are addressed in Subsection 3.3.1.4. As indicated in that subsection, the Unit 2 Safety Analysis Report (SAR) describes the existing water source, referred to as the household and drinking water supply and coming from Upper Zieva Springs, as also supplying Metsamor town. The water is fed to two onsite tanks of capacity 1,000 m^3 each by pumps of capacity 250-360 m^3/h. Ref. [4.4-23]

The Metsamor Master Plan describes the potable water supply to Metsamor town as coming from a single well with capacity of 120 m^3/h using water pumps with capacities of 250 m^3/h, pumping into a basin of daily regulation of capacity 2x250 m^3. Ref. [4.4-24]

A recent clarification from ANPP indicates that the ANPP household and drinking water system no longer supplies Metsamor. Ref. [4.4-25]

The water supply for Metsamor also is used as the source for fire fighting water and guidelines for supplies of fire fighting water indicate that the capacity of the basin of daily regulation should be increased and water supply pipelines should be through two independent piping systems in order to serve a population of 10 to 25 thousand. In addition, the Plan recommends a second well be drilled and more than a single drinking

water supply system be provided. Ref. [4.4-26] As discussed above, the increase in tax revenues may allow Metsamor Town to implement such infrastructure projects. If a substantial amount of new housing is constructed in Metsamor to accommodate the construction workforce (such as the hostel suggested in Subsection 4.4.2.1), then these infrastructure improvements should be implemented as a part of that construction.

Sanitary Waste Water Treatment for Armavir and Metsamor Towns and Norapat Village

As discussed in Subsection 3.6.2, the original waste water plant for ANPP also served Metsamor and Armavir Towns and Norapat village. To meet sanitary needs of the Unit 3 operating staff and the staff of Units 1 and 2, Subsection 3.6.2 commits to completing construction of a new waste water treatment plant for the site. The waste water treatment plant originally intended to serve ANPP, Armavir, Metsamor, and Norapat should be rehabilitated to serve the communities.

The Metsamor Master Plan (Ref. [4.4-27]) indicates that design task orders are needed for:

- design of a sewage and water supply systems for those areas where deficiencies exist and to serve any new residential areas;
- rehabilitation of the deteriorated or damaged sewage pipes and wells; and
- design of a waste water treatment plant for the proposed sewage system.

Accommodation of the relocating construction workers, as reflected in Table 4.4-3, will result in MODERATE impact due to additional sanitary waste from the communities in the plant vicinity. In light of the fact that sanitary wastes from the ANPP, Metsamor and Armavir Towns and Norapat Village are currently untreated, the rehabilitated waste water treatment plant discussed above should be sized to serve the predicted populations of these communities. Rehabilitation of the treatment plant should be completed prior to or early in the construction phase for Unit 3.

4.4.2.3.3 Hospitals and Medical Services

First aid and first responder emergency medical treatment will be provided onsite during construction; however extended treatment for any injuries and illnesses among the relocating population will be done at hospitals and medical clinics in the *region of influence*.

Healthcare institutions are discussed in Subsection 2.5.2.3. According to Table 2.5-16, there were nearly 18,000 doctors and paramedical personnel and over 8,000 hospital beds in the *region of influence* in 2005. According to Table 2.5-18, Armavir marz, and the towns of Armavir and Metsamor in particular, have excess hospital capacity, with hospital bed occupancy at less than 40%. Yerevan City's average occupancy of hospital beds in 2006 was less than 60%. Sufficient capacity appears to exist within the *region of influence* and the impacts of the relocating construction workforce on hospitals and medical facilities will be SMALL.

4.4.2.3.4 Local Governance

The political structure of Armenia is described in Subsection 2.5.4.1. Local administration of services and infrastructure will be the responsibility of the mayors of the urban centers (Armavir, Metsamor, Vagharshapat, and Yerevan) and the community heads for rural villages. Approval of construction and development plans for construction of Unit 3 will involve the leaders of local communities, the provincial governor (Marzepet) of Armavir marz, and the mayor of Yerevan.

Evidenced by the recent publication of the Master Plan for Metsamor Community (Ref. [4.4-21]), Metsamor town is setting the pace for community development planning. Such a master plan for Armavir Town would be helpful in defining impacts on that community.

As discussed above, the town of Metsamor and the Government of Armenia will benefit from tax revenues as a result of construction of Unit 3. The Government of Armenia should consider a program of revenue sharing to support the increased burden on governing authorities of Armavir Marz, Armavir town, and Yerevan city. In any case, the impact on these governing authorities is expected to be SMALL.

4.4.2.4 IMPACT ON RECREATION

Recreational facilities are discussed briefly in Subsection 2.5.6.4. There are no recreation areas that will be impacted by the construction activities. Spas and resorts elsewhere in Armenia will likely have increased customers due to the influx of foreign workers and improved salaries of the construction workforce. The impact on recreational facilities will be SMALL.

4.4.3 Environmental Justice Impacts

Subsection 2.5.1.3 describes the demographics of the Republic of Armenia in the site region (50 km zone). Table 2.5-10 provides the income, poverty, and education demographics data for each marz within 50 km of the site. Figure 4.4-3 illustrates the relative distribution of population in the *region of influence* and in urban and rural areas of the entire Republic of Armenia (RoA).

Demographics of Turkish territory within the 50 km zone, except for population estimates, are not discussed herein, as such data were generally not available to the authors of the EBID and no impacts of construction are anticipated within the territory of Turkey.)

4.4.3.1 IMPACTS ON LOW INCOME POPULATION

As seen in Table 2.5-10 and Figure 4.4-3, a majority of the population in Armavir marz falls into the lower two quintiles of income. This could be taken as an indication that the construction will take place in an area of predominately low income. As can be seen by the RoA-wide statistics reflected in Figure 4.4-3, the relative income distribution in Armavir marz is similar to that for rural areas of the RoA. This is not surprising, since 64% of the population in Armavir marz resided outside of the three defined urban areas of Armavir, Metsamor, and Vagharshapat (data available in Table 2.5-5). Since all three

of these towns fall within 16 km of the site, if income statistics were compiled on a community-by-community basis, the income level distribution of the 16 km zone most likely would be similar to that for the RoA-wide distribution in urban areas and that the income levels would exceed those of the balance of Armavir marz. This is especially the case since most of the ANPP workers (82%) live within the 16 km zone.

As shown in Figure 4.4-3, rural areas tend to have lower income populations. The predominant land use in rural areas around the site is agriculture (see Section 2.2). The agricultural land around the site could be impacted by re-designation of agricultural land for the purposes of construction or by diversion of irrigation water for construction. No changes in land use are needed for construction of Unit 3 and the amount of water used during construction (see Section 4.2) will be small relative to that being used by the operating Unit 2. The impacts of construction noise and traffic noise in the agricultural areas around the site will generally be greater than in residential areas, but are expected to be transitory and of moderate to small significance, as discussed above. Even though rural populations tend to be engaged in agriculture, they live primarily in established villages and will not be impacted significantly from the construction and traffic noise that may be of greater impact in the fields surrounding the site.

The impacts of construction are not expected to fall disproportionately on low income population in the *region of influence* and no measure for mitigation, beyond those identified in Subsections 4.4.1 through 4.4.2, are necessary.

4.4.3.2 IMPACTS ON ETHNIC MINORITY POPULATION

Ethnic groupings in Armenia and in the 50 km zone are discussed in Subsection 2.5.1.4. As discussed in that Subsection and shown in Figure 2.5-5, it appears that there is a concentration of the Kurdish ethno-linguistic group in southwestern Armavir marz, near the Araks River, which most likely consists of peoples identified in the Armenian census as Yezed. Since this population is remote from the ANPP site, and outside the 16 km zone, the impacts of construction on this ethnic minority are expected to be minimal and not disproportionate and no mitigating measures are needed.

Table 4.4-1, Attenuated Noise Levels (dBA) Expected From Construction Equipment

Type of Noise Generating Equipment	Distance from Source (in m)					
	15[a]	100	400[b]	3,000[c]	4,000[d]	4,600[e]
Heavy Trucks	89	73	61	43	41	39
Dump Trucks	88	72	60	42	40	38
Concrete Mixer	85	69	57	39	37	35
Jack Hammer	88	72	60	42	40	38
Scraper	89	73	61	43	41	39
Bulldozer	102	86	**74**	**56**	54	52
Generator	76	60	48	30	28	26
Crane	88	72	60	42	40	38
Loader	86	70	58	40	38	36
Grader	91	75	63	45	43	41
Dragline	85	69	57	39	37	35
Pile Driver	95	79	**67**	49	47	45
Fork Lift	95	79	**67**	49	47	45

[a] Maximum Noise levels (dBA) at 15.24 m (50 ft) (Ref. [4.4-4]).

[b] Approximate minimum distance from construction area to site boundary.

[c] 3,000 m is the approximate minimum distance from the potential major construction activities and the nearest residence.

[d] 4,000 m is the approximate distance to the nearest business.

[e] 4,600 m is the approximate distance to the center of Metsamor town and the hotel and hospital there.

Values in BLUE exceed lower acceptable range level of 60 dBA, in **BOLD BLUE** exceed the maximum acceptable range level of 65 dBA.

Values in RED exceed the lower MoH Order 138 guideline range level of 50 dBA, in **BOLD RED** exceed the maximum of the range level of 55 dBA.

Noise attenuation calculation:
Noise level change (dBA) = 20 log (d_1/ d_2) where d_1 is the original distance from the source and d_2 is the measured distance from the source.

Table 4.4-2, Potential Range of Values for Peak Construction Workforce

Factor over NP2010 [a]		Residences			
	Total	Armavir	Metsamor	Yerevan	Other
120%	2,880	1,608	668	572	32
150%	3,600	2,010	835	714	41
180%	4,320	2,412	1,002	857	49
200%	4,800	2,680	1,113	953	54

Table 4.4-3, Relocated Workers and Families

Factor over NP2010[a]	New Residents / Students			
	Total	Armavir	Metsamor	Yerevan
120%	4,856	2,912	972	972
	799	479	160	160
150%	6,068	3,640	1,214	1,214
	999	599	200	200
	Housing Units Required / % of Available Stock			
120%	1,215	729	243	243
	0.47%	9.3%	10%	0.10%
150%	1,519	911	304	304
	0.59%	12%	12%	0.12%
	Relocated Construction Workers			
120%	1,860	1,116	372	372
150%	2,326	1,396	465	465
		Percent Increase		
120%	2013 pop.	9.1%	9.6%	0.09%
	2006 students	7.4%	10%	0.12%
150%	2013 pop.	11%	12%	0.11%
	2006 students	9.3%	12%	0.15%

[a] Ref. [4.4-10]

Figure 4.4-1, Potential Range of Peak Construction Force Size

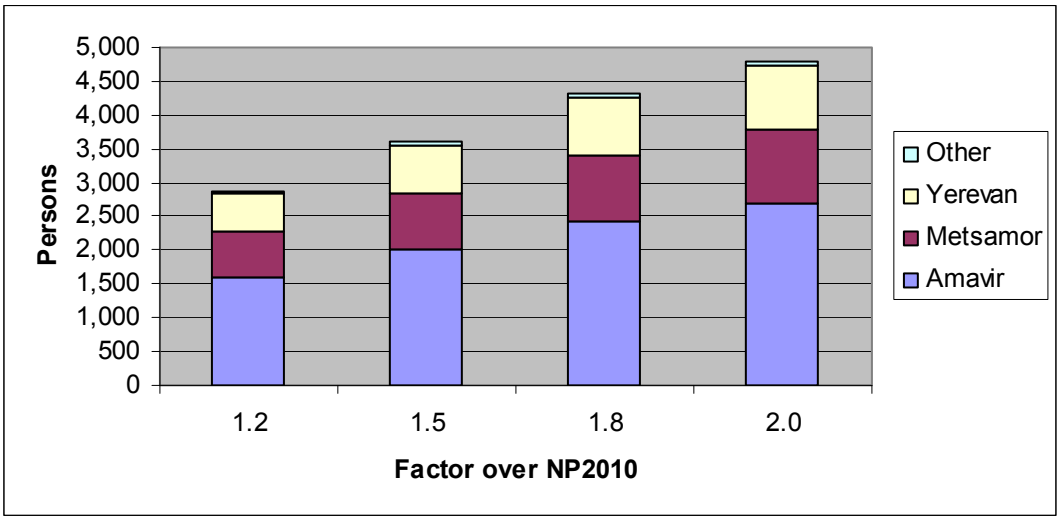


Figure 4.4-2, Construction Workforce by Quarter

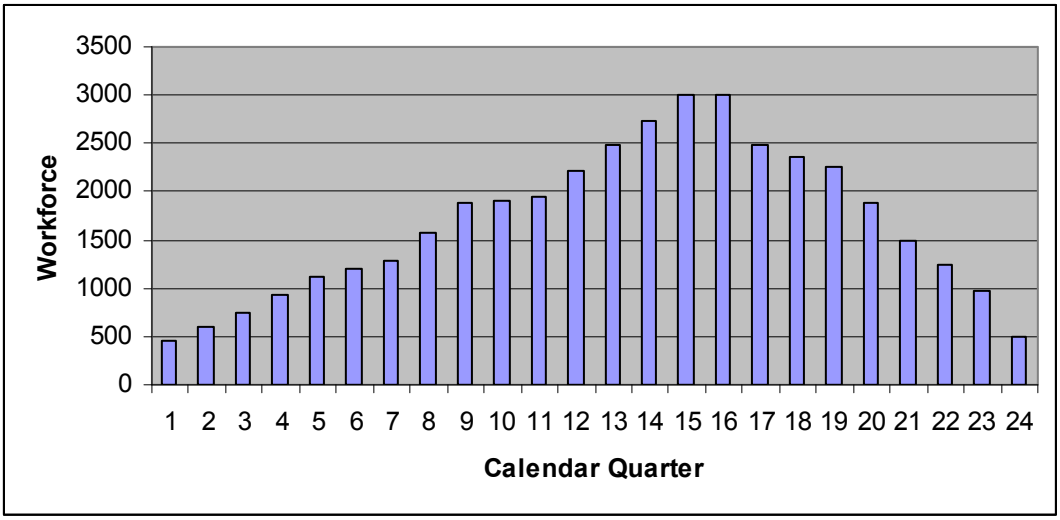
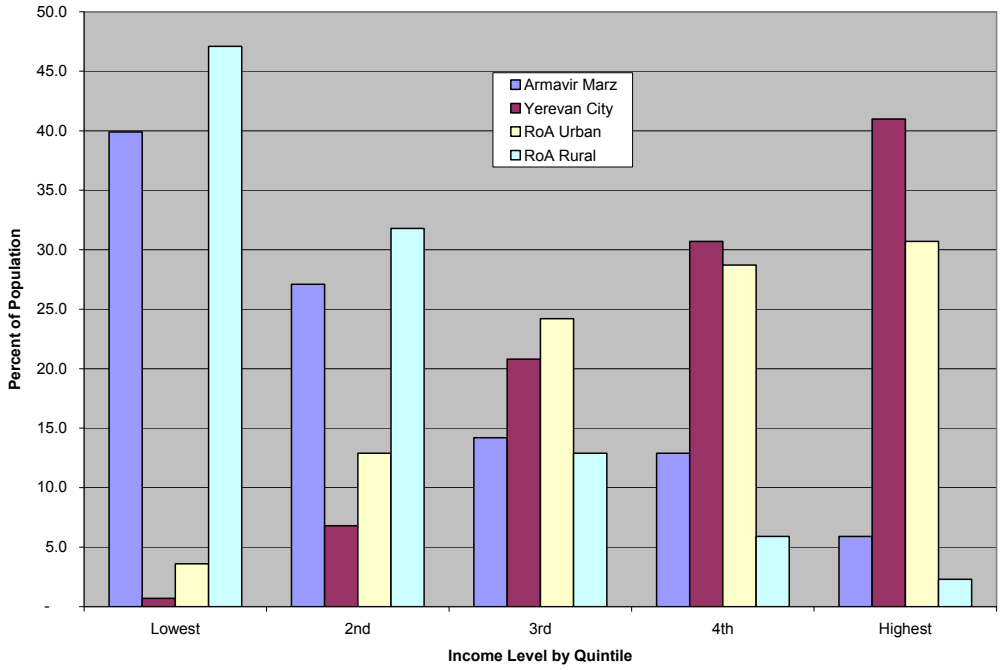


Figure 4.4-3, Income Levels



REFERENCES:

[4.4-1] Interview with Energy Network Design Institute, CJSC, 9 April 2008.

[4.4-2] RoA Ministry of Health Order № 138, 6 March 2002, "Sanitary Standards N 2 III-11.3 for Noise at Work Place, in Residential and Public Buildings and Residential Construction Sites"

[4.4-3] U.S. Nuclear Regulatory Commission, 1996, *Generic Environmental Impact for License Renewal of Nuclear Plants*, NUREG-1437, Vol. 1 and Vol. 2.

[4.4-4] Tennessee Valley Authority, 2007, *Bellefonte Nuclear Plant, Units 3 & 4, COL Application, Part 3, Environmental Report*, Table 4.4-1.

[4.4-5] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Sections 4.3.5 and 6.8.

[4.4-6] RoA Ministry of Health Order № 138, 6 March 2002, *Sanitary Standards N 2 III-11.3 for Noise at Work Place, in Residential and Public Buildings and Residential Construction Sites*, Table 3.

[4.4-7] Glasson, 2005, "Better Monitoring for Better Impact Management: the Local Socio-economic Impacts of Constructing Sizewell B Nuclear Power Station", *Impact Assessment and Project Appraisal*, volume 23, number 3, September 2005, pages 215–226, Beech Tree Publishing, 10 Watford Close, Guildford, Surrey GU1 2EP, UK

[4.4-8] Fortum Power and Heat Oy, 2008, *Supplementing the Loviisa Nuclear Power Plant with a Third Plant Unit – Environmental Impact Assessment Report*, Section 8.3.1 (see URL: http://www.fortum.com/gallery/Loviisa/englanti.pdf, accessed 6 April 2008).

[4.4-9] National Statistical Service of Armenia, 2007, *Social Snapshot and Poverty in Armenia, Statistical Analytical Report, Based on the Results of the 2006 Integrated Living Conditions Survey of Households*, Section 1.2.

[4.4-10] U.S. Department of Energy, 2005, *DOE NP2010, Nuclear Power Plant Construction Infrastructure Assessment*, MPR-2776, Rev. 0, dated October 21, 2005, prepared for Department of Energy, Washington D.C., under Order No. DE-AT01-020NE23476.

[4.4-11] U.S. Nuclear Regulatory Commission, 2006, *Environmental Impact Statement for an Early Site Permit (ESP) at the Grand Gulf ESP Site*, NUREG-1817 Final Report, Subsection 4.5.2.

[4.4-12] U.S. Department of Energy, 2004, *DOE NP2010 Construction Schedule Evaluation*, MPR-2627, Revision 2 dated September 24, 2004, prepared for the U.S. Department of Energy under contract DE-AT01-020NE23476.

[4.4-13] Metsamor Town, 2007, *Master Plan …*, Section 5.2.1.

[4.4-14] PA Consulting Group, 2005, *Armenia Power Sector 2005 Least Cost Generation Plan*, Table 8.1.

[4.4-15] Fortum Power and Heat Oy, 2008, *Loviisa-3 EIA*, Section 8.4.

[4.4-16] http://www.armstat.am/Arm/StatData/Taregirq_07/TAREGIRQ_07_12.pdf, accessed 8 April 2008.

[4.4-17] Fortum Power and Heat Oy, 2008, *Loviisa-3 EIA*, Table 8-6.

[4.4-18] Interview with Ashot Vardanyan, Director HAEK-i SHINARARUTIUN CJSC, 8 April 2008.

[4.4-19] Glasson, 2005, pp 219-220.

[4.4-20] Tennessee Valley Authority, 2007, *Bellefonte Nuclear Plant, Units 3 & 4, COL Application, Part 3, Environmental Report*, Section 4.4.2.2.

[4.4-21] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007.

[4.4-22] Glasson, 2005, pp 221-222.

[4.4-23] CJSC “Armenia Nuclear Power Plant”, 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.10.

[4.4-24] Metsamor Town, 2007, *Master Plan …*, Section 3.2.14.1.

[4.4-25] Letter dated August 12, 2008, CJSC “ANPP” to Head of Atomic Energy Department of the Ministry of Energy and Natural Resources.

[4.4-26] Metsamor Town, 2007, *Master Plan …*, Sections 5.2.8.1 through 5.2.8.3.

[4.4-27] Metsamor Town, 2007, *Master Plan …*, Section 5.2.8.3.

4.5 RADIATION EXPOSURE OF CONSTRUCTION WORKERS

The sources of radiation exposure to site preparation and construction workers include direct radiation and gaseous radioactive effluents from ANPP Unit 2 and from the onsite radioactive waste storage facilities during the site preparation and construction phase. Exposure to liquid radioactive waste discharges will be negligible. With the exception of the switchyard expansion, all major construction activities are expected to occur outside of the ANPP Unit 1 & 2 protected area boundary (fenced area) but inside the site boundary. (Work on the plant discharge pipe and pumping stations to support Unit 3 will take place at the plant discharge and water supply locations that are remote from the main ANPP site.)

4.5.1 Site Layout

Figure 2.1-4 illustrates the areas of construction in relationship to the established site boundaries[5] and the protected area fence and structures of Units 1 & 2. Depicted in that figure are:

- Unit 3 power block and cooling water systems construction area;
- Unit 3 (400 kV) switchyard construction area; and
- Construction lay-down and support building area.

4.5.2 Radiation Sources (Ref. [4.5-1])

The main sources[6] of radiation exposure for construction workers include:

- The Phase I (Units 1 and 2) main buildings (item 1 in Figure 2.1-4);
- The Phase I ventilation stack (item 26);
- A radioactive waste storage facilities (items 36 and 74); and
- Three buildings within a fenced area (near item 78, but otherwise not reflected in Figure 2.1-4).

The onsite dry spent fuel storage pad and another waste storage area (items 9 and 85) are distant from the construction area and are not expected to contribute to the construction worker dose.

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[5] GoA Decision 1848-N, dated 9 December 2004, “on Changing the Target Importance of Lands and Lands Allotment” transferred 289 hectares of land to ANPP. This additional land was not reflected in the maps provided for preparation of the EBID and are not reflected in Figure 2.1-4.
[6] In accordance with the IAEA Safety Glossary, a source is: “Anything that may cause radiation exposure – such as by emitting ionizing radiation or by releasing radioactive substances or material – and can be treated as a single entity for protection and safety purposes.”

The results of environmental radiological surveillance in the vicinity of ANPP are reported in the National Report of Republic of Armenia under Convention on Nuclear Safety. Ref. [4.5-2]. The "supervised area" is within 10 km of the site, which encompasses all of the potential construction areas for ANPP Unit 3.

Exposure monitoring of population residing in the supervised area is implemented by:

- Environmental sampling (air, water, vegetation, food, soil and etc.);
- Measurement of dose rates in different points of the supervised area;
- Measurement of population exposure dose by TLD dosimeters.

According to systematic measurements, gamma dose rate on the territory of the supervised area was 0.08-0.09 μSv/hour. In certain areas of the Armenian NPP site the dose rate was 0.22 μSv/hour.

According to results of integrated dosimeters, the population exposure dose is 1.87 mSv per year. Comparing these values with the averaged results of the population exposure doses before the Armenian NPP start-up in 1977, which was 1.65 mSv (0.8 mSv from cosmic exposure and 0.85 mSv from natural and artificial radionuclides of soil), it can be concluded that the population exposure doses are on the same level as before the Armenian NPP start-up in 1977.[7]

The switchyard construction area is within the protected area fence for Units 1 and 2. Therefore, that construction work will require personnel badged for site access. These personnel will be issued standard dosimeters, even though the expected exposures during this construction will be minimal.

Liquid discharges from Units 1 and 2 are via the sanitary sewage system or combined with Unit 2 cooling tower blowdown that is discharged from the plant discharge pipe approximately 7 km from the main construction area, (in the vicinity of the technical water supply pumping station shown on Figure 2.1-6). The plant liquid discharges, then, do not impact the Unit 3 power block construction area. However, workers involved in extension of the plant discharge pipe to the Sevjur River may be exposed to the liquid discharges. The tie-in between the discharge extension and the existing pipe should be accomplished during a Unit 2 outage when no discharges are taking place.

The 2007 Report under the Convention on Nuclear Safety indicates that the plant discharges are limited to 7.4 Bq/l and reports average annual summary gross β activity of the Sevjur River are 1.2 Bq/l, ^{137}Cs - 0.11Bq/l and ^{90}Sr - 0.025Bq/l (Ref. [4.5-2]). Annual discharges of long-lived radionuclides (Sr + Cs) from the ANPP

[7] The National Report does not specify the manner in which the pre-1977 exposure doses were measured; it must be assumed, based on the way the data are reported, that the measurement methods are consistent with those for current annual exposure doses.

averaged 0.998 GBq during the period 2000 to 2006, with the peak in 2004 at 1.45 GBq. Ref. [4.5-3]

Radiation exposure data are also reported in the 2007 Report on Justification of Safety of the ANPP Unit 2. Ref. [4.5-4]

- Table 5.11.6-19 reports 2004 dose rates at specific control points.

- Table 5.11.6-36 reports similar data for 2005.

- The dose rates on and nearby ANPP are repeated in EBID Table 4.5-1.

- The readings for these four monitoring locations, averaged over 24 months is 9.735 μR/hr (~9.735 μSv/hr[8]) .

{To support the final environmental assessment, a detailed radiation survey of the construction zones and construction support area shown on Figure 2.1-4 should be conducted (including along the fences surrounding the buildings near item 78 in that figure) and the results used to confirm that the doses predicted below are bounding.}

4.5.3 Construction Worker Estimated Doses

Exposure to gaseous releases from the Phase I ventilation stack (150 m high) will be minimal. In any case, external exposures due to gaseous releases are encompassed within the exposures measured by environmental TLD dosimeters. Conservatively assuming that the maximally exposed construction worker will be on the ANPP site for 3,000 hours per year (six ten-hour shifts per week, 50 weeks per year), at the reported exposure of 0.08 to 0.09 μSv/hour, the construction worker exposure should be approximately 0.27 mSv per year. Applying dose rate at the highest exposure location reported for the ANPP site (0.22 μSv/hour), leads to an annual exposure of 0.66 mSv.

In accordance with Armenian radiation safety norms (Ref. [4.5-5]), members of the general population may receive up to 1.0 mSv annual effective dose. This is the same limit established for members of the public by IAEA (Ref. [4.5-6]). Accordingly, the ANPP Unit 3 construction workers are, for the purposes of radiation protection, members of the general population (public) and are not subject to a radiation dosimetry program.

Because the construction workers are not radiation workers, but are, for the purposes of radiation protection, treated as members of the general population, individual monitoring and radiation training of construction workers on ANPP Unit 3 should not required.

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[8] This is an approximation that is not always accurate; see discussion below on R, Rad, Rem, and Sv.

Construction workers will be treated, for purposes of radiation protection, as if they are members of the general population working in unrestricted areas.

Using an approximation of 100 μR ≈ 100 μRad ≈ 100 μRem = 1 μSv[9] and the average readings over 24 months for the four monitoring locations listed in Table 4.5-1, an annual construction worker dose could be as high as 29 mSv. This value exceeds the limiting value for members of the general population, therefore reinforcing the need to conduct detailed surveys of the construction area, including cumulative monthly or annual dose measurements by dosimeter.

4.5.4 Collective Doses to ANPP Unit 3 Construction Workers

Using the "supervised area" dose rate of 0.08-0.09 μSv/hour, 3000 workers working 3000 hours each, the annual collective exposure is calculated as 0.72 to 0.81 man-Sv. If all workers were exposed to the dose rate of 0.22 μSv/hour, the resultant collective dose is conservatively calculated to be less than 2 man-Sv.

4.5.5 Measures to Ensure that ANPP Unit 3 Construction Worker Dose is as Low as Reasonably Achievable (ALARA)

To ensure that the construction workers continue to meet the limits of exposure for members of the general population, ANPP will establish a continuous monitoring program to measure exposures at the Unit 1 and 2 protected area fence and at nearest points of approach to the sources listed in Subsection 4.5.2 above, and at selected locations throughout the construction and construction support building areas. If the measured dose rate at any measured location would result in a calculated annual exposure exceeding 0.75 mSv, corrective measures, such as establishing barriers at a safe distance from sources, will be implemented. If construction workers must access these areas, they will be subject to radiation worker training and dosimetry.

Personnel working in the switchyard construction area will be badged for site access, will be subject to the ANPP dosimetry program, and will be issued standard dosimeters, even though the expected exposures during this construction will be minimal.

Prior to any construction activities on the plant discharge pipe or the project to extend the discharge pipe to the Sevjur River, surveys of dose rates and contamination by radioisotopes of concern will be conducted. Especially, contamination will be measured in the Kosh-Ujan storm water drainage canal downstream of the current plant discharge point. If contamination levels or radiation dose rates exceed limits for the general population, the construction workers on the plant discharge pipe project will be subject to

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[9] See [4.5-1] for definitions. The Roentgen (R) is a unit of *exposure*, equal to $2.58 \cdot 10^{-4}$C/kg (exactly). Rad is a unit of *absorbed dose*, equal to 0.01 Gy (0.01 J/kg = $2.39 \cdot 10^{-3}$C/kg ≠ $2.58 \cdot 10^{-4}$ C/kg), thus the use of ≈ in the expression. Rem is a unit of *dose equivalent* and *effective dose equivalent*, equal to 0.01 Sv, thus the use of = in the expression.

training as radiation workers and issued dosimetry and personnel protective measures, as appropriate.

Table 4.5-1, Averaged Irradiation Dose Rates at Control Points of the ANPP Supervised Area, μR/hr

Monitoring Point ID	Month 1	2	3	4	5	6	7	8	9	10	11	12	Annual Average
	2004 [(a)]												
13	13	11	9	8.5	8	9.5	9.5	16	15	10	8.5	8	10.5
14	11	9.5	9	8	9	8.5	9.5	9.5	9	7.5	8	7.5	8.83
15	11	11	8.5	8	9	7.5	7.5	9.5	9	8.5	6.5	7	8.58
16	9	8.5	8	9.5	7.5	10	8.5	10.5	10.5	8.5	8	9.5	9
	2005 [(b)]												
13	12	11.5	11	11	10.5	15.5	9	9	10	30	20	22.1	14.3
14	11	10	11	9.5	9.5	10	8	8	9	9.5	10.5	9.5	9.63
15	9	9	9	8	7.5	8	7.5	9	8	8.5	9.5	9	8.5
16	9	8.5	9	9.5	8	9	9	8	8.5	7.5	8.5	8	8.54

Legend

13 ANPP industrial site (average of four points)
14 Road from the ANPP to the entombment structure for low-activity waste
15 Road Metsamor-ANPP
16 By-pass highway

[(a)] Ref. [4.5-4], Table 5.11.6-19
[(b)] Ref. [4.5-4], Table 5.11.6-36

REFERENCES:

[4.5-1] IAEA, 2007, IAEA Safety Glossary, Terminology Used in Nuclear Safety and Radiation Protection, 2007 Edition.

[4.5-2] Armenian Nuclear Regulatory Authority (ANRA), 2007, *National Report of Republic of Armenia under Convention on Nuclear Safety*, Section 3.6.2.3.

[4.5-3] ANRA, 2007, *National Report of Republic of Armenia under Convention on Nuclear Safety*, Figure 3.

[4.5-4] CJSC "Armenian Nuclear Power Plant", 2007, *Report on Justification of Safety of The ANPP Unit No. 2*, Section 5.11.6.

[4.5-5] GoA Resolution № 1219, dated 18 August 2006, *On Approval of Radiation Safety Norms*, Appendix, Chapter V, paragraph 31.

[4.5-6] International Atomic Energy Agency, 2003, *International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources*, *Safety Series No. 115,* Schedule II-8.

4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION

This section summarizes the potential adverse environmental impacts of construction and describes the measures and controls to limit adverse impacts. The potential impacts and measures and controls to limit those impacts are summarized in Tables 4.6-1 through 4.6-5.

The tables list the potential impacts associated with the construction activities described in Sections 4.1 through 4.5. The tables identify, from the categories listed below, which adverse impact(s) may occur as a result of construction activities:

- Erosion and Sedimentation (ES)
- Air Quality (dust, air pollutants) (AQ)
- Wastes (effluents, spills, material handling) (WS)
- Surface Water (SW)
- Groundwater (GW)
- Land Use (L)
- Water Use and Quality (W)
- Terrestrial Ecosystems (TE)
- Aquatic Ecosystems (AE)
- Socioeconomic (S)
- Aesthetics (A)
- Noise (N)
- Traffic (T)
- Radiation Exposure (R).

The tables identify a relative significance rating (i.e., [S]mall, [M]oderate, or [L]arge) following implementation of associated measures and controls. These relative significance ratings are defined in the introduction to Chapter 4. Tables 4.6-1 through 4.6-5 also include a brief description, by EBID Section, of each potential impact and the measures and controls to minimize the impact, if needed.

Impacts due to construction are best controlled by using construction practices that do not produce impacts or at least minimize impacts. Construction activities should be planned and conducted in a manner that results in minimal environmental impact. The US Environmental Protection Agency (EPA) and the US Federal Highway Administration (FHWA) have both adopted the term “Best Management Practices” to identify the set of construction practices that minimize impacts.

EPA best management practices focus primarily on protecting water quality. They rely on air quality standards to control airborne emissions during construction. They rely on standards applicable to stationary and mobile sources to control noise impacts. The FHWA has looked more broadly at construction impacts and has done much of the background work on the impacts of construction noise.

“Best Management Practices” is used broadly to include all management practices that serve to minimize the generation of waste streams, or even more broadly to include practices that minimize the creation of environmental impacts.

The EPA recently issued a guide which may be helpful in developing a Best Management Practices document for a specific project, such as construction of ANPP Unit 3. Ref. [4.6-1]

Other detailed guidance is available for addressing specific construction activities, as follows:

- Soil erosion and runoff and other consequences of land clearing and grading are discussed in Ref. [4.6-2].
- Practices for pollutants other than sediment, (e.g., fuels, lubricants, and chemicals) are discussed in Ref. [4.6-3].
- Control of dust is addressed in Ref. [4.6-4].
- Control of impacts at concrete batch plants is addressed in Ref. [4.6-5].
- An example of best management practices to control transmission line impacts is included as Ref. [4.6-6].

4.6.1 Land-Use Impacts

Land-use impacts and control measures are summarized in Table 4.6-1. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the construction of ANPP Unit 3 are anticipated to be SMALL, if any, for all categories.

4.6.2 Water-related Impacts

Water-related impacts and control measures are summarized in Table 4.6-2. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the construction of ANPP Unit 3 are anticipated to be SMALL, if any, for all categories evaluated.

4.6.3 Ecological Impacts

Ecological impacts and control measures are summarized in Table 4.6-3. Based on existing site conditions, as well as the measures and controls proposed, the potential

adverse impacts identified from the construction of ANPP Unit 3 are anticipated to be SMALL, if any.

4.6.4 Socioeconomic Impacts

Socio-economic impacts and control measures are summarized in Table 4.6-4. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the construction of ANPP Unit 3 are anticipated to be SMALL, if any, for all categories evaluated except:

1. traffic impacts due to transportation of workers and equipment;
2. noise impacts on nearby residents due to operation of construction equipment;
3. noise impacts due to peak traffic volume if it is routed through Metsamor Town; and
4. impacts of in-migrating workers on Metsamor and Armavir Towns (based on the assumptions listed in Section 4.4 that the majority of workers will locate there).

4.6.5 Radiation Exposure to Construction Workers

Radiation exposure to construction workers and control measures are summarized in Table 4.6-5. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts on radiation exposure of construction workers during the construction of ANPP Unit 3 are anticipated to be SMALL.

Table 4.6-1, Measures and Controls to Limit Land Use Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
4.1 Land Use Impacts						S				S		S			
4.1 Land Use Impacts	General construction impacts in the vicinity. (All)														Identify the areas of the site to be used for construction activities. Prohibit activities on the site outside of the identified construction areas. Prohibit the movement of heavy construction equipment outside of the construction area. Institute specific best management practices to control dust and noise from the batch concrete plant (Ref. [4.6-5]).
4.1.1 Impacts on neighboring land values	Changes in land values due to changes in land-use and nuisance effects of construction. (L)														No mitigation necessary.
4.1.2 Impacts Resulting from Destruction of historic and cultural properties	Degradation, destruction or restriction of access to historic or cultural properties. (S)														No mitigation necessary.

Table 4.6-1, Measures and Controls to Limit Land Use Impacts

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
Offsite Land Use Impacts due to: 4.1.3.1 Air Quality	Degradation of air quality by engine and boiler emissions and fugitive dust (L)(AQ), including: - Disruption of grazing by dust on neighboring land - Impact on cultivated lands by settling of dust - Impact on citizens of Metsamor by falling dust	Maintenance of vehicles to minimize engine emissions.
		Implement vehicle emissions inspection program.
		Limit idling of equipment.
		Limit burning of construction wastes.
		Limit the speed of construction equipment on unpaved roads.
		Remove dirt spilled onto paved roads on the construction site.
		Cover haul trucks during unloading and loading activities.
		Cease grading and excavation during periods of high winds or extreme air pollution episodes.
		Phase construction activities to minimize daily emissions.
		Phase grading to minimize the area of disturbed soils.
		Re-vegetate road medians and slopes.
Offsite Land Use Impacts due to: 4.1.3.2 Noise	Decreased visits to cultural sites within 10 km (S)	No mitigating actions.
	Impacts of noise on nearby residents (S)	See Table 4.6-4.

Table 4.6-2, Measures and Controls to Limit Water-Related Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
4.2 Water-Related Impacts	S		S	S	S		S								
4.2.1 Hydrological Alterations	Alteration of storm water drainage courses on the site. (ES)														Design studies needed to determine if provisions must be made for storm water on/from/across the site.
	Silt transfer to streams. (ES)(W)														No mitigation necessary due to low precipitation.
	Alteration of groundwater quality. (GW)														No mitigation necessary due to depth of nearest groundwater (64m to 94m below surface).
	Alteration of the Sevjur River channel for water intake. (SW)														Design studies needed for water supplies; mitigation not needed if existing facilities are used; if intake design must be modified, mitigation measures should be specified.

Table 4.6-2, Measures and Controls to Limit Water-Related Impacts

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.2.1 Hydrological Alterations (continued)	Alteration of the Sevjur River channel for water discharge. (SW)	Design studies are needed for extension of the discharge pipe to the Sevjur River; mitigation is not expected to be necessary, but should be considered based on discharge design.
4.2.2 Water-Use Impacts	Water use for construction site watering. (W)	Can use existing cooling water supply with no mitigation necessary.
	Water use for cement batch plant. (W)	Drill new deep wells to supply Unit 2 and Unit 3 operational needs, use Upper Zieva Springs source for batch plant and construction personnel needs[10].
	Water use for potable needs by construction workforce. (W)	
4.2.3 Water Quality Impacts	Contamination of groundwater and surface waters due to construction site runoff, chemicals and waste water. (WS)(W)(GW)(SW)	Good construction practices (Refs. [4.6-2], [4.6-3])
		Direction of runoff to a settling pond or filtration of runoff through hay-bales.
		Collection of oily and chemical wastes and proper disposal not to surface or ground waters.
		Make provisions for capturing and collecting spills in areas used for storage of construction chemicals.

[10] Mitigation measures may be required in connection with environmental review of permit for drilling of wells.

Table 4.6-2, Measures and Controls to Limit Water-Related Impacts

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		Limit the period unvegetated soil is exposed.

Table 4.6-3, Measures and Controls to Limit Ecological Impacts during Construction

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
4.3 Ecological Impacts	S		S	S		S	S	S	S			S			
4.3.1 Terrestrial Ecosystems	Alteration or destruction of vegetative cover on the ANPP Site (TE)														Limiting disturbed area of the site by marking boundaries of construction zones and controlling movement of vehicles beyond these zones.
															Restoration of disturbed portions of the site after the completion of construction.
															Employment of best

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		management practices (Ref. 4.6-1])
		Allow temporary use areas to re-vegetate after construction.
	Alteration or destruction of vegetative cover near intake and discharge sites at/near the Sevjur River (TE)(AE)	Review of construction impacts and environmental protection plans after design is defined.
4.3.1 Terrestrial Ecosystems (continued)	Loss of habitat (TE)	Limiting disturbance of natural habitat on the site by marking boundaries of construction zones and controlling movement of vehicles beyond these zones.
		Restoration of disturbed portions of the site after the completion of construction.
	Increased erosion from the ANPP site (ES)(L)(TE)	Employment of best management practices (Ref. [4.6-1])
	Increased interaction between humans and wildlife (TE)	Minimizing potential for human contact with wildlife by marking boundaries of construction zones and controlling movement of people beyond these zones.
4.3.2 Impacts to Flora	Destruction of species of special importance (TE)	Conduct an inventory of floral species present at or near the ANPP site and intake and discharge areas on the Sevjur River.
		Develop measures to protect

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		any identified species of special importance.
4.3.3 Impacts to Fauna	Destruction of individuals of several species at the ANPP site (TE)	Conduct an inventory of faunal species present at or near the ANPP site.
		Develop measures to protect any identified species of special importance.
	Destruction of individuals of several species at the ANPP site (continued)	Limiting area affected by heavy equipment by marking boundaries of construction zones and controlling movement of vehicles beyond these zones.
		Confining vehicle movements to established roads and authorized construction areas.
	Destruction of individuals of several species associated with the intake and discharge sites on the Sevjur River (TE)(AE)	Conduct an inventory of faunal species present at or near the intake and discharge areas on the Sevjur River.
		Develop measures to protect any identified species of special importance.
4.3.3.1 Impacts of cooling towers on avian species	Reduction in bird populations (TE)	No mitigation measures possible.
4.3.3.2 Impact of Noise	Departure of mobile faunal species (N)	Limit noise impacts by implementing noise control measures identified in Table 4.6-4.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
4.3.4 Aquatic Ecosystems	Release of chemicals, fuels and lubricants (WS)(SW)(AE)	Use of best management practices (Ref. [4.6-1]) on construction site.
	Silting in the Sevjur River (SW)(AE)	Conduct an inventory of aquatic species in the affected regions of the Sevjur River.
		Evaluate potential impact on identified species based on design decisions.

Table 4.6-4, Measures and Controls to Limit Adverse Socio-Economic Impacts during Construction

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
4.4 Socio-Economic Impacts		S								M	S	M	M		
4.4.1 Physical Impacts	Local and regional traffic increase. (AQ)(N)(T)														Establish centralized parking and shuttle service for construction workers.
															Encourage use of railroad transport by construction workers.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		Staggered work start times.
		Install signals and signs at intersections with M-5.
		Route traffic along eastern access road.
	Equipment and non-routine noise. (N)	Meet limits in Ministry of Health Order №138, to the extent possible.
		Alter terrain during early site preparation to provide noise barriers.
		Limit speeds onsite.
		Require mufflers on equipment and restrict use of engine braking.
		Require monitoring of noise levels from mobile and fixed equipment.
4.4.1 Physical Impacts (continued)	Air emission (fugitive dust, engine exhaust) increases. (AQ)(WS)	Comply with RoA regulations and permits on equipment emissions.
		Phased construction.
		Equipment inspection and maintenance programs.
		Develop and implement dust management plans.
4.4.2 Socio-Economic Impacts	Influx of construction workforce. (S)	Complete assessment of workforce needs and impacts based on joint IAEA and MoE study.
		Establish temporary worker accommodations (hostel) near site (Metsamor or Armavir towns) or provide incentives to locate in Yerevan.
	Increased employment and tax revenues. (S)	Beneficial impact, no mitigation required.
		Establish skilled worker training programs to develop internal Armenian workforce.
	Social Services Impacts. (S)(T)	Cooperation between police and constructor to develop site induction training and feedback systems

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		Install traffic signals and signage at intersections with M-5.
		Improvement or renovation of sewage treatment plant for Metsamor, Armavir and Norapat.
		Develop revenue sharing program to distribute tax benefits to impacted communities.
4.4.3 Environmental Justice Impacts	Disproportionate impacts on low income population. (S)(O)	No mitigation necessary.
	Disproportionate impacts on ethnic minorities. (S)(O)	No mitigation necessary.

Table 4.6-5, Measures and Controls to Limit Radiation Exposure Impacts during Construction

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
4.5 Radiation Exposure to Construction Workers	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
														S	
4.5.3 Construction Worker Dose Estimates	Construction worker doses qualify them to be treated, for purposes of radiation protection, as if they are members of the general population working in unrestricted areas.														No mitigation necessary.
4.5.5 Measures to Ensure that ANPP Unit 3 Construction Worker Dose is ALARA	Potential for worker exposures exceeding estimates.														Continuous monitoring program to measure exposures at the protected area fence and selected locations throughout the construction and construction

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
		support building areas.
	Measured exposure approaching limits for members of the public.	Barrier off areas with projected exposures exceeding 0.75 mSv or establish radiation worker training and dosimetry programs for workers in those areas.
	Worker contamination from plant discharge pipe or plant discharges into the Kosh-Ujan storm water drainage canal.	Monitor contamination and radiation levels prior to work on plant discharge pipe extension and take appropriate protective measures if levels exceed limits.

REFERENCES:

[4.6-1] US Environmental Protection Agency, Office of Compliance, 2005, *Managing Your Environmental Responsibilities: A Planning Guide for Construction and Development*, EPA/305-B-04-003.

[4.6-2] US Environmental Protection Agency, 2002, *Development Document for Proposed Effluent Guidelines and Standards for the Construction and Development Category*, EPA-821-R-02-007, Section 5.1, p 5-1.

[4.6-3] US Environmental Protection Agency, 1973, *Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activities*, EPA 430/9-73-007, Chapter VII, p. 89.

[4.6-4] US EPA, 2002, *Development Document …*, EPA-821-R-02-007, p 5-103.

[4.6-5] State of California, 2003, *California Best Management Practices for Stormwater*, *California BMP Handbook NS-16, Construction - Temporary Batch Plants*, available at www.cabmphandbooks.com.

[4.6-6] Tennessee Valley Authority (TVA), 1992, *A Guide for Environmental Protection and Best Management Practices for Transmission Construction and Maintenance Activities*, Technical Note TVA/LR/NRM 92/1.

Environmental Background Information Document

Chapter 5: Environmental Impacts of Operation

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5. ENVIROMENTAL IMPACTS OF OPERATION

Chapter 5 presents the potential environmental impacts of operation of Armenian Nuclear Power Plant Unit 3 (ANPP Unit 3). The impacts are analyzed, and a single significance level of potential impact to each resource (i.e., SMALL, MODERATE, or LARGE) is assigned. Unless the significance level is identified as beneficial, the impact is adverse, or in the case of "small," may be negligible.

The definitions of significance are as follows:

SMALL	Environmental effects are not detectable or are so minor that they neither destabilize nor noticeably alter any important attribute of the resource. For the purposes of assessing radiological impacts, those impacts that do not exceed permissible levels in RoA laws and regulations are considered small.
MODERATE	Environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
LARGE	Environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

This chapter is divided into ten sections:

- Land-Use Impacts (Section 5.1).
- Water-Related Impacts (Section 5.2).
- Impacts of Cooling System Operation (Section 5.3).
- Radiological Impacts of Normal Operation (Section 5.4).
- Environmental Impacts of Waste (Section 5.5).
- Transmission System Impacts (Section 5.6).
- Uranium Fuel Cycle Impacts (Section 5.7).
- Socioeconomic Impacts of Station Operation (Section 5.8).
- Decommissioning Impacts (Section 5.9).
- Measures and Controls to Limit Adverse Impacts during Operation (Section 5.10).

These sections present potential ways to avoid, minimize, or mitigate moderate or large adverse impacts of operation to the maximum extent practical.

5.1 LAND-USE IMPACTS

The impact on land use due to the siting and construction of ANPP Unit 3 was discussed in Section 4.1. This section describes the impacts of ANPP Unit 3 operation on land use at the site and the site vicinity within a 10 km radius from the site.

This section includes an assessment of the impact of operation on air quality except for impacts resulting from the operation of the condenser cooling water system. The cooling tower may potentially impact land use by creating fog or ice. Salt drifting from the top of the cooling tower may also be of concern. The impact of the cooling tower on air quality and land use is discussed in Section 5.3.

The impact of operation and maintenance of new transmission corridors is discussed in Section 5.6.

5.1.1 Land Use

Chapter 4 described and evaluated impacts to neighboring properties and residents that will occur during the construction of Unit 3. Following the completion of construction and the startup of the new unit, the impacts that occur will revert back close to those that currently exist due to operation of ANPP Unit 2. Traffic will be reduced from the construction levels. Noise and dust generation will also be more typical of the conditions associated with operation of ANPP Unit 2.

Access to land under the control of the ANPP CJSC will still be restricted. Traffic to and from the site will primarily be employees coming to and leaving work. There will be some truck traffic bringing operation and maintenance supplies to the site. Since Unit 3 will be of a different design and will have a greater capacity than Unit 2 the number of employees and the truck traffic needed to support operation is expected to be different.

Section 3.2 states that the bounding number of employees for operation of Unit 3 would be 1750 (see Table 3.2A-1, section 17.5). During outages the number of employees on site will increase to 2000. This contrasts with a peak construction work force between 2500 and 3500 and with a current work force of 1743 employees at Unit 2.

The ANPP site is large enough to provide a buffer adequate to protect most land uses from Unit 3 operating activities. Since the site will continue to be used for the generation of energy any restrictions on use of neighboring lands will remain in place. Planning organizations should continue to be sensitive to any contemplated activities on neighboring lands that might present a hazard to safe plant operation. Planning should also consider how new activities affect emergency plans. The law authorizing construction of ANPP Unit 3 should include requirements for planning organization notification of the ANPP operating organization when changes to land use or new activities in the site vicinity are authorized.

Because the impacts resulting from operation of Unit 3 will be the same impacts experienced during operation of Unit 2, differing only slightly in magnitude, the impact of operation on neighboring land use will be SMALL.

5.1.2 Noise

Section 3.2 provides bounding values for noise levels expected from operation of the new unit. The major noise sources during operation will be the cooling tower(s) and the standby diesel generators. The diesel generators will be operated intermittently for periodic testing. The noise level from each of these major sources is expected to be less than 55 dba at a distance of 300 m from the noise source. This limiting value is less than the noise levels that will occur during construction.

Section 4.4 discussed the impact of noise at offsite areas. Section 4.3 expected noise levels during construction to be generally below 65 dba at the site boundary. Within the town of

Metsamor, the noise from the site will be less than ambient noise levels and will essentially be unnoticed.

Section 4.3 discussed the impact of construction noise on the fauna of the site. It was noted that the high noise levels during construction might cause some fauna to leave or avoid the construction area. However no wildlife damage would occur at 65 dba expected at the site boundary. It did note that small birds might migrate away from the area at lower noise levels.

Section 4.3 also reported that noise surveys resulting from operation of Unit 2 were not available but that noise levels at operating nuclear plants are in the range of 50-60 decibels. Based on the bounding values for the larger noise generation sources, noise levels at Unit 3 should be within the range given for operating reactors and thus comparable to noise levels at Unit 2. The composition of the avian community following the completion of construction should return to that which currently exists.

Based on the foregoing, it is concluded that the noise impacts to terrestrial ecological resources will be SMALL, and no mitigation is warranted

5.1.3 Air Quality

Certain auxiliary equipment necessary to support the operation of Unit 3 will produce gaseous emissions of potential concern. The first major component is the auxiliary boiler which will be used as a source of heat during outages and to preheat components and feed water for startup following an outage. There will be one auxiliary boiler.

The bounding values for annual emissions from an auxiliary boiler adequate for any of the alternative designs were presented in Table 3.2A-4. Data from Table 3.2A-4 are summarized in Table 5.1-1 showing all emissions from burning of fuel (natural gas).

Data on the emission of carbon dioxide is added to the table because of its role as a greenhouse gas. The principle greenhouse gases include carbon dioxide, methane, nitrogen oxides, and some organic chemicals such as chlorofluorocarbons. The major greenhouse gas of concern is carbon dioxide.

In section 3.2 it is indicated that natural gas will be used to fuel the boiler. The energy input rate of the auxiliary boiler as 46 MW. This will result in an emission rate of carbon dioxide of 8,332 kg/hr [Ref 5.1-1]. The auxiliary boilers will be operated for thirty days per year. The annual emissions will be 6,000,000 kg/yr.

The second major set of components are the four emergency diesel generators which provide a source of power to shut the unit down safely in the event of the loss of offsite power. These generators may never be called into service but must be tested at regular intervals to ensure that they will function if needed. The emissions occur during operability testing.

The analysis is based on four generators, each with a capacity of 2,000 kW. The annual emissions for the emergency diesel generators from Table 3.2A-5 have been added to Table 5.1-1.

Each diesel generator will consume fuel at about 537 liter per hour (141.9 gallon per hour) when running fully loaded [Ref 5.1-2]. Using a carbon dioxide emission rate of 26.7 g/l [Ref 5.1-3], the rate of emission of carbon dioxide from a fully loaded generator is estimated to be

14.3 kg/hr. For 192 hours of diesel generator operation per year, this results in 2,750 kg CO_2/year.

The four diesel generators each operating for 48 hours per year together would consume roughly the same amount of fuel as a large highway tractor or a major piece of construction equipment with a 500 hp diesel engine running less than 800 hours per year. The emissions would also be comparable. The emergency diesel generators do not represent a large source of combustion products, including carbon dioxide.

The air quality in the site vicinity is not limited by vehicle emissions. The impact on air quality from the auxiliary equipment will be SMALL.

A recent summary of life cycle emissions from all electrical generation options [Ref 5.1-4] showed nuclear power to have higher emissions than hydroelectric power but lower emissions than wind and solar power. The emissions from the nuclear option were well below the emissions from fossil-fueled generation.

Thus the impact of the greenhouse gas emissions from Unit 3 will be SMALL.

5.1.4 Terrestrial Ecology

During construction the flora of the site will be eliminated from graded areas. The construction support areas will be heavily used. Vehicular movement on unpaved roadways will make it difficult for vegetation to become established until construction is completed. The compacted soil may slow the natural process of re-vegetation. When construction of the planned units 3 and 4 (VVER-440) was terminated, vegetation from adjoining desert areas extended its range back onto the site. Following construction of the new Unit 3, if permitted, vegetation from the surrounding area will again encroach back onto the site. This process could be accelerated if the ANPP operating organization were to restore construction support areas to conditions favorable to the desert species.

Fauna leaving the area during construction will also gradually repopulate the area to existing levels.

Land use impacts from the imposition of the new cooling tower are described in Section 4.1. It was noted in Section 4.1 that there will be some minor impact to birds as a result of collisions with the cooling tower. This will continue for the operating life of the plant.

In conjunction with their procedures for extending the expiration date of operating licenses for existing operating plants, the US Nuclear Regulatory Commission did an extensive review of literature and data on bird impacts with cooling towers [Ref 5.1-5]. The NRC concluded that local bird populations were not being significantly affected by collision with cooling towers. Waterfowl and other birds that are commonly present as permanent or summer residents around nuclear plants do not frequently collide with the towers. Instead, a very high percentage of the collision mortalities occur during the spring and fall bird migration periods and involve primarily birds migrating at night. Studies that have been conducted at six nuclear plants, in conjunction with literature reporting total collision mortality (Section 4.5.6.2), show that (1) avian mortality associated with cooling towers is a very small part of the total mortality and (2) local bird populations are not being significantly reduced.

The impact of Unit 3 operation on terrestrial ecology will be SMALL.

5.1.5 Historic Properties and Cultural Resources

Section 2.5.6 discusses historic, cultural and recreational resources in the region. Figure 2.5-7 identifies the locations of archeological and cultural sites registered within 10 km of the site. None of the resources is on or adjacent to the site. Section 4.5 evaluated the impact of construction on the areas. The evaluation considered construction noise, traffic, and air quality impacts and concluded that the impact would be small. During operation these factors will be less than during construction and will remain small.

New impacts which will occur during the operation of Unit 3 will be the result of the operation of the new, larger cooling tower. The plume from the tower may at times causes shadowing of the historic and cultural resource areas. It is also possible that there may be impacts due to fogging, ice formation and deposition of drift. The cooling tower impacts are addressed in Section 5.3. Because the closest of the resources is several kilometers from the site, the impact of Unit 3 operation on historic properties and cultural resources will be SMALL.

Table 5.1-1, Atmospheric Emissions at ANPP Unit 3

Yearly Emissions to the Atmosphere		
Pollutant	**Auxiliary Boiler** [(1)(2)]	**Emergency Diesel Generators** [(3)(4)(5)]
	Bounding Value	
	kg	**kg**
Particulates	390	550
Sulfur oxides	31	1,700
Carbon monoxide	4,300	3,100
Volatile Organics	280	
Unburned hydrocarbons		2,100
Nitrogen oxides	14,300	12,000
Carbon dioxide[(6)]	6,000,000	2,750

[(1)] PPE, Section 13.2

[(2)] Emissions are based on 30 days of operation per year.

[(3)] See PPE, Section 16.1.3

[(4)] Emissions are based on 4 hrs/month operation for each DG, bounding is VVER with 8,000 kW of capacity.

[(5)] Further reduction in emissions can be achieved with the addition of emission control equipment on the D.G.s.

[(6)]See calculation in narrative.

REFERENCES:

[5.1-1] Natural gas Supply Association, 2004, *Natural Gas and the Environment,* from their website: http://www.naturalgas.org/environment/naturalgas.asp#greenhouse

[5.1-2] Diesel Supply and Service, Inc., undated, *Approximate Fuel Consumption Chart,* Brighton, Colorado, from their website: http://www.dieselserviceandsupply.com/Diesel_Fuel_Consumption.aspx, Website visited on 17 July 2008.

[5.1-3] US Code of Federal Regulations, Title 40, Environmental Protection, Section 600.113-78, *Fuel Economy Calculations*. Revised November 14, 1978.

[5.1-4] Nuclear Energy Institute (NEI), 2000, *Emissions Produced by 1 Kilowatt-hour of Electricity Based on Life-Cycle Analysis*, from: "Hydropower-Internalized Costs and Externalized Benefits," Frans H. Koch, International Energy Agency (IEA)-Implementing Agreement for Hydropower Technologies and Programs, Ottawa, Canada, 2000. Available on the NEI website: http://www.nei.org/

[5.1-5] US Nuclear Regulatory Commission, 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, (NUREG-1437 Vol. 1), par 4.3.5.2.

5.2 WATER-RELATED IMPACTS

This section provides the identification, analysis, and description of hydrologic alterations resulting from plant operation and adequacy of the water sources proposed to supply plant water needs. The three major needs for water for operation of Unit 3 are: condenser cooling, service water for component cooling, and high purity water for steam generator and reactor coolant makeup. In addition, water must be provided for domestic uses within the plant. A supply of water for fire protection must also be secured to be used in the event of an emergency.

The largest quantity of water will be required for makeup to the Circulating Water System. The Circulating Water System cools the condensers. This system is described in Section 3.3.1.2 and 3.4.1.1. The Sevjur River will be the source of water for this system. Blowdown from the system will be returned to the river by the ANPP discharge pipe.

The Sevjur River will also provide makeup to the Service Water System, described in Section 3.3.1.3 and 3.4.1.2. The discharge from the service water system will be returned to the Sevjur by the ANPP discharge pipe.

Household water for Unit 2 is obtained from the Upper Zeiva Springs. The capacity of Upper Zeiva Springs is not adequate to support the operation of Unit 3. Then ANPP CSJC has had plans prepared the drilling wells to upgrade the water supply at the site. The plans have not been implemented but should be implemented for providing potable quality water to Unit 3, as described in Section 3.3.1.4. This new deep well system will provide water to the Potable Water System described in Section 3.3.1.4 and the Demineralized Water System described in Section 3.3.1.5. This source will also serve the Fire Protection Supply described in 3.3.1.6.

Water withdrawals from the proposed new deep well system must be in accordance with water use permits, as described in Section 1.2. The permitting process requires an environmental review. Since the wells will be designed and built to serve the needs of unit 3, the permitting process should provide assurance that other ground water users are not impacted. Information provided on ground water usage does not identify other users drawing water from the same aquifer. The impact on ground water users will be SMALL.

The wastewater from the domestic uses will be sent to a wastewater treatment plant for treatment before being discharged to the Sevjur River (see Section 3.3.1.4). The impact of sanitary waste discharges is discussed in Section 5.5.

This section will discuss only those impacts to other users of the Sevjur River resulting from the taking of water from the Sevjur River for Unit 3. There are additional impacts resulting from the operation of the cooling water system. These impacts are discussed in Section 5.3.

Evaporative losses of water from the cooling tower and the use of chemicals to treat water in the plant will degrade the quality of the water before it is discharged back to the Sevjur. The impact of the chemical waste discharges are discussed in Section 5.5.

5.2.1 Water Requirements for Unit 3

The rates of water used in Unit 3 for the various purposes and the sources of the water for each use are provided and discussed in detail in Section 3.3. The uses of water for the various needs are summarized below in Table 5.2-1. The flow rates are obtained from Table 3.3-1.

Table 5.2-1 shows that water will be drawn from the Sevjur River at an average flow rate of 1948 l/s and from groundwater wells at an average flow rate of 47 l/s. Water will be returned to the Sevjur River from the two sources at a total average flow rate of 1005 l/s. The net loss from the Sevjur River water balance will occur at an average rate of 943 l/s (0.94 m^3/s) during operation of Unit 3. The discharge from the potable water system will be returned to the Sevjur River upstream of the water intake. The discharge from the other systems will be returned to the Sevjur River about 0.8 km downstream of the intake.

The ANPP provided data showing the water withdrawn from and returned to the Sevjur River for each calendar quarter in 2006 and 2007. The data are included here as Table 5.2-2. From the data in the table, the consumptive use by Unit 2 is calculated to be 0.40 m^3/s. Thus, Unit 3 will consume an additional 0.54 m^3/s. That is, Unit 3 will cause a further reduction in flow in the Sevjur flow, on average, by 0.54 m^3/s.

5.2.2 Availability of Water

There is adequate water available in the water balance of Armenia. Section 2.3.1 describes the water balance of the Republic of Armenia (RoA). Table 2.3-1 lists the total average water available to the RoA as 4.22 billion m^3/yr. Table 2.3-2 showed that as of the year 2006, a total of 2.83 billion m^3/year were being abstracted for use within the RoA. The total consumption in 2006 was reported as 1.99 billion m^3/yr for industrial, domestic, and agricultural purposes. There is a surplus of water in the national water balance of about 2.2 billion m^3/yr.

The consumptive requirement for ANPP Unit 3 is 990 l/s, or 31.2 million m^3/yr. The consumptive use of the Unit 3 is about 0.74 % of the year 2006 consumptive use nationwide. A reliable source of electrical energy is important to the RoA. The impact on the water balance of the Republic of Armenia resulting from operation of ANPP Unit 3 will be SMALL.

The national water balance does not assure that water will be available at all seasons or at all locations.

In Section 2.3.5, a summary annual water balance for the Sevjur River was developed. The balance is summarized in Table 2.3-13. Table 5.2-3, below, has the incremental water requirement of Unit 3 added to the water balance. If the determination of whether adequate water for Unit 3 were to be based on an annual water balance, the flow numbers are marginal. The additional consumptive loss at Unit 3 would decrease the net available flow by 4.5% and would drop the annual average flow just slightly below the required environmental flow value.

To enable the comparison of permitted water use with river flow, the permitted withdrawals were expressed in a flow rate assuming uniform use throughout the year. However, as was noted in Section 2.3, the Sevjur River is an important source of water for agricultural needs. The primary agricultural use is for irrigation of cultivated farm land. Peak irrigation

usage is in the summer. The holder of a permit is entitled to take the permitted amount of water as he needs it.

A look at the historic flow data and the current flow data for the Sevjur contributes to a better understanding of the conflict between water uses. Statistical data for water flow in the Sevjur River are included in Table 2.3-4. Water flow data are provided for two monitoring stations, Taronik and Ranchpar. The Taronik monitoring station is just downstream of the ANPP cooling water intake, 31 km upstream from the confluence of the Sevjur River with the Araks River. The Ranchpar hydrological monitoring station is about 26 km downstream from the Taronik monitoring station. The Ranchpar station is about 5 km upstream from the point where the Sevjur River joins the Araks River.

Because of its proximity to the ANPP water intake, the flows at the Taronik monitoring station are the best indicator of water that is available. According to Table 2.3-4, the average flow at the Taronik monitoring station is 20.6 m^3/s. It also shows that 95% of the time, flow at the Taronik station exceeds 16.0 m^3/s. These flows appear to be the natural flows or the flows that would prevail if there were no withdraws of water upstream of the Taronik station.

Flow at the Ranchpar monitoring station is of interest because flow in the Sevjur River increases just a short distance downstream from the ANPP water intake. The natural flow at the Ranchpar monitoring station averages 33.9 m^3/s. For 95 % of the time, the natural flow at the Ranchpar station exceeds 27.58 m^3/s. The Kasakh River flows into the Sevjur river just about 5 km downstream from the Taronik monitoring station. The Kasakh has a very large drainage basin. The flow from the Kasakh accounts for much of the increase in flow between the Taronik and Ranchpar monitoring stations. Table 2.3-4 shows that the monitoring station on the Kasakh at Ashtarak has an average natural flow of 7.44 m^3/s.

The data from Table 2.3-4 for the natural river flow at the two monitoring stations on the Sevjur is presented graphically in Figure 5.2-1. The flow that is exceeded 90% of the time is not much less than the flow that is only exceeded 10% of the time. This shows that there is not a wide range in the variation of the historic flows. The difference in flow between the two monitoring stations also appears fairly consistent at all frequencies of exceedance.

The flows measured at the two stations more recently show a different picture. Table 2.3-8 is a summary of data that were obtained from the RoA Hydromet office for several monitoring stations on rivers near the Unit 3 site. The table included data for the Taronik and Ranchpar monitoring stations on the Sevjur River. Data were requested for the most recent three years for which data were available for all stations. For various technical reasons, the data could not be obtained for the same years at all stations. The data are valuable for showing how flow varies throughout the year. Analyzing the data for a longer time period would change numbers slightly but would not be expected to lead to different conclusions.

From this flow data the flows that were exceeded at various frequencies during the recent periods of record were derived so that recent flows could be compared to historic flows. Figure 5.2-2 has the recent flow data added to the historic flow data that appeared in Figure 5.2-1. The figure shows the percent of time the average flow was below the indicated value during these three years. The figure shows the extent of the flow reductions that have occurred in the Sevjur at both monitoring stations. The difference in flow between the two monitoring stations is no longer uniform at all stages of flow.

The flows measured between 2004 and 2006 are lower than the historic flows as a result of the withdrawal of water in accordance with the permits that have been issued. The average flow in the Sevjur at the Taronik monitoring station during this recent three year period was 10.4 m^3/s. The low year flow average was 9.8 m^3/s and the high year was 10.9 m^3/s. This compares to the historic average of 20.6 m^3/s.

During this three year period, the ANPP Unit 2 was in operation and accounted for a net reduction in Sevjur River flow of approximately 0.4 m^3/s

The flow data from Table 2.3-8 are presented graphically again in Figure 5.2-4 to show how the flow at the two monitoring stations varies throughout the year. High flows occur at both monitoring stations in winter. Flows are much lower at both stations between May and November. The range in flows is greater than would be expected from the statistical data. Most of the variation in flow rates is caused by the seasonal patterns of usage for agriculture.

Looking at the extreme flows completes the picture showing potential conflicts between water uses. The minimum daily average flow observed during the three year period was 6 m^3/sec. The minimum average flow for the lowest month was 6.66 m^3/s.

The data do suggest that additional water might be available downstream from the existing ANPP intake. There has been no analysis of the use of the water in the Kasakh River. At this point there is no expectation that the flows in the Kasakh River can be sustained for the operating life of Unit 3.

5.2.3 Impact on Other Water Users

The annual water balance for the Sevjur River as shown in Table 2.3-13 suggests that the flow in the Sevjur River is sufficient to support operation of ANPP Unit 3. This will not be possible to do so at low flow without impacting other water users.

The major uses of water from the Sevjur are agriculture and aquaculture. Little of the water withdrawn for agriculture is returned to the river. From the Water Withdraw and Water Discharge permits it appears that 94% of the water withdrawn for aquaculture is returned. Thus, it is expected that the major impact of ANPP Unit 3 water use will be on the agricultural users.

The ANPP has reported that other water users of the Sevjur River have had to reduce their use of water during periods of extreme low flow so that the ANPP Unit 2 could continue to operate (Ref [5.2-1]). The need for other water users to reduce their use of the Sevjur River will continue during the operation of Unit 3 and may even occur more often. There is no information on which users had to reduce the amount of water used. Nothing is known about whether the reduction in water use caused a financial loss to the other users. This can be assumed to be the case but the size of the financial loss is still unknown. The records should be studied to determine the magnitude of the impact of curtailment of water use for agriculture during periods of low river flow.

The manner in which water is allocated and used for agriculture makes it difficult to know whether agricultural uses can be reduced. The RoA Water Resource Management Agency issues permits to water pipeline companies authorizing the pipeline companies to withdraw the water. The pipeline companies build and operate pipelines or canals to distribute the water to farmers. The farmers buy the water from the pipeline companies.

Table 2.3-13 indicates that eleven permits have been issued to withdraw water from the Sevjur for irrigation.

The land reform actions following the dissolution of the Soviet Union divided many large collective farms into small parcels. It is possible that there are hundreds of small farms relying on the water from the Sevjur. The water withdrawal permits issued to the pipeline companies do not specify a usage rate. There are no time restrictions. The permits specify a total annual volume of water authorized to be withdrawn or discharged. The rate of withdrawal by agricultural users will vary seasonally. In the three years analyzed, the flow in the Sevjur River was low from May to November.

In Section 2.3 it was noted that some of the water used for irrigation may be applied excessively (Refs [5.2-2] and [5.2-3]). It may be unreasonable to expect that reductions in agricultural water usage can or will be made on a schedule that will resolve the water issue prior to making a decision regarding the construction of ANPP Unit 3.

The RoA has initiated a program to rehabilitate a number of irrigation systems currently contributing to some of the excessive uses of water (Ref [5.2-7]). The rehabilitation efforts will reduce water use in specific project areas but will not affect water use in the Sevjur basin. Table 2.3-2 shows that the rate of consumptive use of water for agriculture increased by 61 % from 2002 to 2006. The agricultural sector accounted for almost all of the total increase in water use in the RoA during that four year interval. Other uses of water, such as for hydroelectric power generation, are also increasing.

Even though the water flow in the Sevjur appears to be adequate based on average flow data, seasonal flow variation and seasonal usage patterns create conflicts between competing water demands at certain times of the year. Further authorizations for withdraws from the Sevjur have the risk of exhausting the resource.

The burden of this future problem must be addressed by in a manner that satisfies all required demands for water in Armenia. When the RoA takes action to establish a formal allocation of the water in the Sevjur River and include allocation of water for the ANPP Unit 3, the potential impact on other water users will be SMALL

5.2.4 Ecological Impacts

In addition to the uses of the Sevjur River to support agriculture and power generation, flows must be maintained sufficient to protect the biota of the river. The taking of water during periods of low river flow are of particular concern.

The minimum river flow that must be maintained in order to protect the aquatic habitat is referred to as environmental flow. The need to maintain environmental flows in major rivers was established by RoA Government Decree No. 592 (Ref [5.2-4]). The Law on the National Water Program (Ref [5.2-5]) establishes the need for Basin Management Organizations. The National Water Code (Ref [2.5-6]) requires established Basin Management Organizations to determine the environmental flow requirements for each major river. The Code also requires that the environmental flow requirements be part of Water Quality Standards for the basin. This has not yet been accomplished for the Akhuryan Basin Management Organization, which includes the Sevjur River.

Until the BMO determines specific values for the river, the law requires that the environmental flow be set at 75% of the flow that is exceeded 95% of the time. For the Sevjur River at Taronik, this would be a minimum flow of 12 m^3/s considering only the

historic flow records. From Figure 5.2-2 it can be determined that flow was less than the environmental flow 75 % of the time for the Taronik monitoring station during the three year period for which data were available. Flow at the Ranchpar monitoring station was below the environmental flow 58 % of the time.

Data have not been found showing whether there have been changes in the abundance and distribution of aquatic species in that time interval. No methodical study has been done of the aquatic species, either flora or fauna, of the Sevjur River. Accounts of fisheries of Armenia discussed in Section 2.4.5 suggest that the Sevjur is still productive and still harbors populations of diverse species of fish.

The Sevjur River has a small gradient. Table 2.3-3 shows that the average slope of the Sevjur is 1‰. That means the surface elevation drops 1 m in a 1 km stretch, on average. This may make it a unique river in Armenia. The table shows the slopes of the other major rivers range from 5.7 ‰ to 95 ‰. The gentle slope makes the Sevjur a slower flowing stream and it may harbor an assemblage of aquatic life unique in Armenia or aquatic species found only in isolated pools elsewhere.

Great variations in river flow often result in alternately flooding and uncovering bottom areas of potential importance to benthic organisms and species that find important habitat in littoral zones. Because of the gentle slope of the Sevjur, water depth may not have extreme variation over the range of prevailing flow conditions. The intake for the power plant is in a small pool created by an agriculture flow diversion dam. The Taronik monitoring station is located on this pool also. Between 2004 and 2006 the water depth at the Taronik monitoring station varied over a range of 60 mm. During this interval the measured flow ranged from 6 to 21.3 m^3/s. Downstream of the plant where the river is free flowing again, greater changes in depth may occur.

Species composition is often different between standing and swiftly moving water. Biological monitoring may bear out the inference that the reduction in flow over the last twenty years is not likely to have caused a shift in species composition. Many aquatic species can tolerate variations in flow if critical habitat does not disappear as the flow changes. Occasional excursions to values below the environmental flow may be tolerated. Sustained periods of extreme high or low flow may eliminate the less tolerant of the species.

The reduction of flow may have a greater impact on the aquatic ecosystem downstream of the agricultural diversion dam. Water depths in the free flowing stretches may show a greater variability with flow.

About 5 kilometers downstream from the ANPP intake, the Sevjur River is joined by the Kasakh River. The Kasakh is the major tributary entering the Sevjur River between the Taronik and Ranchpar monitoring stations and essentially provides the additional flow recorded at Ranchpar as shown in Figures 5.2-1 and 5.2-2. Below this confluence, the impact of diminished flow will be lessened. The impact to the ecosystem caused by flow reduction due to water use by Unit 3 may be greatest in that stretch of the river between the agricultural diversion dam and the junction with the Kasakh.

From studies cited in Section 2.4 (Refs. [2.4-47] and [2.4-48]), thriving aquatic communities are found in the Sevjur River. It must be concluded that the River has remained productive in spite of the reductions in flow to this point.

As noted in Section 2.3.3.3, the RoA Akhurian Basin Management Organization must establish the environmental flow to be maintained in the Sevjur River prior to issuing a water use permit. By complying with the required environmental flow, the ecological impact of the additional use of water for Unit 3 will be SMALL.

The laws and regulations of the RoA provide a mechanism for allocating water in a manner which protects all national interests including protection of the environment. Implementation of the new laws is evolving. Because of the long time required to design and construct Unit 3, a water use permit will be needed for Unit 3 before all of the mechanisms established by the National Water Policy, the National Water Program and the National Water Law are in place. This should be pursued as soon as a decision is made to proceed with Unit 3. If the use of water from the Sevjur River is consistent with the RoA allocation of water, as documented by the issuance of a water use permit, the impact of water use will be SMALL.

5.2.5 Conclusions

Unit 3 will reduce flow in the Sevjur flow, on average, by 0.54 m^3/s.

The reduction in flow in the Sevjur River due to the operation of Unit 3 will have a SMALL impact on other users of the Sevjur River. The interests of agricultural users will be protected by the water allocation by the GoA.

The reduction in flow in the Sevjur River resulting from the operation of Unit 3 will have a SMALL impact on aquatic ecology if established environmental flows can be sustained.

Other, less demanding, plant water needs are met by the drinking water supply system. The current drinking water supply from Upper Zeiva Springs will be replaced by a set of wells to the northeast of the current ANPP cooling towers. The capacity of this system will be sufficient to supply potable water, fire system makeup, and demineralized water system influent for Unit 3.

Alternative technologies for circulating water cooling are discussed in Section 3.4, several of which would reduce the water consumed by the circulating water system. The technologies that would reduce water consumption include:

- A dry cooling tower system that would virtually eliminate the need for makeup to the circulating water system (a savings of 930 l/s), but which would result in a significant energy penalty (loss of net electrical output);
- A hybrid wet/dry cooling tower system that would reduce the water consumption by one-third to one-half, from 930 l/s to 465-620 l/s.

The proposed cooling for the service water system is a spray pond system. The alternative to spray ponds is a mechanical draft wet cooling tower system that, based on values in Table 3.2A-1 items 3.3.4, 3.3.15, 3.5.3, and 3.5.12, is estimated to reduce net water use by half, to 12 l/s. By comparison with the water demand for the circulating water system, this savings is insignificant and considerations other than water use should determine the technology selected for service water cooling.

There will be NO water-related impact from these other Unit 3 water systems.

Table 5.2-1, Plant Water Use

Stream	Normal Intake Flow (l/s)	Water Source	Normal Discharge Flow (l/s)	Discharges to
Circulating Water System	1900	Sevjur River	970	Sevjur River
Service Water System	48	Sevjur River	24	Sevjur River
Demineralized Water System Makeup	27	New wells[(b)]	5.4	Sevjur River[(a)]
Fire Protection Water Makeup	0.32 to 62	New wells	(c)	Sevjur River
Potable Water	20	New wells	6	Sevjur River via the waste-water treatment plant.
Total Water Flows for Unit 3	1995		1005	Sevjur

Footnotes:

(a) The Demineralized Water System discharges to the Sevjur by way of the Circulating Water System discharge pipe.
(b) See Section 3.3.1.4 for the tentative location of the new wells. They will be in the planning area of the Sevan-Hrazdan BMO.
(c) The Fire Protection System is used for fire fighting during emergencies only. See Section 3.6.1.2.2 for discharge points.

Table 5.2-2, Water Balance for the Sevjur River

	Average Flow conditions (m^3/s)	95% Flow conditions (m^3/s)
Sevjur Flow	**20.6**	**16.0**
Approved withdraws	**18.8**	
Approved Discharges	**10.6**	
Net available flow	**12.4**	
Environmental Flow Requirement		**12**
Incremental loss from Unit 3	**0.54**	

Table 5.2-3, Water Intake and Discharge Rates at ANPP Unit 2

	Rate of Withdraw from the Sevjur	Rate of Discharge to the Sevjur	Net Rate of Consumption from the Sevjur
	m^3 /quarter	m^3 /quarter	m^3 /quarter
2006			
First Quarter	6,477,480	2,527,487	3,949,993
Second Quarter	6,524,287	2,999,956	3,524,331
Third Quarter	6,461,481	2,786,906	3,674,575
Fourth Quarter	3,527,416	1,983,567	1,543,849
2007			
First Quarter	6,415,674	2,481,540	3,934,134
Second Quarter	6,319,502	2,910,575	3,408,927
Third Quarter	6,472,394	2,776,451	3,695,943
Fourth Quarter	3,321,650	1,590,176	1,731,474
Total	45,519,884	20,056,658	25,463,226
Average Rate expressed as m^3/s	0.722	0.318	0.404

Figure 5.2-1, Statistical summary of Historic flows in the Sevjur River at the Taronik and Ranchpar Monitoring Stations

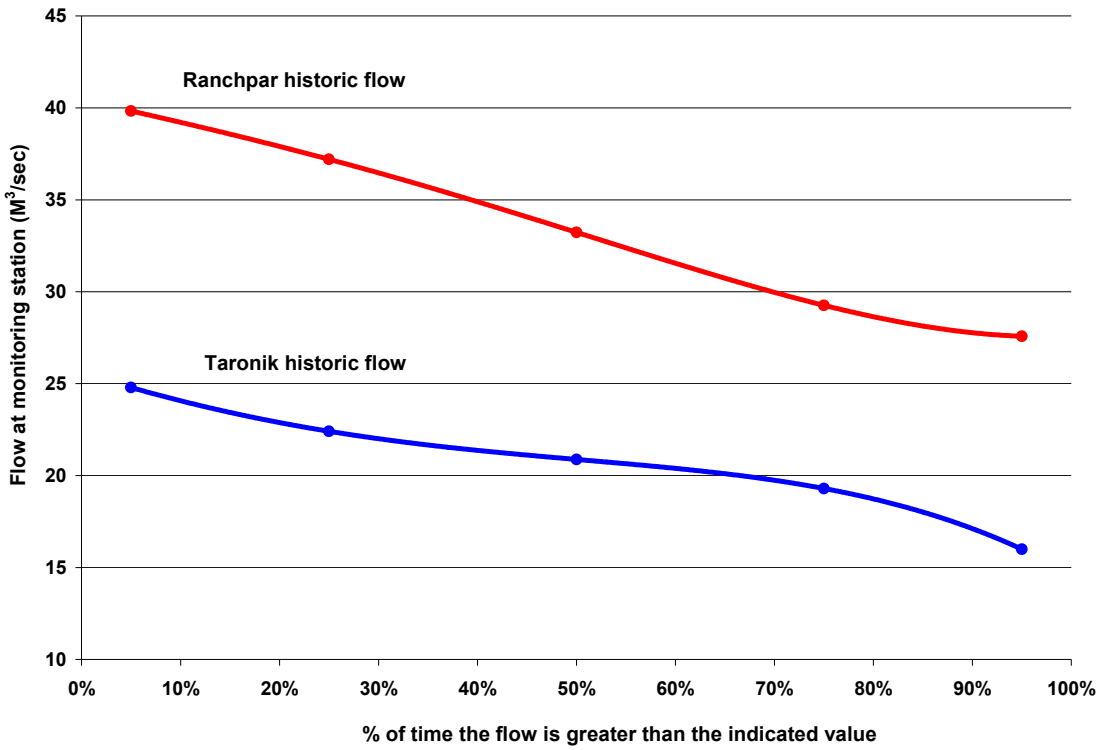


Figure 5.2-2, Statistical summary of Recent flows in the Sevjur River at the Taronik and Ranchpar Monitoring Stations

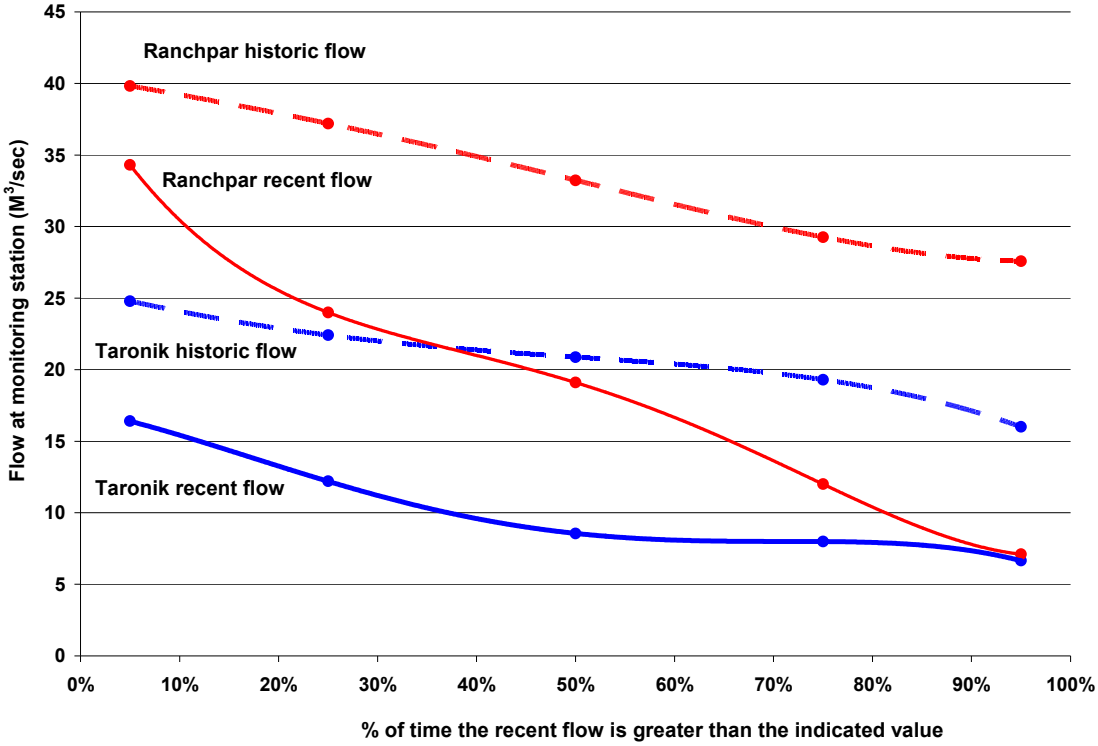
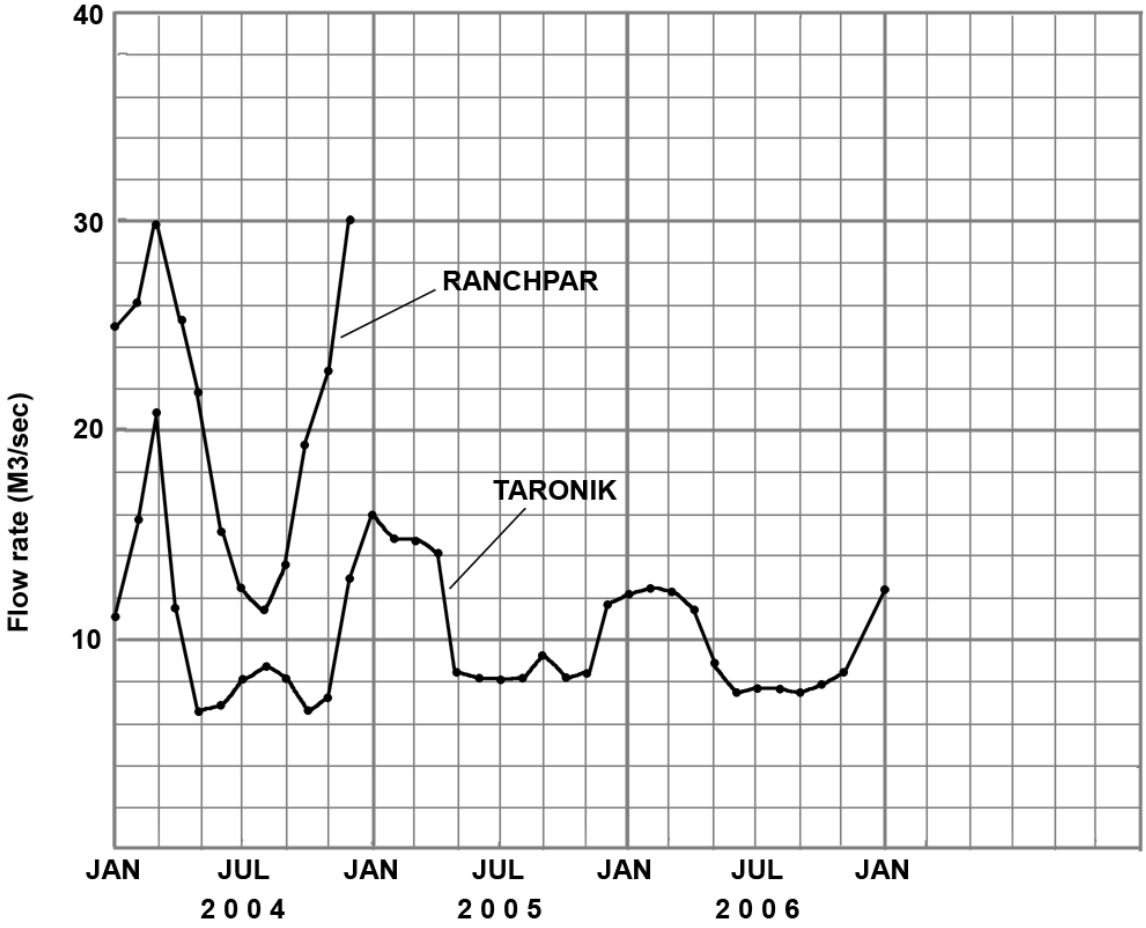


Figure 5.2-3, Flow rate at Taronik and Ranchpar Monitoring Stations by monthly average.



REFERENCES

[5.2-1] CJSC "Armenian Nuclear Power Plant", 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Rev.1, 2007. Section 1.49.

[5.2-2] The World Bank, 2004, *Project Performance Assessment Report, Armenia Irrigation Rehabilitation Project (Credit 2667-Am)*, Document of The World Bank, Report No.: 28847, May 5, 2004.

[5.2-3] Ministry of Nature Protection of the Republic of Armenia, 2002, *National Action Programme to Combat Desertification in Armenia*,.

[5.2-4] The RoA Government Decree No. 592-N dated May 22, 2003, *On Approval of the Procedure for Determination of Permitted Marginal Volumes of Unrecoverable Water Withdrawal for Each Water Resource in the Section of Ecological Discharges and Surface Flow*.

[5.2-5] Law of the Republic of Armenia, adopted November 27, 2006, *On The National Water Program Of The Republic Of Armenia*.

[5.2-6] Republic of Armenia, *Water Code of The Republic of Armenia*, Adopted By The National Assembly Of The Republic Of Armenia On June 4th, 2002

[5.2-7] Republic Of Armenia, Ministry Of Agriculture, January 2000, *Irrigation Rehabilitation Project, Project Implementation Unit, Environmental Assessment of Irrigation Development Project,* Draft Final EA Report.

5.3 IMPACTS OF COOLING SYSTEM OPERATION

This section assesses the predicted physical impacts caused by the plant intake system including entrainment, entrapment and impingement of aquatic species. The section also discusses impacts of the plant discharge system including impacts on turbidity in the Sevjur River and the impact of temperature changes in the river.

The impacts of chemical wastes discharged to the river through the cooling system will be discussed in Section 5.5.

This section evaluates the potential impact of the cooling tower emissions on the terrestrial environment. This includes impacts of the vapor plume on the human environment. It also includes impacts on the terrestrial ecosystem resulting from the chemicals carried out of the top of the cooling tower as drift.

5.3.1 Impacts of the Cooling Water Intake

Water drawn into the cooling water intake will entrain and carry with it everything that is in the water. This will include dissolved minerals, silt, plankton, and possibly fish. The organisms drawn into the intake will be killed.

Organisms must move or be carried into the zone of influence of the intake flow to be entrained. The aquatic habitat in the vicinity of the intake and the use that various species make of that habitat are important. Eggs and larvae of fish that build nests and protect their young are unlikely to be entrained, even if the spawning and nursery area is near the intake structures. Adult or larger fish may have swimming speeds which will allow them to escape the influence of the plant intake.

The placement and design of the intake structure also affects the number of organisms drawn into the intakes. For example, the orientation of the intake relative to the direction of stream flow is important. An intake perpendicular to the flow of the river, as the design of the Unit 2 intake is, will entrain fewer fish than an intake facing into the river flow. Also important is the velocity of the water toward the intake opening. Providing an intake with a large cross sectional area will allow smaller fish to escape the intake current. Long intake canals can trap fish even though their swimming speeds exceed the intake velocity (References [5.3-1] and [5.3-2]). Section 3.4.2.1 includes a commitment that: “For the river intake channel, the maximum water velocity of the cross-section will be less than 0.15 m/s.” Most fish should be able to swim out of the canal against this current.

The US Environmental Protection Agency has been concerned about impingement and entrainment losses at power plant cooling water intakes since 1973. As recently as February 2004 they proposed revisions to their regulations applicable to intakes (Ref. [5.3-3]). Their revisions were to apply to cooling water intakes withdrawing more than 189 million liter per day (50 million gallons per day). This is a little larger than the proposed Unit 3 water requirement. For the plants to which the regulations do apply, the amount of water drawn into a cooling water intake on a free flowing river is limited to no more than 5% of the average river flow. Below this rate the U.S. Environmental Protection Agency (USEPA) expects that the impacts would be acceptably small.

Since ANPP Unit 3 will use a closed cycle cooling water system, the volume of water drawn into the plant will be small relative to the volume of water required for once -through

cooling. Table 5.2-1 shows that Unit 3 will draw water from the Sevjur River at a rate of 1.95 m^3/s.

The annual average historic flow in the river is 20 m^3/s. Because of withdraws of water upstream for other purposes the annual average flow as measured at the Taronik monitoring station near the Unit 3 intake is closer to 11 m^3/s. The lowest flow at the Taronik Monitoring Station between 2004 and 2006 was about 6 m^3/s. Thus, Unit 3 will withdraw between 10 and 20 % of the Sevjur flow.

There are eleven (11) agricultural intakes on the Sevjur taking water at an annual average rate of 10 m^3/s (See table 2.2-10). The average withdrawal at each intake is close to 1 m^3/s. The irrigation water is used during seven months of the year, so the actual intake rate may be greater or lower at various times of the year (see Section 5.2). When the final design of the intake for Unit 3 is evaluated, the losses of eggs and larvae at all of the intakes should be assessed to put the power plant in perspective with all of the losses in the Sevjur River system. This will also provide an assessment of cumulative losses.

The ANPP Unit 3 intake is on a small pool backed up behind an agricultural irrigation diversion dam (known as Zeiva dam – see Ref. [5.3-4]). The pool backs water up for about 2.5 to 3.0 km. The river gradient in the pool is about 0.0005 m/m. The banks of the pool are generally water logged and there is lush vegetation at the edges of the pool (Ref. [5.3-4]). The water flows at a slower velocity than the water on the free flowing reaches of the Sevjur. Downstream from the diversion dam, the water again flows freely between well defined banks.

Organisms that are entrained in the intake flow and pumped up into the Unit 3 cooling water system will be lost from the ecosystem. Factors unique to the life cycle of each species must be considered to determine the likely entrainment losses of the species, their habitat preferences, feeding habits, and spawning behavior are important. A species present in the vicinity of the intake must move or be moved into the zone of water withdrawal. Structural design and operational factors also affect exposure.

There have been 33 species of fish identified recently as having been observed in the Sevjur River. These are included in Table 5.3-1.

This list is based on species identified in Section 2.4. Species specifically noted in Table 2.4-7 as being found in the Sevjur river are included. The additional species known to be in the river as identified by Dr. Gabrielyan, Director of the Institute of Hydroecology and Ichthyology at the RoA National Academy of Sciences (References [5.3-12] and [2.4-49] have been added).

The Sevjur is 38 km long. However it is only 7 km from the diversion dam up to the headwaters. It is not known whether the species favoring free flowing rivers were observed in the 7 km stretch upstream of the diversion dam. During periods of very high flow, gates in the dam are opened and water does flow freely in all sections of the river. Upstream migration could occur during these high flow conditions.

The list of species is large and diverse, indicating the apparent health of the river. The importance of the river in sustaining the species is unknown. No studies have been found describing spawning that may occur in the river. The preferred habitats, feeding habits, and spawning habits of each species have been included in Table 5.3-1 from other sources, where known.

Several species listed (primarily among the Cyprinidae) should favor the habitat in the pool where the intake structure is located over other stretches of the river. Generally, these are the species that favor calmer or stagnant water. The benthic or bottom feeding species are also more likely to be found in the pool. The larvae and juveniles of these species are most subject to entrainment. The species that favor the free flowing segments of the river are less likely to spawn in the pool. Their larvae and juveniles should suffer lower entrainment losses.

Many of the species that favor the pool attach their eggs in vegetation. This should minimize entrainment of the eggs of those species. Those that broadcast their eggs and allow them to drift with the current are more subject to entrainment losses.

The design includes a maximum intake velocity. It also includes travelling screens and filters [See Chapter 3]. Traveling screens prevent the entrainment of fish. Fish are removed from the screens and returned to the river. Fish eggs and larvae will pass through the screens. However if it is determined that the potential loss of the entrainable life stages are unacceptable, fine mesh screens of various designs can be used for collecting and returning the eggs and larvae to the water body (Ref. [5.3-1]).

Trash bars and screens were noted at the ANPP Unit 2 settling pond pumping station. However these seemed to be for the protection of the pumps. There did not appear to be a provision for returning fish to the River.

Unit 3 will withdraw 18% of the 11 m^3/s average flow of the river. This is well above the 5% rate that the USEPA has determined that impacts would be acceptable without analysis. Therefore, the impact to fish from entrainment losses at Unit 3 will be MODERATE if the intake design does not give proper consideration to reducing entrainment of eggs and larvae. A commitment has been made to design the intake to minimize entrainment and impingement losses. It is recommended that a study of the fish species above the diversion dam be undertaken to determine what design features should be included in the Unit 3 intake to reduce this impact. If the necessary design features are included, the impact will be SMALL.

5.3.2 Cooling Water Discharge Impacts

The potential impacts associated with the power plant discharge include hydrological alterations at the discharge. Other potential impacts are due to the addition of the heat and chemical substances in the discharge flow.

Blowdown from the circulating water system is combined with other discharge flows and piped to the river. The Unit 2 discharge is 1000 l/s (See Section 3.6).

The discharge from Unit 2 currently enters the Kosh-Ujan storm water drainage canal through which it flows about 0.5 km to the river. It has been recommended in Section 3.4 that the pipeline be extended so that the cooling water from Unit 3 can be returned directly to the Sevjur River. It is assumed that this discharge would be near the point where the canal joins the river. This discharge point is about 0.8 km downstream from the intake (See Section 3.4). At this point the Sevjur is once again free flowing. The river boundaries are well defined and the banks are no longer water logged (Ref. [5.3-5]).

Because the river is faster flowing at this point and is lacking shoreline vegetation, the habitat may not be attractive to the same species found in the pool at the intake. Species

favoring the pool habitat may make transit through the area. However, the vulnerable species at the discharge will be those that prefer the faster flowing water.

If a 1000 mm pipeline is used, the velocity of the water in the pipeline will be greater than 1 m/s. It may be necessary to reduce the energy in the discharge to prevent scouring from occurring. The discharge will be completely mixed with the river within 5 to 10 river widths or 75 to 150 m downstream of the discharge.

As noted in Section 2.2, the average temperature in the Sevjur River varies from 12.4ºC in January to 15.4ºC in July (Ref. [5.3-5]).

The ANPP provided quarterly average discharge temperature data for Unit 2 for 2006 and 2007 . The average temperature of the discharge ranged from 13.5ºC in the first quarter of 2006 to 21ºC in the second quarter of 2007. It is noted that the bounding value for discharge temperature based on the Plant Parameter Envelope is an average of 33 º/C and a maximum of 38 ºC. These discharge temperatures at Unit 2 may be a better indicator of the results of the evaporative cooling to be expected at Unit 3. Using the ANPP Unit 2 results, the temperature difference between the discharge and the river will average about 1.1ºC in the winter and about 5.6ºC in the summer.

The Unit 3 discharge flow rate is 0.9 m^3/s. The winter flow of the river is about 20 m^3/s (See Section 5.2). After mixing, the temperature increase in the river in the winter will be less than 0.1ºC and will raise the river temperature to about 12.5ºC. In the summer the river temperature will be increased about 0.6ºC to a temperature of 16ºC in the summer. Using the bounding value for discharge temperature of 38ºC from Section 3.4.1.1, the maximum temperature increase in the river after mixing of the Unit 3 discharge would be predicted to be 2.6ºC.

The applicable water quality standard for Fisheries Protection specifies that water temperature should not rise more than 5°C, compared to the natural temperature of the water body: The standard further specifies that the temperature should not exceed 20°C in summer, and 5°C in winter for the water bodies for cold-water fishes (salmon, trout, white-fish). For other water bodies, temperature should not exceed 28°C in summer and 8°C in winter (See Section 2.3). The temperature increase after mixing will be within the 5ºC temperature increase limit for all seasons. The ambient temperature in the Sevjur River remains well above 8ºC in the winter. Thus compliance with the standard is impossible. The GoA will determine the limitations that should be placed on the discharge when a water use permit is issued..

In the rapidly flowing area of the river where the discharge will be located, organisms will be carried along with the river flow. They will not be in the plume long enough to be effected by the difference between the discharge and the river temperature. Therefore the impact of the heated water discharge will be SMALL.

5.3.3 Cooling Tower Impacts

Unit 3 includes two evaporative cooling systems. The larger source of heat is the circulating water system that removes heat from the condensers. The second cooling system is the service water system. The service water system provides component cooling and for some reactor designs may serve as the ultimate heat sink for removing heat from the reactor in the event of an accident (See Section 3.4).

The circulating water system will dissipate heat to the atmosphere using a natural draft cooling tower. The height of the tower will be 170 m. Air exiting the tower is carried high above the top of the tower by the exit velocity. The exiting air is also warmer and less dense than the ambient air. The buoyancy due to the difference in air density will also tend to propel the air upward as it exits the top of the cooling tower. The service water system will be cooled by a spray pond that will release the heat at close to ground level. The types of potential impacts of the two systems are similar. However, because of the lower heat load in combination with the lower elevation of the release, the magnitude of the impacts of the service water cooling system will be smaller and will essentially be contained within the site boundaries.

Several cooling system types are considered for the circulating water system (See Section 3.4.) The natural draft cooling tower has the potential to cause impacts farthest from the tower. Mechanical draft cooling towers can cause higher impacts but these impacts will occur closer to the towers.

This section addresses impacts to residents and to terrestrial ecosystems. Evaporative cooling adds a lot of moisture to the atmosphere. This can result in fog or cloud formation and possibly icing of paved surfaces close to the site. Deposition of salt in the drift from the cooling towers has the potential to impact flora in agricultural and natural areas.

5.3.3.1 FOGGING

Water will be evaporated from the cooling tower at a rate of about 980 l/s (See Section 3.3). As the vapor plume exiting the top of the cooling tower mixes with the cooler, drier ambient air, the temperature is decreased, the mixture becomes saturated with moisture and fog or a cloud may form. As additional quantities of the drier ambient air are mixed in, the water vapor is absorbed and the plume seems to end.

At times the ambient air may not be dry enough to absorb the moisture from the cooling tower within a short distance of the plant. Cloudy skies often occur naturally when the air is saturated with moisture. Data collected at the Hoktemberian and Yerevan Agro meteorological stations show that cloudy skies prevail the winter. The relative humidity is high, reaching a maximum in December. During the months of December through February on average there are eight (8) foggy days. The average duration of the fog during these months is six (6) hours. Fog occurs less regularly in the summer months. The average number of days with fog each year is 38 (Ref. [5.3-5]) (also see Section 2.7).

The additional water vapor added by the operation of Unit 3 will be well above ground level. It may result in an increase in the duration of fog events and may increase their frequency of occurrence slightly. Since the frequency of occurrence of fog will remain small, it is not expected to have an impact on residents near the site.

The USNRC recently studied the environmental impacts at 18 operating nuclear power plants in the US. The study included 8 units using natural draft cooling towers and 10 using mechanical draft towers. The study concluded that increased fogging has little potential to affect crops, and adverse effects have not been reported at plants using either type of cooling tower (Ref. [5.3-7]).

The impact of the cooling water system on fog will be SMALL.

5.3.3.2 ICING

Ice can form in the winter when cooling tower drift is deposited on surfaces having temperatures below 0ºC. In its study of 18 operating power plants, the USNRC found that ice damage to vegetation resulting from drift deposition had occurred at three plants with mechanical draft cooling towers (Ref. [5.3-7]). Drift deposition occurs farther away from natural draft cooling towers and at a lesser rate. The USNRC study did not find damage to crops or natural vegetation from drift at any of the plants with natural draft towers.

Ice can also form when low-level clouds or fog occur at ground level in freezing conditions. Frost has been observed to occur an average of 8.2 days per year in the ANNP site vicinity (Ref. [5.3-5]). The increase in the moisture content of the air by the natural draft cooling tower may contribute to frost formation. Based on the USNRC study, ice formation is unlikely (Ref. [5.3-7]).

The impact from ice formation caused by Unit 3 will be SMALL.

5.3.3.3 CLOUD COVER AND SHADOWING

The cooling tower discharge plume from the natural draft tower will rise into the atmosphere 500 meters or more. This added moisture may increase the potential for low level cloud formation. Cloud cover is reported in the ANPP site vicinity 90 days per year. Of these, 17 days are reported as having low level cloud cover (Ref. [5.3-5]).

Computer modeling of the natural draft cooling towers at the Bellefonte Nuclear Plant predicted a maximum cooling tower plume length of 5 km, occurring in the winter. At that time of year the average plume length was predicted to be 4.5 km (Ref. [5.3-8]).

The USNRC study found that increased cloud cover resulting from cooling-tower operation has little potential to affect crops, and adverse effects have not been reported (Ref. [5.3-7]).

The impact of the cooling tower plume on cloud cover will be SMALL.

5.3.3.4 DRIFT

Air flows into the base of the natural draft cooling tower and then flows upward past the warm condenser cooling water that is flowing downward over wetted surfaces within the tower (See Section 3.2 and Figure 3.2-3). The upward flowing air cools the downward flowing water by evaporation. The air also picks up water droplets and carries them out the top of the cooling tower. The water droplets will contain whatever chemicals were dissolved in the cooling water.

The air is accelerated as it flows upward through the tower. The exiting air will be warmer and lighter than the ambient air. The resulting buoyancy also helps propel the warm air upward. As the air exiting the tower rises, the surrounding air is entrained, reducing the buoyancy and the velocity of the rising air mass. As the rising air loses its upward velocity, the ambient wind also turns the plume downwind. The entrained water droplets will begin to fall to the ground.

The droplets exiting the top of the tower vary in size. The larger droplets will fall faster than the smaller droplets and will be deposited on the ground close to the cooling tower.

The smaller droplets continue downwind. During the transport out of the towers and downwind, the water forming the droplets is being evaporated. Concentration of salt within a droplet approaches the solubility limit and salt crystals may be precipitated in the droplets. If the droplets evaporate completely, salt crystals and remaining chemical molecules will remain airborne. The crystals and molecules will no longer be settling. They can no longer be deposited on vegetation at a significant rate. The material will be carried along with the wind until the crystals of molecules may impinge on vegetation or on the ground or be removed from the atmosphere by rain.

If the deposition rate is high enough, the chemicals that fall to the earth in water droplets near the cooling tower may damage vegetation. In some desert areas where the soil has a natural high salt content, the salt deposited from the drift may further degrade the soil. The chemical constituents not be deposited in droplets and may be of concern as air pollutants.

Cooling tower designers have been able to determine drift rates at existing towers. Drift rate is normally expressed as a fraction of the circulating water flow rate. The drift rate is a function of the cooling tower design and can be kept small by including drift eliminators in the tower. The use of drift eliminators may result in a very small reduction in tower performance.

The Unit 3 tower water droplets are assumed to escape the top of the Unit 3 cooling tower as drift at a rate of 7.6 l/s (See Section 3.3). The concentration of contaminants in the drift droplets will be the same as the concentration in the circulating water system. The contaminants will include chemical species present in the water drawn from the Sevjur as makeup, plus chemicals intentionally added to the circulating water system to limit scale formation and biological growths (See Table 3.6-1).

The rate of deposition of salts that will occur in the area around ANPP Unit 3 can be estimated by looking at computer modeling results for other natural draft cooling towers.

New units at the Bellefonte Nuclear Plant will use cooling towers that are 145 meters tall (Ref. [5.3-8]). Bellefonte is on the Tennessee River where water quality is high. The quantity of salts leaving the tower as drift is very small.

New units at the Calvert Cliffs Nuclear Plant in Maryland will use mechanical draft cooling towers that are 50 meters tall (Ref. [5.3-9]). Calvert Cliffs is located on the Chesapeake Bay where the water is quite high in Salinity.

Cooling tower design and drift rate data for the two plants and for ANPP Unit 3 are shown in Table 5.3-2.

Calvert Cliffs and Bellefonte used the same computer model to estimate drift deposition (References [5.3-10] and [5.3-11]). The computer model requires several years of meteorological data similar to the data requirements for the radiological dose pathway modeling in Chapter 7.

Using the model results for these two plants, the drift emissions rate can be scaled to show what the models would have predicted for the ANPP Unit 3 emissions rate. The deposition rate for the natural draft tower at Bellefonte reached a maximum at 2.3 km from the tower. The deposition rate for the 50 m mechanical draft tower at Calvert Cliffs is predicted to peak closer to the tower at 1.1 km. The tower at ANPP Unit 2 is slightly taller

than the Bellefonte tower and thus peak deposition may occur at a slightly farther distance.

The maximum deposition rates are 5.7 kg/ha per month at the 145 m natural draft tower and 2.6 kg/ha per month at the 50 m mechanical draft tower. The difference in the exit air velocity at the two types of towers and the difference in tower heights account for some of the difference in the peak deposition rates. Because results are averaged over a month and several years of data were used, different meteorological conditions should not account for much of the difference in deposition rates.

At ANPP Unit 3 the prevailing wind direction is from the west. Most of the drift deposition will occur to the east of the tower.

The USNRC did a review of the impact of drift deposition on vegetation. They concluded that the deposition rate that could cause vegetation damage is higher than 10 kg/ha per month. Therefore there is insignificant potential impact to vegetation from salt deposition at ANPP Unit 3.

The potential impact of the cooling system on the terrestrial ecosystem due to cooling tower drift is SMALL.

The electrical switchyard for Unit 3 will be located approximately 500 meters from the cooling tower. The switchyard at Calvert Cliffs, which used a 50 m mechanical draft cooling tower, is also 500 m from the tower. Using the same drift model the deposition rate at the ANPP switchyard would be 0.033 kg/ha per month. The deposition rate at the switchyard was not computed for the natural draft cooling tower at Bellefonte. Because of the height of the tower and the height of the plume, the deposition rate 500 m from the tower will also be SMALL.

Based on industry experience, solids deposition on switchyard equipment would require adjustments to maintenance frequencies (e.g., insulator washing). However, the expected deposition rates will not affect switchyard component reliability or increase the probability of a transmission line outage.

The potential impact of cooling tower drift on the switchyard equipment will be SMALL.

Table 5.3-1, Habitat Preferences of Fish Reported in the Sevjur River

ORDER I. SALMONIFORMES **Family 1. SALMONIDAE**	
Salmo trutta fario	Brown Trout prefers fast flowing streams
Salmo trutta trutta	Sea Trout prefers cold upland waters
ORDER II. CYPRINIFORMES **Family 3. CYPRINIDAE**	
Acanthalburnus microlepis	Brackbrow bleak.
Alburnus filippi	Kura bleak. Benthopelagic.
Alburnus alburnus hohenackeri	North Caucasian bleak. Eggs sticky laid on submerged plants.
Alburnoides bipunctatus	Spirlin. Inhabits rivers with very calm waters.
Aspius aspius	Asp. Prefers quiet rivers moves upstream to spawn.
Barbus lacerta cyri	Carp native to Sevjur
Barbus capito	Spawns on gravel bottoms in lowland streams usually in strong current
Barbus mursa	Spawns over sand gravel bottoms
Blicca bjoerkna	Carp frequent stagnant waters or calm waters. Only found in Sevjur.
Blicca bjoerkna derjavini	White bream. Frequents stagnant waters of lakes and reservoirs. Rivers with calm waters.
Capoeta capoeta	Transcaucasian barb. Mountain rivers and lower reaches. Spawn on stony ground in rivers.
Carassius gibelio	Prussian Carp form of goldfish. Lake dweller moves into rivers to avoid low oxygen concentrations.
Chondrostoma cyri	Kura nase is benthopelagic – bottom dweller
Cyprinus carpio carpio	Common carp benthopelagic. Spawns in spring and summer laying sticky eggs in shallow vegetation.
Gobio gobio	Gudgeon, Prefers fast flowing rivers with gravel bottom. Found in still waters. Eggs are released above bottom and drift with current, sink and stick to substrate. Larvae and juveniles are benthic, prefer detritus rich sandy habitat and slow current.
Gobio persus	Kura Gudgeon bottom dweller.
Leucaspius delineatus	Carp spawns in vegetation.
Leuciscus cephalus	*Squalius cephalus*. European Chub. Attach eggs to gravel, stones, and weeds in flowing water.
Mylopharyngodon piceus	Black Carp. Eggs are semipelagic and

	hatch while drifting downstream.
Pseudorasbora parva	Stone moroko found in cool running water.
Rhodeus amarus	Bitterling. Found among plants over sand and muddy bottoms in shallow water.
Rutilus rutilus	Roach benthopelagic in slow flowing or still muddy water.
Family 4. COBITIDAE	
Sabanejewia aurata	Goldside loach
Family 5. BALITORIDAE	
Nemacheilus angorae	Angora loach. Benthopelagic feeds throughout the water column.
Barbatula barbatula caucasica	Stone Loach inhabits shallow fast flowing streams with gravel bottoms. Sheds eggs among stones and water plants.
ORDER III. CYPRINODONTIFORMES	
Family 6. POECILIIDAE	
Gambusia affinis	Mosquito fish in standing to low flowing water, typically ponds or lakes.
Gambusia holbrooki	Eastern mosquito fish. Introduced for mosquito control.
ORDER IV. SILURIFORMES	
Family 7. SILURIDAE	
Silurus glanis	Wells catfish. Found in deep waters of dams.
Family 8. ICTALURIDAE	
Ictalurus punctatus	Channel catfish. Prefers clean well oxygenated water benthopelagic.
ORDER V. PERCIFORMES	
Family 9. GOBIIDAE	
Knipowitschia caucasica	Perch-like species likes shallow water with weeds. Attaches eggs.
Neogobius fluviatilis.	Monkey goby. Benthopelagic.

Table 5.3-2, Cooling Tower Drift Deposition Analysis

Unit	Drift, l/s	Drift concentration, mg/dm^3	Drift rate, kgms/day	Unit 3 Drift Rate/Other plant Drift rate	Tower Height, m	Maximum Deposition Rate, kg/ha per month	Distance to max deposition, m	Estimated Maximum Unit 3 Deposition Rate based on indicated Unit, kg/ha per month
Unit 3	7.6	2000	1313		168			
Calvert Cliffs	2.48	18133	3885	0.34	50	7.6	1100	2.6
Bellefonte	6.7	40	23	57	145	0.1	2300	5.7

REFERENCES

[5.3-1] Wisconsin Department of Natural Resources, February 22, 2005, *Guidance for Evaluating Cooling Water Intake Structures,* [Implementing Section 316(b) of the Clean Water Act and Chapter 283.31(6), Wis. Stats.]

[5.3-2] US Code of Federal Regulations, Title 40: Protection of Environment, Part 125, Criteria And Standards For The National Pollutant Discharge Elimination System, Subpart I—Requirements Applicable to Cooling Water Intake Structures for New Facilities Under Section 316(b) of the Act, Dec. 18, 2001.

[5.3-3] US Environmental Protection Agency, Feb 17, 2004, News Release: *National Standards Announced for Cooling Water Intake Structures at Large Existing Power Plants*

[5.3-4] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of Armenian Nuclear Power Plant*.

[5.3-5] State Unitarian Enterprise Scientific-Research Design and Construction Institute of the Ministry of Atomic Energy of the Russian Federation, 2001, *Armenian Nuclear Power Plant Unit 2, Essential Service Water Cooling System, Substantiation of Safety of the Essential Service Water System, including Issues of Environmental and Radiological Safety*, Section 8.2.3.1.

[5.3-6] CJSC Armenian Nuclear Power Plant, 2007, *Safety Analysis Report On Power Unit № 2: 1.4. General Information On The Power-Generating Unit Site*, Table 1.4-3.

[5.3-7] US NRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, (NUREG-1437 Vol. 1) pars 4.3.4.1.1, 4.3.5.1.1

[5.3-8] Tennessee Valley Authority, 2007, *Bellefonte Nuclear Plant, Units 3 & 4 COL Application, Part 3, Environmental Report, Section 5 Impacts of Operation.*

[5.3-9] Constellation Generation Group, UniStar Nuclear Operating Services, 2007, *Applicant's Environmental Report, Combined License Stage, Calvert Cliffs Nuclear Power Plant Unit 3, Rev 0*.

[5.3-10] Policastro, 1993**.** *A Model for Seasonal and Annual Cooling Tower Impacts*. Atmospheric Environment Volume 28, No. 3, Pages 379-395, A. Policastro, W. Dunn, and R. Carhart.

[5.3-11] Electric Power Research Institute (EPRI) Cooling Tower Plume Prediction Code, also known as the Seasonal and Annual Cooling Tower Impacts (SACTI) Model. The SACTI model, developed by Argonne National Laboratory for EPRI, predicts the probable dimensions of the visible cooling tower plume by utilizing meteorological data and cooling tower design parameters (Houck and Phillips 1997c; see Appendix I). The details of the modeling assumptions and the calculation methods of this model are contained in the document titled: Users Manual: Cooling-Tower-Plume Prediction Code, EPRI CS-3403-CCM.

[5.3-12] Gabrielyan, B.K., October, 2007, *Personal Communication*, at a meeting with the Scientech and PA staff on October 17, 2007.

5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION

This section provides results of analyses of individual and collective doses due to radioactive gaseous and liquid effluents released from the unit in the course of normal unit operation. This section presents a summary of the analysis and evaluation of the radiological impacts on individuals due to radioactive effluents released from the unit in the course of normal operation. It also describes the analysis to determine if there is any potential for significant radiological impacts to biota other than members of the public.

This section also details information on recent monitoring results of radioactivity of the environment in the ANPP site vicinity, as follows:

- Table 5.4-2, Activities in Water Bodies;
- Table 5.4-3, Radionuclide Concentrations in Agricultural Produce;
- Table 5.4-5, Measured Airborne Radiation in ANPP Unit 2 Vicinity;
- Table 5.4-6, Radioactivity on the Ground and in Soils;
- Table 5.4-7, Environmental Exposure Doses, 2007; and
- Figure 5.4-1, External Doses in Vicinity of ANPP Unit 2, 2007.

{Radiological impacts of normal operation are typically predicted based on detailed calculations using computer software, such as LADTAP[1], GASPAR[2], and XOQDOQ[3], that use expected source term data for the NPP to predict exposures that will be received by onsite personnel, members of the public, and flora and fauna in the region of the unit. Since a specific reactor design has not been selected, complete source term data are not available for such analyses. In addition, specific receptor data, such as consumption rates for agriculture and aquaculture products from the region are needed to complete accurate analyses. Therefore, rather than reporting on detailed calculations, this section evaluates PPE source term data to confirm expectations that releases will be within regulatory limits. Population exposures are predicted based on data from ANPP Unit 2. The final environmental assessment should include the results of appropriate analyses based on site-specific environmental factors and expected source terms for the selected reactor.}

5.4.1 Republic of Armenia Regulatory Requirements and International Guidelines

For evaluation of doses to members of the general public from ANPP Unit 3, a limit of 0.1 mSv annual effective dose is assumed, based on the following requirements.

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[1] See http://www-rsicc.ornl.gov/codes/ccc/ccc3/ccc-363.html
[2] See http://www-rsicc.ornl.gov/codes/ccc/ccc4/ccc-463.html
[3] See http://www-rsicc.ornl.gov/codes/ccc/ccc3/ccc-316.html

5.4.1.1 GOVERNMENT OF ARMENIA RESOLUTION № 1219-N (REF. [5.4-1])

5.4.1.1.1 Main Dose Limits for the Public

Resolution 1219-N, Paragraph 31 sets the following main dose limits for the public (population):

- Up to 1 mSv annual effective dose - for subsequent averaged 60 months (5 years), but not more than up to 5 mSv effective dose for each separate year (for subsequent 12 months);
- Up to 15 mSv annual (subsequent 12 months) equivalent dose on lenses (of the eye);
- Up to 50 mSv annual (subsequent 12 months) equivalent dose on palms of hands and toes or on the skin.

5.4.1.1.2 Additional Restrictions on Dose to the Public

Additional requirements on doses to the population from Resolution 1219-N include:

- For population, the effective dose shall not exceed 70 mSv in the lifetime (70 years). (¶ 32)
- Annual aggregate radiation dose of population from all anthropogenic radiation sources shall not exceed main values of the dose limit (Paragraph 31). (¶ 34)
- Annual penetration marginal values of radioactive isotopes through the pancreas and the respiratory tract, as well as their permissible volumetric activities and levels of intervention are represented in Table 3. (¶ 36)
- levels of intervention are represented in Table 3. (¶ 36)

The above noted annual limit of 1 mSv for the general population is from all sources and the State Regulatory Committee for Nuclear and Radiation Safety apportions that by applying a limit of 0.25 mSv from any single existing source and 0.1 mSv for evaluation of a potential new source, such as ANPP Unit 3 (Ref. [5.4-2]). Therefore, the limit for assessment of population dose due to normal operation of ANPP Unit 3 will be 0.1 mSv/yr.

5.4.1.2 IAEA SAFETY SERIES № 115 (REF. [5.4-3])

Many International Atomic Energy Agency (IAEA) publications provide international requirements and guidelines related to radiation exposures. Among these are:

- INSAG-12 (Ref. [5.4-4]);
- Safety Requirements NS-R-3 (Ref. [5.4-5]);
- Safety Guide NS-G-3.2, (Ref. [5.4-6]); and

- Safety Guide WS-G-2.3 (Ref. [5.4-7]).

Each of these refers to the Basic Safety Standards (BSS) for protection against ionizing radiation in IAEA Safety Series № 115.

BSS Paragraph 2.23 sets limits on doses, thus: “The normal exposure of individuals shall be restricted so that neither the total effective dose nor the total equivalent dose to relevant organs or tissues, caused by the possible combination of exposures from authorized practices, exceeds any relevant dose limit specified in Schedule II …”. Appendix III, Paragraph III.9 also refers to Schedule II for limits of discharges to the environment.

BSS Schedule II, paragraph II-8 sets limits for estimated average dose to the relevant critical groups of members of the public that are attributable to practices (e.g. NPP operation) that are consistent those specified in Paragraph 31 of GoA Resolution № 1219-N, as quoted above.

BSS Table II-VI provides committed effective dose per unit intake via ingestion by members of the public for specific age groups by radionuclide. BSS Table II-VII provides committed effective dose per unit intake via inhalation by members of the public for specific age groups by radionuclide.

5.4.2 Exposure Pathways

Radiological exposure due to operation of ANPP Unit 3 is highly dependent on the exposure pathway by which a receptor may become exposed to radiological releases from the facility. The major pathways of concern are those that could result in the highest calculated offsite radiological dose. These pathways are determined from the type and amount of radioactivity released, the environmental transport mechanism, and how the environs surrounding the site are used (e.g., residences, gardens, etc.). For gaseous effluents, the environmental transport mechanism is dependent on the meteorological characteristics of the area. An important factor in evaluating the exposure pathway is the use of the environment by the residents in the area around the site. Factors such as location of homes in the area, use of cows and goats for milk, and gardens used for vegetable consumption, are considerations when evaluating exposure pathways.

5.4.2.1 LIQUID PATHWAYS

The release of radioactive liquid effluents will be permitted, so long as the effective doses from such releases comply with the limits specified in GoA Resolution 1219-N, paragraph 31 (Ref. [5.4-8]). Conservatively assuming that water in the liquid effluents must meet standards for drinking water, concentrations of radioisotopes must be less than the levels of intervention given in Resolution 1219-N, Table 3 (Ref. [5.4-9]).

ANPP Unit 2 radioactive liquid discharges currently go primarily to the sanitary sewage system and some to the industrial sewage, or cooling water blowdown, discharge pipe.

Currently untreated[4] sanitary sewage flow enters the Sevjur River upstream of the plant cooling water intake and cooling water blowdown is discharged into the Kosh-Ujan storm water drainage canal which joins the Sevjur downstream of the plant intake structure. Recent discharge data for Unit 2 is reported in the Report on Radiation Safety at the Armenian Nuclear Power Plant for 2007 (Ref. [5.4-10]).

ANPP Unit 3 liquid effluent will be discharged to the Sevjur River via the discharge pipe which will be extended to the river bank downstream of the plant intake. This effluent will include added radioactivity due to discharged liquid radioactive waste and any contamination of cooling water resulting from leaks in heat exchangers.

ANPP Unit 2 Measured levels of liquid releases from ANPP Unit 2 via the sewage system are given in the National Report of Republic of Armenia under the Convention on Nuclear Safety (Ref. [5.4-11]). Releases of long-lived radionuclides (Sr + Cs) amounted to 5.87 GBq over the five-year period of 2002-2006, for an average of 1.17 GBq/y. Comparing this discharge with that predicted in Plant Parameter Envelope, Table 3.2A-8, for Sr + Cs, results in a ratio of 0.77 (Unit 3 discharges to Unit 2 discharges). Although Unit 3 will produce higher amounts of radioisotopes in the fuel due to its higher power level, improved system designs will result in lower annual discharges of radioisotopes in liquid effluents.

Annual radioactive liquid discharges from Unit 3, including a factor for anticipated operational occurrences, are given in Table 3.5-1. The discharges will be diluted by cooling tower blowdown. Assuming a circulating water system (CWS) blowdown flowrate of 950 l/s[5] and cooling system operation 80% of the year, the annual releases will be diluted by $2.39 \cdot 10^{10}$ liters of water. If alternate cooling technologies are used to eliminate or reduce the water usage in the CWS, the releases will be diluted only by service water system (SWS) blowdown of $7.88 \cdot 10^{8}$ liters of water. The resulting releases from ANPP Unit 3 are given in Table 5.4-1, along with the intervention levels for drinking water (Ref. [5.4-12]) and average annual releases from Unit 2 during the years of 2006 and 2007 (Ref. [5.4-13]). As can be seen in Table 5.4-1, the average annual concentrations for dilution by either CWS blowdown or SWS blowdown are well below intervention levels for drinking water, without taking any credit for dilution by the flow in the Sevjur River. The calculated concentrations for ^{90}Sr and ^{137}Cs are also well below those reported for ANPP Unit 2.

Specific liquid exposure pathways for ANPP Unit 3 are discussed below.

5.4.2.1.1 Drinking Water

Internal exposure results from radioactive contaminants in drinking water. This liquid pathway is not considered as a source of exposure from ANPP Unit 3, based on the following:

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[4] It is reported (Ref. [5.4-2]) that the flow does pass through settling ponds that have some impact on reducing contamination before the water enters the Sevjur River.
[5] Table 3.2A-1, PPE item 2.5.4 (natural draft tower blowdown is less than for mechanical draft).

- As reported in EBID Section 2.3, no permits have been issued for withdrawal of water for household (drinking water) use from either the Sevjur River or the Araks River (into which the Sevjur eventually flows)[6].
- Drinking water supplies in Armenia are generally taken from wells or springs, rather than from surface waters.
- Results from monitoring of observation wells around ANPP indicate no contamination of groundwater has resulted from operation of ANPP nor from storage of radioactive waste on the site (Ref. [5.4-14]).
- Construction of Unit 3 is not expected to affect the permeability of site soils nor impact pathways for contamination of groundwater[7]. The system of structures and fluid containment in Unit 3 will prevent leakage of radioactive water into the groundwater.
- As can be seen in Table 5.4-1, discharge concentrations from Unit 3 are anticipated to be well below RoA intervention levels for drinking water.

5.4.2.1.2 Surface Water and Shoreline Deposits

Humans, flora and fauna receive external exposure from the surface of contaminated water and shoreline sediment, and from immersion in contaminated water. Table 5.4-2 provides the results of environmental samples of water bodies and sediments, based on Ref. [5.4-15], along with the drinking water limits from Ref. [5.4-12].

The National Report (Ref. [5.4-16]) summarizes activity levels in water during 2006:

> "According to the monitoring program samples are taken from the [Sevjur] River in a distance 100m from the discharge area towards the water flow. Average annual summary gross activit[ies] of the [Sevjur] River are 1.2 Bq/l, ^{137}Cs - 0.11 Bq/l and ^{90}Sr - 0.025 Bq/l."

The reported values are well below the drinking water limits for ^{137}Cs (≤ 11 Bq/l) and for ^{90}Sr (≤ 5 Bq/l). With liquid discharges from Unit 3 at concentrations that are several orders of magnitude below those from Unit 2, the resulting radionuclide concentrations in the surface water and shoreline deposits of the Sevjur River are likely to be lower following shutdown of Unit 2.

5.4.2.1.3 Aquatic Foods

Humans can receive internal exposure from eating foods, such as fish and crayfish, from contaminated water. The results of water samples in the plant vicinity are given in

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[6] Withdrawal by individual households does not require water permits, so use of the rivers for drinking water cannot be ruled out.
[7] The subsurface water flows are at a depth of 64m to 94m from the surface (see Section 2.2) compared to a foundation embedment of 22m or less (see PPE, item 1.1.2).

Table 5.4-2. Fish are grown in ponds in the ANPP observation zone (Ref. [5.4-17]). Radionuclide concentrations in fish are given in Table 5.4-3 (Ref. [5.4-18]), along with the generic action levels for foodstuffs from the IAEA Basic Safety Standards, Table V-I.

As shown in Table 5.4-3, the concentrations in fish are well below the action levels specified by IAEA. When Unit 2 is shutdown and no longer discharging liquid waste to the sanitary sewerage system, Unit 3 discharges at lower average concentrations directly into the main Sevjur River channel downstream of the fish ponds, should result in an overall reduction in contamination of aquatic foods.

5.4.2.1.4 Irrigated Foods

Humans can receive internal exposure from eating foods irrigated with contaminated water. The foods grown in the ANPP observation zone include tomatoes, eggplant, cucumbers, grapes, apricots, peppers, grain-crops, and greens (Ref. [5.4-17]). Sources of irrigation water are included in Table 5.4-2; specifically Aknalich Lake, irrigation dam (source for the technical water supply pumping station), and the Sevjur River. Radionuclide concentrations in food are given in Table 5.4-3 (Ref. [5.4-18]), along with the generic action levels for foodstuffs from the IAEA Basic Safety Standards, Table V-I.

As shown in Table 5.4-3, concentrations in foodstuffs are well below the action levels specified by IAEA. Since water discharged from Unit 3 will have radionuclide concentrations well below the current concentrations in the water bodies in the plant vicinity, the impact of Unit 3 on concentrations in irrigated foods should be negligible.

5.4.2.2 GASEOUS PATHWAYS

The normal release of gaseous effluents will be permitted if the doses from such releases (in combination with liquid releases) comply with the dose limits specified in Paragraph 31 of GoA Resolution 1219-N (Ref. [5.4-8]) and if the concentrations of radioisotopes are less than the levels of intervention in Table 3 of that same resolution (Ref. [5.4-9]).

Gaseous effluent releases from ANPP Unit 3 may result in doses to the public due to: external exposure to airborne radioactivity; external exposure to deposited activity on the ground; inhalation of airborne activity; and ingestion of contaminated agricultural products. Table 5.4-4 provides calculated concentrations of selected radioisotopes in the Unit 3 ventilation stack exhaust and in the plant vicinity, based on parameters in the Plant Parameter Envelope. The table also includes the regulatory limits for exposure of the public (Ref. [5.4-12]) confirming that the limits will not be exceeded.

Table 5.4-5 gives average annual releases from Unit 2 in 2006 and 2007 (Ref. [5.4-19]), as well as average of four quarterly readings of airborne concentrations of ^{90}Sr and ^{137}Cs in the vicinity of Unit 2 (Ref. [5.4-20]).

The National Report (Ref. [5.4-16]) summarizes atmospheric activity levels in the vicinity of Unit 2 during 2006:

> "The aspiration devices are installed around the Armenian NPP for measurement of contents of radionuclides in atmosphere. The measurement results show that the main radionuclides contained in atmosphere are ^{137}Cs, ^{90}Sr and ^{7}Be, the activity of which in the supervised area in average is 0.03/E-4Bq/m^3, 0.019/E-4Bq/m^3 and 13.42/E-4Bq/m^3 respectively."

The airborne concentrations for ^{90}Sr and ^{137}Cs reported in Table 5.4-5 and in the National Report (Ref. [5.4-16]) are well below the PAAC levels given in Table 5.4-4.

5.4.2.2.1 External exposure due to airborne radioactivity

The nature of external exposure to airborne gases and airborne contamination is such that such doses will be accounted for in the environmental monitoring of thermo-luminescent detectors (TLDs). (See discussion below in Section 5.4.4.)

5.4.2.2.2 External exposure due to deposited activity on the ground

The nature of external exposure to contamination deposited on the ground is such that such doses also will be accounted for in the environmental monitoring of thermo-luminescent detectors (TLDs). (See discussion below in Section 5.4.4.)

Table 5.4-6 gives values for 2007 amounts of radioactive fallout on the ground (Ref. [5.4-21]) and concentration in soils (Ref. [5.4-22]) around the ANPP Unit 2. Review of these values reveals no discernable pattern to explain the differences in the readings from location to location. The variations in levels of activity could very well be within the measurement accuracies, reported to be from 10% to 30%, depending on the analysis methods used.

5.4.2.2.3 Inhalation of airborne activity

Inhalation of airborne particulate radioisotopes results in deposition in the lungs that causes chronic exposure. Inhalation of gaseous radioisotopes results in a short-term internal exposure to the lungs and airways. Since the expected concentrations in Unit 3 releases are well below the permissible annual concentrations in air, as shown in Table 5.4-4, doses should not contribute significantly to committed effective doses due to deposition in the lungs.

5.4.2.2.4 Ingestion of contaminated agricultural products

Radionuclide concentrations in food are given in Table 5.4-3 (Ref. [5.4-18]), along with the generic action levels for foodstuffs from the IAEA Basic Safety Standards, Table V-I. As shown in Table 5.4-3, the current levels of radioactivity in food are well below the guideline action levels and the same is expected during operation of Unit 3.

5.4.3 Receptors

The populations exposed to releases from ANPP are described in EBID Section 2.5. Table 2.5-9 provides population within designated compass sectors and distance segments from the site, projected for the year 2055. The total projected population within 50 km is 2,438,062. The total projected population within the 10 km environmental observation zone is 111,778.

A specific census of farm animals was not conducted, but will be necessary, along with food sources, to complete accurate dose estimations for members of the public within the different compass and distance sectors/segments.

5.4.4 Radiation Doses to Members of the Public

In the absence of detailed dose estimates for ANPP Unit 3, data related to operation of Unit 2 are used to infer expected doses to members of the public (population).

5.4.4.1 EXTERNAL DOSE

The National Report (Ref. [5.4-16]), states:

- "According to systematic measurements, gamma dose rate on the territory of the supervised area was 0.08-0.09 μSv/hour."

- "According to results of integrated dosimeters, the population exposure dose is 1.87mSv per year. … the population exposure doses before the Armenian NPP start-up in 1977 ("zero background"), … was 1.65 mSv (0.8 mSv from cosmic exposure and 0.85 mSv from natural and artificial radionuclides of soil)."

This indicates an individual external exposure dose to personnel and biota in the 10 km observation zone due to operation of ANPP was on the order of 0.22 mSv, which is less than the dose limit of 1 mSv for all sources of exposure and the dose limit of 0.25 mSv for single existing sources.

Table 5.4-7 gives annual external exposure doses for 17 locations around the ANPP, based on Ref. [5.4-23]. Figure 5.4-1 illustrates the monthly average values for these locations. As can be seen from this figure, except for the doses on the ANPP industrial site (location 13), there is not a significantly discernable pattern of dose rates among the locations or through the year and thus it is not possible to define what level of dose is due to operation of ANPP relative to other sources of radiation such as that from radionuclides existing in the soil, water sources, etc. In any case, the measured doses are less than those reported in the National Report and therefore also less than the limiting values discussed above.

5.4.4.2 INHALATION DOSE

Table 5.4-8 gives calculated inhalation doses based on releases indicated in the Plant Parameter Envelope and dose factors specified in Resolution 1219-N (Ref. [5.4-12]) and in the IAEA Basic Safety Standard (Ref. [5.4-24]).

The most limiting values of factors for committed effective dose (CED) per unit intake in the Basic Safety Standard are used in Table 5.4-8, which most often correspond to the factor specified for infants less than 1 year old. The corresponding factors given in Resolution 1219-N are most often for another age group and factors are not specified for every isotope. In any case, the calculated total inhalation dose for either set of factors is substantially less than the annual external dose and can be ignored in calculating total effective equivalent public doses. A similar conclusion can be reached when comparing the estimated average concentrations in the plant ventilation discharge with the permissible average annual concentrations (PAAC) in air, as shown in Table 5.4-4, which are intended to keep committed effective doses below levels that would cause detectable effects on personnel.

5.4.4.3 INGESTION DOSE

The National Report (Ref. [5.4-25]) states:

> "Analysis of environmental monitoring results and evaluation of population exposure dose origination through food chain show that exposure dose incurred by population residing around Armenian NNP was approximately 1 μSv/year…"

Based on comparison of expected releases from Unit 3 as compared with releases from Unit 2 that can result in ingestion dose, it is expected that the dose from the food chain to be no greater than that reported during to operation of Unit 2.

5.4.5 Impacts to Members of the Public (Population)

Based on the above discussion and the estimated maximum individual doses to the public, they are well below the level at which effects are expected, and thus, represent a SMALL impact.

A more accurate estimate of limiting individual and collective doses may be done when all relevant parameters and data are available to predict doses for limiting individuals and locations.

5.4.6 Impacts to Biota Other than Members of the Public

Based on minimal or no impact on members of the public, no impacts are expected to terrestrial faunal species in the plant vicinity. Since liquid releases are expected to be well below the limits for drinking water, no impacts are expected on aquatic fauna. Based on the accumulated activities measured in sediments and algae in nearby bodies of water due to operation of ANPP Unit 2, no impacts are expected to aquatic biota.

Table 5.4-1, Calculated Liquid Releases from ANPP Unit 3

Isotope	Release GBq/yr [a]	CWS dilution only Bq/l [b]	SWS dilution only Bq/l [c]	Drinking Water Limit Bq/kg [d]	Unit 2 Releases [e]	
					Sanitary	Industrial
C 14	2.16E-02	9.04E-13	2.75E-11	2.40E+02		
Fe 59	1.45E-02	6.06E-13	1.84E-11	7.70E+01		
Co 60	3.86E-01	1.61E-11	4.90E-10	4.10E+01		
Sr 90	4.31E-04	1.80E-14	5.48E-13	5.00E+00	6.50E-02	5.50E-02
I 131	8.09E-01	3.38E-11	1.03E-09	6.30E+00		
I 134	4.86E-02	2.03E-12	6.17E-11	7.30E+00		
Cs 137	7.60E-01	3.17E-11	9.65E-10	1.10E+01	1.85E-01	1.85E-01

[a] Table 3.5-1

[b] Assumed dilution by CWS blowdown, l/yr = 2.39E+10

[c] Assumed dilution by SWS blowdown, l/yr = 7.88E+08

[d] Ref. [5.4-12]

[e] Average 2006-2007, Ref. [5.4-13]

Table 5.4-2, Environmental Monitoring Results for Water Bodies within the ANPP Observation Zone

Sample Location	Specific Activities (Bq/kg)					
	Bottom Sediments [(a)]		Algae [(b)]		Open Water [(c)]	
	^{137}Cs	^{90}Sr	^{137}Cs	^{90}Sr	^{137}Cs	^{90}Sr
1. Aknalich lake	11.9 / 14.8	3.6 / 4.1	11.0 / 12.6	1.9 / 2.4	0.12 / 0.14	0.02 / 0.016
2. Fish hatchery	11.0 / 12.4	2.4/ 2.86	12.1 / 14.4	1.6 / 2.1	0.10 / 0.15	0.01 / 0.02
3. Technical water supply pump station	10.1 / 10.5	2.0 / 2.4	12.6 / 15.2	2.1 / 2.7	0.08 / 0.06	0.02 / 0.018
4. Potable water for the town of Metsamor	11.4 / 13.6	2.3 / 2.7	10.4 / 9.6	2.0 / 2.8	0.17 / 0.11	0.03 / 0.01
5. Water intake for the pump station	12.7 / 14.4	3.1 / 4.2	11.3 / 13.6	2.2 / 3.1	0.09 / 0.11	0.009 / 0.012
6. Potable water for the town of Armavir	11.5 / 12.5	2.8 / 3.9	9.8 / 11.5	1.6 / 1.8	0.11 / 0.08	0.02 / 0.01
7. Discharge point of sanitary sewage	15.8 / 19.6	3.0 / 4.3	11.7 / 16.8	2.1 / 3.0	0.19 / 0.07	0.02 / 0.008
8. Discharge point of industrial sewage	14.8 / 18.9	3.7 / 5.4	10.8 / 12.6	1.9 / 2.6	0.14 / 0.08	0.03 / 0.012
9. Sevjur River					0.18 / 0.11	0.02 / 0.015
Drinking Water Limit from Ref. [5.4-12]					11	5

[(a)] Ref. [5.4-15], Table No. 12 (2007 / 2006)

[(b)] Ref. [5.4-15], Table No. 13 (2007 / 2006)

[(c)] Ref. [5.4-15], Tables No. 15.1 and No. 15.2 (Measurement 1 / Measurement 2)

Table 5.4-3, Radionuclide concentrations in agricultural produce (Bq/kg)

Produce [(a)]	Specific β activity	^{137}Cs	^{90}Sr
Strawberry (Arshaluys)	233	0.33	< 0.01
Strawberry (Metsamor)	378	0.42	< 0.01
Milk (Arshaluys)	169	0.16	0.08
Meat (Metsamor)	192	0.22	< 0.01
Fish (pond)	148	0.21	< 0.01
Edible greens	359	0.29	0.03
Cucumber	295	0.18	0.09
Tomatoes	410	0.31	0.1
Pepper	320	0.29	0.07
Eggplant	385	0.34	0.03
Cabbage	194	0.34	0.02
Generic Action Levels for Foodstuffs (IAEA SS 115, Table V-I)		1000	100

[(a)] Data from Ref. [5.4-18]

Table 5.4-4, Calculated Airborne Releases from ANPP Unit 3

Nuclide	Unit 3, GBq/y [(a)]	Unit 3, Bq/m^3 [(b)]	Q, Bq/s [(c)]	χ, Bq/m^3 [(d)]	PAAC, Bq/m^3 [(e)]
Co-60	3.22E-01	3.65E-01	1.02E+01	2.86E-05	1.10E+01
Sr-90	4.44E-02	5.03E-02	1.41E+00	3.94E-06	2.70E+00
Ag-110m	3.70E-05	4.19E-05	1.17E-03	3.29E-09	
I-131	4.79E+00	5.43E+00	1.52E+02	4.25E-04	7.30E+00
Cs-134	6.99E+01	7.92E+01	2.22E+03	6.21E-03	1.90E+01
Cs-137	1.75E-01	1.98E-01	5.55E+00	1.55E-05	2.70E+01

[(a)] Unit 3 values from PPE, Table 3.2A-6.

[(b)] Concentration in the ventilation exhaust, using 28,000 l/s ventilation flow from PPE (Table 3.2A-1, item 9.4.6).

[(c)] Converting GBq/y to Bq/s using 31,536,000 s/y.

[(d)] Using $\chi/Q = 2.8 \times 10^{-6}$ s/m^3 (Table 3.2A-1, Item 9.2).

[(e)] PAAC - Permissible average annual concentration in air, Ref. [5.4-12].

Table 5.4-5, Measured Airborne Radiation in ANPP Unit 2 Vicinity

Nuclide	Unit 2 Releases, GBq/y [(a)]	Airborne Radioactivity, Bq/m^3 [(b)]			
		ANPP Site (1km)	Metsamor (5km)	Pond (7km)	Yerevan (30km)
Co-60	8.30E-02				
Sr-90	2.88E-04	1.15E-06	1.30E-06	2.73E-06	2.20E-06
Ag-110m	9.62E-03				
I-131	2.77E-02				
Cs-134	4.82E-03				
Cs-137	5.00E-02	2.58E-06	3.55E-06	5.50E-06	3.80E-06

[(a)] Unit 2 average of 2006 and 2007 values from Ref. [5.4-19], Table No. 5.

[(b)] Ref. [5.4-20], Table No. 8.1.

Table 5.4-6, Radioactivity on the Ground and in Soils

Isotope	NPP [a]	1 radius [b]	2 radius [c]	3 radius [d]	Yerevan
	Cumulative Annual Fallout on the Ground, Bq/m^2 [e]				
^{137}Cs	9	13.7	9.6	13.1	20.1
^{90}Sr	1.7	2.9	2.7	2.1	2.0
^{7}Be	44	255	79	129	111
	Radionuclide Activity in the Soil, Bq/kg [f]				
^{137}Cs	14.0	12.5	17.0	14.2	9.3
^{90}Sr	3.5	4.4	4.3	3.6	3.9

[a] ANPP industrial site

[b] Metsamor Town, Village Aygherlitch, Aspiration installation (500 m from ANPP).

[c] City Armavir, City Vagharshapat, and Village Aygeshat

[d] Village Mughan, Yerevan City, Village Nairi

[e] Ref. [5.4-21], Table 9.1

[f] Ref. [5.4-22], Table 10.1

Table 5.4-7, Environmental Exposure Doses, 2007

Table 5.4-7, Environmental Exposure Doses, 2007

No.	Location	Approx. Distance, km	Average Annual Dose		
			μR/h [(a)]	mR/y [(b)]	mSv/y [(c)]
1	Metsamor Town	4.6	8.83	77.4	0.77
2	Aknalich village	4.0	8.08	70.8	0.71
3	Aspirating facility at ANPP	0.5	9.17	80.3	0.80
4	Armavir Town	9.2	9.17	80.3	0.80
5	Aghavnatun village	10.7	9.08	79.5	0.80
6	Vagharshapat Town	13.0	9.25	81.0	0.81
7	Aygeshat village	13.5	9.25	81.0	0.81
8	Mrgashat village	9.0	8.83	77.4	0.77
9	Mugan village	?	9.00	78.8	0.79
10	Yerevan City	32.0	9.25	81.0	0.81
11	Nor Armavir village	16.5	8.83	77.4	0.77
12	Nairi village	?	9.17	80.3	0.80
13	ANPP industrial site (average of 4 locations)	0.0	18.17	159.2	1.59
14	Road from ANPP to LLW burial ground		9.25	81.0	0.81
15	Road from Metsamor to ANPP		8.75	76.7	0.77
16	[Detour Road]		8.75	76.7	0.77
17	Road to Special Industrial complex		8.33	73.0	0.73
	Average (without location No.13)		8.94	78.3	0.78
Annual Limit for General Population from all sources (Ref. [5.4-1])					1.00

[(a)] Values from Ref. [5.4-23], Table 7

[(b)] Using 8,760 h/y and converting to mR

[(c)] Using 1 mSv = 100 mRem ≈ 100 mR

Table 5.4-8, Gaseous/Airborne Releases and Resultant Dose Values

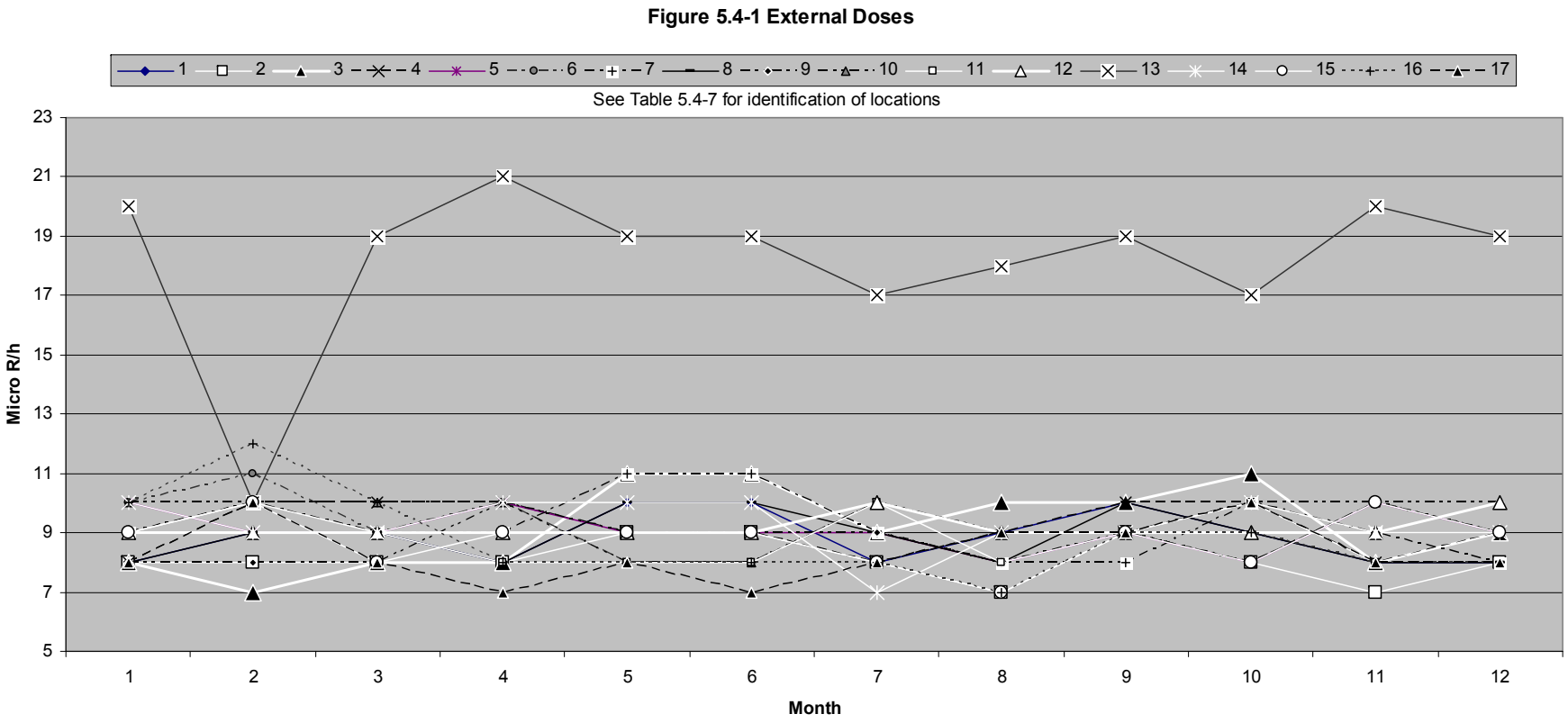
Table 5.4-8, Gaseous/Airborne Releases and Resultant Dose Values

Isotope	Annual Release [a] GBq/y	CED [b] Sv/Bq	CED [c][d] µSv	CED [e] Sv/Bq	CED [f][d] µSv
H-3	1.18E+05	2.70E-10	8.95E-02	1.20E-09	3.98E-01
I-131	4.8E+00	7.20E-08	9.66E-04	7.20E-08	9.66E-04
I-132	4.1E+01			1.10E-09	1.25E-04
I-133	3.1E+01			1.90E-08	1.67E-03
I-134	7.0E+01			4.80E-10	9.40E-05
I-135	4.5E+01			4.10E-09	5.12E-04
C-14**	3.6E+02	2.50E-09	2.53E-03	1.90E-08	1.93E-02
Na-24	7.5E-02			2.30E-09	4.83E-07
P-32	1.7E-02	4.00E-09	1.90E-07	2.20E-08	1.05E-06
Cr-51	6.5E-01	2.10E-10	3.82E-07	2.60E-10	4.73E-07
Mn-54	1.0E-01	1.90E-09	5.32E-07	7.50E-09	2.10E-06
Mn-56	6.5E-02			1.10E-09	2.00E-07
Fe-55	1.2E-01	6.20E-10	2.08E-07	1.10E-09	3.70E-07
Co-57	3.0E-04	6.70E-10	5.69E-10	4.40E-09	3.74E-09
Co-58	8.5E-01	2.00E-09	4.77E-06	9.00E-09	2.14E-05
Co-60	3.2E-01	1.20E-08	1.08E-05	9.20E-08	8.29E-05
Fe-59	1.5E-02	4.60E-09	1.93E-07	2.10E-08	8.82E-07
Ni-63	1.2E-04	4.80E-10	1.61E-10	4.80E-09	1.61E-09
Cu-64	1.9E-01			5.80E-10	3.00E-07
Zn-65	2.1E-01	1.90E-09	1.09E-06	1.50E-08	8.62E-06
Rb-89	8.0E-04			1.40E-10	3.13E-10
Sr-90	4.4E-02	5.00E-08	6.22E-06	4.20E-07	5.22E-05
Ru-103	6.5E-02	3.00E-09	5.45E-07	1.30E-08	2.36E-06
Rh-103m	2.1E-03			2.00E-11	1.15E-10
Ru-106	2.9E-03	2.80E-08	2.26E-07	2.60E-07	2.10E-06
Rh-106	3.5E-04			8.50E-10	8.32E-10
Ag-110m	3.7E-05	9.20E-09	9.53E-10	4.60E-08	4.77E-09
Sb-124	3.4E-03	7.70E-09	7.23E-08	3.90E-08	3.66E-07
Sb-125	2.3E-03	5.80E-09	3.67E-08	4.20E-08	2.65E-07
Te-129m	4.1E-03	8.00E-09	9.08E-08	3.80E-08	4.31E-07
Te-131m	1.4E-03	5.80E-09	2.27E-08	8.70E-09	3.41E-08
Te-132	3.5E-04	1.30E-08	1.27E-08	2.20E+00	2.15E+00
Cs-134	1.2E-01	6.60E-09	2.13E-06	7.00E-08	2.26E-05
Cs-136	1.1E-02	2.00E-09	6.16E-08	1.50E-08	4.62E-07
Cs-137	1.8E-01	4.60E-09	2.25E-06	1.10E-07	5.39E-05
Cs-138	3.1E-03			4.20E-10	3.70E-09
Ba-140	5.0E-01	6.20E-09	8.67E-06	2.90E-08	4.06E-05
La-140	3.3E-02	6.30E-09	5.91E-07	8.80E-09	8.25E-07
Ce-141	1.7E-01	4.10E-09	1.95E-06	1.60E-08	7.62E-06
Ce-144	3.5E-04	1.60E-07	1.57E-07	3.60E-07	3.52E-07

[a] From EBID Table 3.2A-6.
[b] Committed Effective Dose per unit intake, Ref. [5.4-12].
[c] Calculated CED according to Ref. [5.4-12].
[d] Using $\chi/Q = 2.8 \times 10^{-6}$ (Table 3.2A-1, Item 9.2).
[e] Committed Effective Dose per unit intake, Ref. [5.4-24].
[f] Calculated CED according to Ref. [5.4-24].

Pr-144	3.5E-04			1.90E-10	1.86E-10
W-187	3.5E-03			2.00E-09	1.96E-08
Np-239	2.2E-01	1.20E-09	7.40E-07	5.90E-09	3.64E-06
Totals		**µSv**	9.31E-02	**µSv**	2.57E+00

Figure 5.4-1, External Doses



REFERENCES:

[5.4-1] GoA Resolution 1219-N dated August 18, 2006, *On Approval of Radiation Safety Norms*.

[5.4-2] Meeting on 8 August 2008 with Mrs. Aida Avetisyan, Head of Radiation Safety Regulations Department, and Mr. Ashot Mnatsakanyan, expert.

[5.4-3] IAEA, 1996, Safety Series № 115, *International Basic Safety Standards for Protection against Ionizing Radiations and for the Safety of Radiation Sources*, (also available in 2003 CD version).

[5.4-4] IAEA, 1999, INSAG-12, *Basic Safety Principles for Nuclear Power Plants 75-INSAG-3 Rev. 1*, a report by the International Nuclear Safety Advisory Group.

[5.4-5] IAEA, 2003, Safety Requirements NS-R-3, *Site Evaluation for Nuclear Installations*.

[5.4-6] IAEA, 2002, Safety Guide NS-G-3.2, *Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation for Nuclear Power Plants*.

[5.4-7] IAEA, 2000, Safety Guide WS-G-2.3 *Regulatory Control of Radioactive Discharges to the Environment*.

[5.4-8] GoA Resolution 1219-N, dated August 18, 2006, paragraph 31.

[5.4-9] GoA Resolution 1219-N, dated August 18, 2006, Paragraph 57.

[5.4-10] CJSC "ANPP", 2008, *Report on Radiation Safety at the Armenian Nuclear Power Plant for 2007*.

[5.4-11] Armenian Nuclear Regulatory Authority (ANRA), 2007, *National Report of Republic of Armenia under Convention on Nuclear Safety*, Section 3.6.2.1, Figure 3.

[5.4-12] GoA Resolution 1219-N, Table 3.

[5.4-13] CJSC "ANPP", 2008, *Report on Radiation Safety …*, Table № 6.

[5.4-14] CJSC "ANPP", 2008, *Report on Radiation Safety …*, Table № 14.

[5.4-15] CJSC "ANPP", 2008, *Report on Radiation Safety …*, Table №s 12, 13, 15.1, and 15.2.

[5.4-16] ANRA, 2007, *National Report …*, Section 3.6.2.3.

[5.4-17] CJSC "ANPP", 2004, *Procedure for Radiation Monitoring of ANPP*, Attachment 1.

[5.4-18] CJSC "ANPP", 2008, *Report on Radiation Safety …*, Table № 15.3.

[5.4-19] CJSC “ANPP”, 2008, *Report on Radiation Safety …*, Table № 5.

[5.4-20] CJSC “ANPP”, 2008, *Report on Radiation Safety …*, Table № 8.1.

[5.4-21] CJSC “ANPP”, 2008, *Report on Radiation Safety …*, Table № 9.1.

[5.4-22] CJSC “ANPP”, 2008, *Report on Radiation Safety …*, Table № 10.1.

[5.4-23] CJSC “ANPP”, 2008, *Report on Radiation Safety …*, Table № 7.

[5.4-24] IAEA, 1996, Safety Series № 115, Table II-VII.

[5.4-25] ANRA, 2007, *National Report …*, Section 4.1.2.

5.5 ENVIRONMENTAL IMPACTS OF WASTE

This section provides assessment of impacts resulting from the discharge of nonradioactive effluents to the biosphere. The discussion addresses plant systems having nonradioactive effluent discharges and the discharges from these systems.

This section also presents the assessment of impacts resulting from the storage or disposal of mixed radioactive wastes. Mixed waste may contain both hazardous waste and radioactive material. The discussion identifies plant systems producing mixed waste and assesses mixed waste storage plans, capabilities, and resulting impacts.

5.5.1 Nonradioactive Waste-System Impacts

This section describes the potential environmental impacts of nonradioactive solid, liquid, and gaseous waste streams associated with the operation of ANPP Unit 3. A description of possible chemical discharges and effluents is provided, based on the Plant Parameter Envelope specifically developed to represent the most conservative bounding values for the project regardless of the selected reactor design.

A description of the nonradioactive waste systems and chemicals is provided in Section 3.6. The wastes generated and the chemicals present and their projected concentrations are provided in Tables 3.6-1 for the liquid effluents. The concentration of chemicals at the main discharge is dependent on their concentration in their respective waste stream and the stream flow in relation to the main discharge flow that it is combined with.

5.5.1.1 IMPACTS OF DISCHARGES TO WATER

Nonradioactive liquid wastewater from ANPP unit 3 may include, but is not limited to, cooling water blowdown, auxiliary-boiler blowdown, water-treatment waste, floor and equipment drains, and storm water runoff.

5.5.1.1.1 Industrial Wastewater and Rainwater Discharges

ANPP Unit 3 includes an industrial wastewater and rainwater disposal system that receives uncontaminated drainage from the cooling of mechanisms and bearings that have no radioactive or other contaminants, blowdown water from cooling towers, rainwater from the roofs of buildings of plant that are equipped with internal drainpipes and rainwater from paved and soil surfaces of part of the plant site. The system will discharge flows from these sources directly to the Sevjur River downstream of the Unit 3 intake by extending the existing Unit 2 piping (See Section 3.6.1.1).

The discharges from this system will average 1,000 l/s (3,600 m^3/hr). The maximum discharge rate may reach 1,600 l/s (5,700 m^3/hr). The total annual discharge from these non-radioactive sources will be 30 million m^3/year.

The major blowdown components and concentrations for ANPP Unit 3 are tabulated (From Table 3.2A-2). The total annual discharges of these major components of the

blowdown were calculated and included in Table 5.5-1. The source of most of these constituents in the discharge is the makeup water drawn from the Sevjur River.

The water quality standards applicable to the Sevjur River are presented in Table 2.3-16. They are also shown in Table 5.5-1. The standards apply after mixing of the discharge with the river flow. At average river-flow there will be about a 20:1 (twenty to one) dilution in the river. At low river flow, the dilution will be closer to 10:1 (ten to one). Several of the constituents in the discharge will violate current water quality standards after mixing. The components of the industrial wastewater and rainwater discharge system that will be in violation based on average flow include copper, oil and grease, and ammonia nitrogen. The sulfate concentration in the river exceeds the standard at all flows. Most of the sulfate in the Unit 3 discharge is sulfate that exists in the makeup water flow. It is further concentrated in the circulating water system by evaporation. The sulfate in the discharge is in apparent violation of current water quality standards. However, the need to control this parameter will be reviewed when a discharge permit is issued.

In addition to the components of the blowdown that were in the makeup water, there will be a variety of chemicals added to control water quality in the systems in Unit 3. Chemicals are added to the Circulating Water System (CWS), the Steam Generator Blowdown System (SGBS), the Service Water System (SWS) and the Demineralized Water System (DWS). These chemicals, essential to maintain proper operation of the systems, include silt dispersants, corrosion inhibitors, anti-scalants, algaecides, other biocides, and oxygen scavengers. Chemicals are added to some systems to control pH.

The chemicals used and discharged by Unit 3 are shown in Table 3.6-1. The major flow stream is from the CWS. Chemical discharge from the SWS system is continuous. Chemical addition in the other systems is intermittent. Discharges from the other systems will be diluted by the flow of the CWS before discharge to the river. The bounding values for chemicals of significance to water quality of the river are summarized in Table 5.5-2.

Hydrazine is added to the steam generators as an oxygen scavenger. During outages it may be necessary to drain a steam generator. The dilution of the CWS will not be available during outages. Hydrazine concentration in the SGBS is 200 mg/l. The pH in the steam generators is controlled with ammonium hydroxide. The bounding value for this chemical in the SGBS is 100 mg/l. The duration of discharges from the SGBS is brief and very infrequent.

The chemicals are widely used in power plants. The discharge of the chemicals added intentionally to various systems to control water quality within the systems does not violate the applicable water quality standards. However there may be concern about the toxicity of several of the chemicals for which standards have not been adopted.

The U.S. Environmental Protection Agency (USEPA) has published criteria for the protection of aquatic life that include limits for chlorine, copper, iron, ammonia, and oil and grease (Ref. [5.5-1]). The criteria include a recommended maximum concentration to which a community can be exposed for a short duration without impact. The criteria also include a recommended continuous concentration limit. The recommended limit for ammonia is dependent on pH, temperature, and life stage

of organisms exposed. There is no recommended limit for hydrazine for the protection of aquatic life. There is a limit recommended for water bodies used as a source of drinking water (Ref. [5.5-1]). The steam generator blowdown would be diluted by mixing with the cooling water system discharge before reaching the river. At the time the design for the various plant water systems is complete, proposed additions of chemicals should be evaluated against applicable water criteria.

Unit 3 will have a sludge accumulation system for the collection of wastewater whose chemical composition does not comply with the requirements of Republic of Armenia water-protection laws (See 3.6.1.3). The sludge accumulation system is located 100 m northeast of the Phase 1 cooling towers. Should the water in any of the plant systems exceed discharge limits, the system discharges will be directed to the blowdown pond for isolation, as discussed in section 3.4. If water in the blowdown pond exceeds discharge limits, it will be directed to the Unit 2 neutralizer pool and evaporator pool for treatment.

The existing system does not appear to be designed to accept and treat the blowdown from the CWS. Except for oil and grease, none of the components in Table 5.5-1 could be removed without extensive chemical treatment. Of the components in Table 5.5-2, residual chlorine would be reduced by holding up the CWS discharge. Chlorine is not used in Unit 2. Oil and grease are best kept out of the discharge system by monitoring the service water systems that are sources of oil or grease.

In spite of the conflict between discharge water quality and currently applicable water quality standards, the impact due to the discharge from this system is SMALL.

5.5.1.1.2 Contaminated Wastewater Network

ANPP Units 3 includes a network for industrial sewage contaminated by oil products. This network receives sewage from rotating mechanisms in the turbine hall, drainage water and hydraulic-cleanup effluent, and rainwater and snowmelt from the gravel pits of transformers and oil circuit breakers. Unit 3 will also have the potential for oil-contaminated drains from the turbine building, diesel generator buildings, auxiliary boiler, and transformers and oil circuit breakers. A portion of the miscellaneous drains, could have oil contamination, and appropriate area drains will be routed to the contaminated treatment system. Drainage from the diesel generator building sumps, the non-radioactive auxiliary building sump and the annex building sump is also collected in the turbine building sumps. The turbine building sumps provide a temporary storage capacity and a controlled source of fluid flow to the contaminated sewage network.

Provisions are included for sampling the sumps. The turbine building sump pumps route the wastewater from either of the two sumps to the contaminated sewage network for removal of oily waste. The diesel fuel oil area sump pump also discharges wastewater to the contaminated sewage network.

Flow from use of the fire protection system (FPS) will be collected in drains serving the area of the fire. Drainage may be directed to the contaminated sewage network to remove oily waste if firefighting activities are in areas with potential oil contamination.

Treatment of waste water flowing into Contaminated Sewage Network (CSN) is performed by mechanical separation with an oil trap and flotation tanks and by adsorption in mechanical filters and beds of expanded perlite. The expanded perlite removes 100 % of oil from the contaminated sewage (Ref. [5.5-2]). After that the wastewater from the contaminated sewage network flows by gravity to the plant discharge pipe.

Because of the demonstrated effectiveness of the expanded perlite the impact of the CSN discharges to Sevjur River is considered SMALL.

5.5.1.1.3 Sanitary System Effluents

Unit 2 does not have a properly working sewage treatment facility. A treatment plant was built to serve the existing ANPP. However because of design flaws, that existing treatment plant does not function well and the untreated sewage is discharged to the river. The sanitary needs during construction of unit 3 will be met primarily by use of portable toilets serviced by an off-site contractor (See Section 3.6.2). The contractor will be required to properly dispose of the waste in accordance to RoA laws regulating this type of waste.

Site preparation for construction of ANPP Unit 3 will include construction of a waste water treatment system for the sanitary waste generated during operation of Unit 3. The design of this facility has not started. It is recommended that the design include capability to also accommodate sanitary discharges from ANPP Phase 1 (Units 1 & 2). The design should also take into account expected peak onsite labor for Unit 1 & 2 decommissioning unless that population will be served by portable toilets as is planned for the Unit 3 construction force. It is further recommended that the new treatment plant be demonstrated to be operating effectively before authorization to operate Unit 3 is granted.

There are various proposals for constructing waste water treatment plant for unit 3 operation (See 3.6.2). Construction of the waste water treatment plant should comply with RoA laws and regulations governing discharges to Sevjur River; thus, the impact of Sanitary Waste System effluents will be SMALL.

5.5.1.2 IMPACTS OF DISCHARGES TO LAND

Significant quantities of solid waste are generated at several points in Unit 3.

5.5.1.2.1 Nonradioactive Solid Waste

Solid nonradioactive waste (SNW) includes, typical office waste, packaging wastes, miscellaneous shop and maintenance wastes, and wastes from food service areas such as aluminum cans, glass, metals, and paper. At this time the SNW from the ANPP is transported to the Metsamor city landfill by truck 9 times per month. On average, the total amount of solid waste removed monthly amounts to 18-20 tons.

It is expected that for unit 3, licensed municipal solid-waste haulers will continue to collect this waste and dispose it in the Metsamor city landfill. The waste does not affect terrestrial ecology, soil, or groundwater on the site. Impacts to ground water and surface water at the Metsamor city landfill were beyond the scope of this review.

5.5.1.2.2 Hazardous Wastes

It is not expected that significant quantities of hazardous waste will be produced at Unit 3 (Ref. [5.5-3]). Because of the potentially high environmental impact and because of the high cost of handling and disposing of hazardous wastes, it is cost effective to find alternative procedures to avoid their production. Hazardous wastes generated through ANPP Unit 3 operations, and hazardous chemical wastes from laboratories and other sources at the facility, are collected and disposed of off-site in accordance with appropriate GoA regulations. These wastes are not released to the environment and do not present an impact potential to the environment.

5.5.1.2.3 Petroleum Waste

Petroleum wastes may include fuels, such as gasoline and diesel oil, and used oil and greases. At Unit 2 these materials are collected and stored on-site in accordance with applicable regulations. This is not an acceptable long term solution to the problem. It is recommended that a plan be developed for recycling petroleum wastes at Unit 3.

Because the petroleum wastes can be contained, the impact of the wastes is SMALL.

5.5.1.2.4 Assessment of Impacts of Discharges to Land

Because nonradioactive solid wastes water-treatment and purification-waste filters from the reversed osmosis (RO) unit, solid hazardous waste, and petroleum wastes (including fuels, such as gasoline and diesel oil, and used oil and greases) are handled per the methods described above and in accordance to GoA laws and regulations the impact from discharges to land is considered to be SMALL.

5.5.1.3 IMPACTS OF DISCHARGES TO AIR

Discharge to the atmosphere are discussed in Sections 5.2 and 5.3.

5.5.2 Solid Radiological Waste System Impacts

During the operation of Unit 3 solid radiological wastes will be produced by a number of activities in the plant.

5.5.2.1 LOW LEVEL WASTES

Low level wastes (Ref. [5.5-4]) will be produced by incidental contamination of protective clothing, of wiping cloths and other cleaning supplies, and of equipment carried into contaminated areas. These contaminated items show a low level of radiological activity and when properly handled do not result in significant occupational exposure. However the low level wastes must be handled and disposed of carefully to ensure that the contamination remains contained.

With all categories of radiological waste steps should be taken to minimize their production. Most nuclear plants have radiological waste reduction programs that are aimed at reducing the production of waste in order to minimize the volume of material to be processed and disposed of.

Low level wastes are not amenable to treatment. The wastes are usually densely compacted before being placed into containers for burial.

Indefinite storage of low level waste should be discouraged. Typically planning for a five year storage facility would allow the wastes to be processed and disposed of in manageable quantities. As discussed in Section 3.5, a national radioactive waste management strategy should be defined for Armenia, based on IAEA waste management requirements and guidelines to define expected technologies and locations for storage and disposal of radioactive waste from ANPP Units 1, 2, and 3. The PPE, Table 3.2A estimates that less than 0.04 ha will be required for low level waste storage at Unit 3.

The IAEA has established fundamental principles for radiological waste management (Ref. [5.5-5]). The principles are intended to provide a common basis for national radioactive waste management programs.

The US NRC has identified more specific requirements and guidelines to ensure that low level waste is stored in facilities that are designed and operated properly and that public health and safety and the environment are adequately protected (Ref. [5.5-6]). NRC requirements and guidelines include the following:

- The amount of material allowed in a storage facility and the shielding used should be controlled by dose rate criteria for both the site boundary and any adjacent off-site areas.
- Containers and their waste forms should be compatible to prevent significant corrosion within the container. After a period of storage, the subsequent transportation and disposal should not cause a container breach.
- Gases generated from organic materials in waste packages should be evaluated periodically with respect to container breech. After a period of storage, the subsequent transportation and disposal should not cause a container breach.
- Gases generated from organic materials in waste packages should be evaluated periodically with respect to container breech. High-activity resins should not be stored more than 1 year unless they are in containers with special vents.
- A program of at least quarterly visual inspection should be established.
- A liquid drainage collection and monitoring system should be in place. Routing of the drain should be to a radiological waste processing system.

The NRC has also published a siting guide for near surface waste disposal (Ref. [5.5-7]).

If low level wastes are handled and stored in a manner compatible with a long term disposal plan, the environmental impact will be SMALL.

5.5.2.2 INTERMEDIATE LEVEL WASTES

Radiological wastes with higher levels of contamination are produced by several systems in the plant. The term “high level waste” is usually applied to spent fuel and is not addressed here. The greatest volume of intermediate level waste (Ref. [5.5-4]) may be the reactor coolant clean-up demineralizers. Spent ion exchange resins are often high in radiological activity. They are produced as wetted solids. The water with the resins is also contaminated. These wastes are often categorized as solid radiological wastes. Usually the wastes are solidified before disposal. Solidification serves to make the dissolved contaminants immobile.

Because of concern over hazardous material, the criteria for storage of intermediate level wastes are more stringent than the criteria for low level waste storage. The major problem with long term storage is the deterioration of the containers (Ref. [5.5-8]). A number of technologies exist for solidification wastes for long term storage and disposal (Ref. [5.5-9]).

It is recommended that development of a disposal plan for permanent disposal of intermediate level wastes at Unit 3 be included in the initial engineering. If the intermediate level wastes are handled and stored in a manner compatible with ultimate disposal plans, the impact will be SMALL.

5.5.2.3 MIXED WASTE

Mixed waste is waste that contains both hazardous waste and radiological waste (Ref. [5.5-4]). This may include either liquid or solid material. If the radiological component is in an immobile form it may be easier to deal with than the hazardous component.

Mixed wastes can originate in a number of systems in Unit 3 although the most likely source will be systems generating waste oil. Typical mixed wastes include solutions collected in containment building sumps, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous drains. Other mixed wastes are generated from laundry facilities (detergent wastes) and wastes generated from personnel and protective equipment decontamination activities.

Unit 3 is not expected to generate significant volumes of mixed waste because of continued progress in reducing mixed-waste generation (Ref. [5.5-10]). Initial engineering plans should ensure that consideration is given to minimizing generation of mixed (radioactive and hazardous) wastes. Engineering planning for Unit 3 should include a permanent disposal facility for these wastes.

If the generation of mixed wastes is controlled and the mixed wastes are handled and stored consistent with a national waste management program, the impact from mixed-wastes will be SMALL.

Table 5.5-1, Annual discharges of chemicals into Sevjur River from Industrial Wastewater and Rainwater Discharge System

Constituent	Annual Discharges (tonne)	Average Concentration, (mg/l)	RoA Water Quality Standard (mg/l)
Iron	8.8	0.3	0.05
Copper	2.9	0.1	0.001
Chlorides	8800	300	300
Oil and grease	17.6	0.6	0.01
Ammonium Ion	23.5	0.8	0.05
Sulfate	26400	900	100
Nitrates	293	10	9.1
Phosphate	58.7	2	3.5

Table 5.5-2, Discharges of chemicals to the Industrial and Rainwater Sewage system

System	Chemical – type/specific	Concentration in waste streams (mg/l)
CWS	Biocide/sodium hypochlorite (NaClO)	0.2 as residual chlorine or 0.36 as sodium hypochlorite
CWS	Algaecide/quarternary amine (ammonium chloride, NH_4Cl)	0.2 as residual chlorine or 0.3 as ammonium chloride
CWS	pH adjustment/sulfuric acid (H_2SO_4)	2.2
CWS	Corrosion Inhibitor/ortho-polyphosphate	30
CWS	Silt Dispersant/polyacrylate	150
CWS	Antiscalant/phosphonate	20
SG BD	Oxygen Scavenging/Hydrazine (N_2H_4)	200 (If steam generator is drained to the discharge pipe.)
SG BD	pH adjustment/ammonium hydroxide (NH_4OH)	100 as ammonia (If steam generator is drained to the discharge pipe.)

REFERENCES:

[5.5-1] United States Environmental Protection Agency, Office of Science and Technology, Office of Water, 2006, *National Recommended Water Quality Criteria,* Note that the concentrations are expressed as micrograms per liter.

[5.5-2] CJSC "Armenian Nuclear Power Plant", 2006, *Ecological Passport of Armenian Nuclear Power Plant*.

[5.5-3] US NRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, (NUREG-1437 Vol. 1) par. 2.2.4

[5.5-4] IAEA, 2003, *Radioactive Waste Management Glossary, 2003 Edition*

[5.5-5] IAEA, September, 1995, *The Principles Of Radioactive Waste Management*, Safety Series 111-F.

[5.5-6] US NRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, (NUREG-1437 Vol. 1) par. 6.4.3.2.

[5.5-7] U.S. Nuclear Regulatory Commission, August 1988, *Guidance For Selecting Sites For Near-Surface Disposal Of Low-Level Radioactive Waste*, Regulatory Guide 4.19, Office Of Nuclear Regulatory Research.

[5.5-8] B. Siskind, D. R. Dougherty, D. R. MacKenzie, and S. A. Romano, December 1985, *Extended Storage of Low-Level Radioactive Waste: Potential Problem Areas*, Brookhaven National Laboratory, Upton, NY 11973. NUREG/CR-4062.

[5.5-9] V. Jain, February 2001, Survey of *Waste Solidification Process Technologies,* Center for Nuclear Waste Regulatory Analyses Southwest Research Institute, 6220 Culebra Road San Antonio, Texas 78238-5166, NUREG/CR-6666

[5.5-10] US NRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, (NUREG-1437 Vol. 1) par. 6.4.5.

5.6 TRANSMISSION SYSTEM IMPACTS

The objective of this section is to identify and evaluate impacts on the terrestrial and aquatic ecosystem induced by the operation and maintenance of transmission systems. The discussion considers effects of rights-of-way maintenance and is limited to an assessment of impacts to “important” terrestrial or aquatic species and habitats other than humans. This section also presents the evaluation of impacts on members of the public induced by operation and maintenance of the proposed transmission system.

Existing and proposed transmission systems are described in EBID Section 3.7. Currently five 220 kV lines connect the operating ANPP Unit 2 with four different substations and from there to the Armenian electricity distribution network. In addition, power transmission from/to ANPP is possible over seven different 110 kV overhead transmission lines to six different substations. A new 400 kV transmission line is proposed to be built between ANPP and Hrazdan 5 Thermal Power Plant (TPP) to provide sufficient transmission capacity to serve both Units 2 and 3.

Once the new 400 kV transmission line is operational and following permanent shutdown of Unit 2, some of the existing 220 kV and 110 kV lines may be taken out of service. For the purposes of this analysis, however, it is assumed that all twelve existing transmission lines will remain operational along with the new line serving Unit 3. Impacts from operation of the existing lines are expected to be no different from those that have occurred during past power line operation; however, continued for transmission of power from Unit 3 will extend their lifetimes by up to 60 years beyond that necessary to support operation of Unit 2.

The routing for the new 400 kV transmission line has yet to be determined, therefore specific impacts due to operation of that line cannot be addressed, except to the extent that such impacts are due to routine maintenance and operation of the line which will be similar to the other lines. It can be assumed, however that the routing will parallel or be similar to existing transmission line Sipan that goes to the Shaumyan-2 substation and from there parallel to the 220 kV lines between Shaumyan-2 and the Hrazdan TPP. A specific review of such potential routing, using images available from Google Earth ® has concluded the following:

- The power plant site is at an elevation of about 930 m above sea level and the new transmission corridor will be entirely above this elevation; thus none of the potential corridor is in the desert landscape zone.
- The potential corridor will remain in the semi-desert landscape zone for the first 42 km from the ANPP switchyard.
- Elevation increases gradually to 1250 m and the next 40 km of the potential corridor are in the dry steppe zone.
- Elevation continues to increase gradually and the final 20 km to the Hrazdan power station are in the steppe landscape zone.

- The first 12 km of the potential route are through un-irrigated, and apparently uncultivated, semi-desert.
- The remainder of the potential route appears to be fairly heavily used for agriculture, although fragments of uncultivated land are included. There is evidence of some industrial activity along the route through the dry steppe and steppe zones. This is primarily mineral extraction.
- The route does not follow stream beds at any location. Major streams will be well known.
- Very little of the potential route is in a pristine environment; because of the extent of prior development and current use, the habitat along this route is unlikely to include highly valuable habitat for flora and fauna.

{Once the new corridor routing is determined, an inventory of flora and fauna along the route should be made by qualified scientists to support the final environmental impact assessment.}

Even though the impacts of transmission line construction, high-voltage line operation, and corridor maintenance are expected to be minimal, adoption of best management practices, such as those developed by the Tennessee Valley Authority (Ref. [5.6-1]), can mitigate and minimize such impacts. Technical procedures on power transmission and distribution system should minimize the impacts of the new transmission lines. Ref. [5.6-2] Rules on operation of high voltage transmission lines provide protection from adverse impacts of line maintenance practices on agricultural crops. Ref. [5.6-3]

5.6.1 Terrestrial Ecosystems

EBID Section 2.4 describes the ecosystems of Armenia. Those most likely to be impacted by the transmission lines from ANPP Unit 3 include:

- Desert and semi-desert areas of the Ararat valley, where minimal right-of-way maintenance is required to control vegetation (these ecosystems would apply primarily to existing transmission lines that have been maintained for many years, with no new impacts expected);
- Dry mountainous steppes in the Ararat valley above 1500m, where minimal right-of-way maintenance is required;
- Mountainous steppes, which represent the dominant ecosystem of Armenia, and occur throughout the country at altitudes between 1200 and 2000m. As noted above, this is the primary ecosystem likely to be involved with the new transmission line route. Vegetation cover is varied, but particularly important plants include grasses. The flora and fauna of this ecosystem are described in Table 2.4A-1.
- Forests, which generally cover the mid-zone of mountains, occurring at altitudes between 500m and 2100m. Forest cover is relatively low in Armenia,

with less that 10% of the land being forested. EBID Table 2.4A-2 lists flora and fauna of this landscape zone.

- Sub-alpine meadows and alpine meadows, which occupy the highest altitudes and would not require right-of-way maintenance to control vegetation. Flora and fauna of these ecosystems are given in EBID Table 2.4A-3.

Environmental expert reviews of new transmission lines typically require that new corridors not pass through forested areas or agricultural lands. Ref. [5.6-4] Nevertheless, potential impacts of such routing are discussed below since existing transmission lines most likely were not subject to such restrictions and it may be infeasible to totally avoid agricultural areas when routing the new 400 kV line between ANPP and Hrazdan. Potential impacts on agriculture are generally manageable and there is no reason for a blanket restriction of transmission lines in agricultural areas. Rules on operation of high voltage transmission lines provide practices that minimize or compensate for potential impacts on agricultural lines, garden plots, etc. Ref. [5.6-3]

5.6.1.1 TRANSMISSION LINE MAINTENANCE PRACTICES

Armenia has established practices for maintenance of transmission lines and corridor rights-of-way to protect the environment. Ref. [5.6-1b] These practices provide for:

- Periodic inspections for encroaching vegetation;
- Removal of vegetation using special machines and equipment;
- Recultivation of disturbed lands;
- Cooperation with land owners/users in performance of repair works; and
- Compensation for damage to crops.

The practices also provide for inclusion of design provisions to protect transmission line equipment from adverse consequences due to nesting birds and to prevent damage to birds nesting on transmission towers.

In light of the fact that most[8] of the subject transmission lines are in arid landscapes requiring minimal control of vegetation, it is judged that the impacts of transmission line maintenance are SMALL. Support for this judgment is based on the following.

The US NRC studied impacts of corridor maintenance practices on wildlife (Ref. [5.6-5]).

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[8] Existing 220 kV lines “Musaler” and “Areg” pass to the south of the site and may pass through wetland and agricultural areas, as does the 110 kV line to “Sevjur” and “Pond” substations.

Most data on the impacts of power line corridors on wildlife are for relatively moist areas where vegetation growth is rapid and vegetation must be controlled to prevent its interference with the transmission lines. In arid regions, such as that in most of Armenia, little or no vegetation control is required, and the potential effects on wildlife are small. Potential effects are also small where lines cross croplands, because no vegetation management is required.

The maintenance of right-of-way vegetation as a low-growing plant community results in a right-of-way wildlife community that is characteristic of such vegetation. This wildlife community has some species of small mammals and birds that are not present in the natural plant communities bounding the right-of-way. Therefore, the presence of the right-of-way vegetation adds to the number of wildlife species found in the area. In addition, the right-of-way provides food and cover for many species of animals that were already present before line construction.

5.6.1.2 SPECIAL MAINTENANCE PRACTICES IN IMPORTANT HABITATS

As discussed above, it is unlikely that transmission corridors involve important habitats, therefore there are no special practices for important habitats. When the routing of the new 400 kV line to Hrazdan is determined, the routing must be reviewed to determine if it passes through important habitats.

5.6.1.3 WILDLIFE MANAGEMENT PRACTICES IN TRANSMISSION CORRIDORS

No wildlife management policy or practices exist for Armenia; thus there are no wildlife management practices specific to transmission corridors. The RoA should consider using best international practices to develop wildlife management practices for transmission corridors.[9]

5.6.1.4 IMPACTS ON IMPORTANT TERRESTRIAL SPECIES AND HABITATS

Potential adverse impacts resulting from transmission line operation and maintenance activities include soil erosion, runoff or uncontrolled release of defoliants and herbicides, barriers to wildlife movements created by clear-cutting of trees, and subtle effects of high energy electrical fields on the behavior of animals.

5.6.1.4.1 Impacts of High Voltage Electricity Transmission

Experience has shown that for transmission lines energized at 765 kV or less, there are no known adverse impacts resulting from ozone formation. At voltages of 765 kV or above, consideration of the possible effects of electric fields and corona discharge, including resulting noise on terrestrial biota, may be warranted. Ref. [5.6-6]

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[9] For example, see: http://www.rights-of-way-env.com/12symp.htm and paper titled "Developing Wildlife Management Strategies for Transmission Line Rights-of-Way" by Kenneth D. Hoover and Michael T. Galvin. There have been numerous symposia on environmental concerns for energy transmission corridors, the proceedings for which contain numerous such articles, see: http://www.rights-of-way-env.com/1content.htm.

The electro-magnetic fields produced by operating transmission lines up to 1100 kV have not been reported to have any biologically or economically significant impact on plants, wildlife, agricultural crops, or livestock. Ref. [5.6-7]

As noted above, the transmission lines serving ANPP Unit 3 will be 110 kV, 220 kV, and 400 kV. Since no transmission lines serving Unit 3 will exceed 765 kV, no impacts are expected due to ozone formation, electrical fields, corona discharge, or resulting noise from the overhead transmission lines. In addition, the potential for bird electrocution is considered negligible for the high voltage transmission systems considered in this review (Ref. [5.6-7]).

5.6.1.4.2 Impacts on Wildlife Habitats and Flyways

Table 2.4-5 lists 15 protected species of fauna known in the vicinity of Metsamor. Section 4.3 states that the four bat species (*R. eurales, R. mehelyi, M. natteri, M. schrieibersi*) are not expected at the ANPP site because of the absence of typical cave habitat, but they could be located in the vicinity of transmission corridors. The Armenian Mountain Viper (*V. raddei Boettger*) is known on the southern slope of Mt. Aragats and thus may be in the vicinity of transmission lines between ANPP and substations to the northeast and northwest. Transmission corridors may also include habitats for the hedgehog (*E. auritas Gmelin*) or the Marbled polecat (*V. peergusna peregusna Guld*). The short toed eagle (*C. golllicus collicus Gmelin*) and the Red footed falcon (*F. vespertinus vespertinus)* may reside in treed areas near transmission corridors.

The U.S. Nuclear Regulatory Commission did a review of published studies of avian mortality resulting from collisions with transmission lines and other man-made objects (Ref. [5.6-8]). The US NRC was concerned that collision mortality could be large enough to cause long-term reductions in bird populations. The US NRC found that existing literature suggested that total collision mortality (cumulative impacts) associated with all types of man-made objects is not reducing bird populations significantly. Design practices for transmission towers are intended to discourage use of transmission towers as nesting sites. It is expected that transmission towers or lines will have a SMALL impact on bird populations in Armenia and no further mitigation measures are needed.

The US NRC studied impacts of transmission lines and corridor maintenance practices on wildlife (Ref. [5.6-5]).

> Most data on the impacts of power line corridors on wildlife are for relatively moist areas where vegetation growth is rapid and vegetation must be controlled to prevent its interference with the transmission lines. In arid regions (such as those in most of Armenia), little or no vegetation control is required, and the potential effects on wildlife are small. Potential effects are also small where lines cross croplands, because no vegetation management is required.
>
> The presence of the transmission line and its cleared corridor is apparently not a great disturbance to any wildlife species. Based on all of the literature reviewed, no wildlife species is known to have disappeared from habitats adjoining the corridors after line construction.

Although animal population density is cyclic in response to vegetation changes in rights-of-way, over the long term (i.e., over many cycles) the populations appear relatively stable, with no species being significantly affected. The overall impact of transmission line corridors, based on an extensive literature search, appears to be neither significantly adverse nor significantly beneficial. The consensus among wildlife biologists appears to be that cleared transmission line corridors and their maintenance do not have significant adverse impacts and that corridors provide valuable wildlife habitats if properly managed. Of the papers reviewed, none was found that identified any impact of transmission line corridors on wildlife that was of great concern to the authors. The evidence supports a conclusion that continued right-of-way management will not lower habitat diversity or cause significant changes in species populations in the surrounding habitat. Thus the impacts are of SMALL significance.

5.6.2 Aquatic Ecosystems

EBID Section 2.4 and its Appendix describe the ecosystems of Armenia. Those in areas of existing transmission lines from ANPP include azonal ecosystems, the most important of which are wetlands including areas in the Ararat Valley where the underground waters are close to the earth's surface. Species associated with wetlands include higher plants (*Astragalus, Acantholimon, Lonicera iberica, Rhamnus pallasii, Cerasus incana, Spirae hypericifolia*), invertebrates (*Lestes sponsa, Puella lunulata, Orthetrum cancellatum,Enochrus melanocephalus, Lymnaca stragnalis, Planorbis planorbis*), amphibians and reptiles (for example, the grass snake *Natrix natrix*) and mammals such as coypu, and water rat.

The US NRC conducted literature reviews to assess potential impacts on floodplains and wetlands (Ref. [5.6-9]).

No transmission line associated with a nuclear plant has been identified as being a significant impact on the functions and values of a wetland or floodplain. Only minor impacts of small significance are expected from rights-of-way maintenance or line repair.

Marshes, ponds, or other types of wetlands lacking trees generally are not subjected to vegetation control and thus should not be affected. Impacts are generally restricted to the rights-of-way and should have no significant impact on the functions and values that have been identified for floodplains, including storage and slow release of floodwaters, water quality maintenance, groundwater recharge, and support of wildlife populations.

Repair of transmission lines may require access by heavy equipment to tower sites in floodplains or wetlands. This access would damage vegetation and disturb wildlife, having the same types of impacts that occurred during construction of the line. Overall impacts are expected to be relatively minor because (1) line repairs at any one location are rarely required, (2) impacts would be temporary and restricted to relatively small areas, and (3) tower sites often avoid wetlands.

5.6.3 Impacts to Members of the Public

As noted above, twelve existing transmission lines of 110 kV and 220 kV serve the ANPP site. The impacts of continued operation of these lines on members of the public will be SMALL (negligible), since they have been in operation for many years.

Only one new 400 kV transmission line will be installed to support operation of ANPP Unit 3. Routing of this line has yet to be determined, so specific impacts of this line on members of the public cannot be assessed at this time; however, impacts should be similar to those of the other high voltage lines currently in use. Procedures for power transmission and distribution prohibit routing of lines over 110 kV through residential areas, thereby minimizing impacts on members of the public. Ref. [5.6-10]

The US NRC conducted literature reviews to assess potential impacts of transmission lines on human health (Ref. [5.6-11]), as discussed in the following subsections. The two human health issues related to transmission lines are the acute effect, shock hazard, and the potential for chronic effects from exposure to electric and magnetic fields.

5.6.3.1 SHOCK HAZARDS

Primary shock currents are produced mainly through direct contact with conductors and have effects ranging from a mild tingling sensation to death by electrocution. Tower designs preclude direct public access to the conductors. Secondary shock currents are produced when humans make contact with (1) capacitively charged bodies such as a vehicle parked near a transmission line or (2) magnetically linked metallic structures such as fences near transmission lines. A person who contacts such an object could receive a shock and experience a painful sensation at the point of contact. The intensity of the shock depends on the electro-magnetic field strength, the size of the object, and how well the object and the person are insulated from ground. Ref. [5.6-12]

Design criteria that limit hazards from steady state currents are based on codes and standards, adherence to which requires that utility companies design transmission lines so that the short-circuit current to ground, produced from the largest anticipated vehicle or object, is limited. In practice, this limits the electric fields near roadways.

Since the existing Armenian electrical distribution network currently has no 400 kV network, there are no established Armenian standards for 400 kV transmission systems. Such standards are currently under development based on standards from other countries that use 400 kV systems. Ref. [5.6-4] {When Armenian standards are established (or international standards accepted as applicable in Armenia) for 400 kV transmission lines, the potential for shock hazards can be reassessed.}

5.6.3.2 CHRONIC EFFECTS OF ELECTROMAGNETIC FIELDS

The US NRC's literature search results address the potential chronic effects of electromagnetic fields (EMF) on human health, as discussed below. Ref. [5.6-13]

> An important question is whether transmission line exposures contribute significantly to total EMF field exposures. In most cases, fields produced inside the home by appliances and electrical wiring exceed contributions from

transmission line fields. Exceptions to this rule are individuals living adjacent to high-voltage transmission line rights-of-way.

A careful review of the biological and physical studies of alternating current EMFs has failed at this time to uncover consistent evidence linking harmful effects with field exposures. EMF fields are unlike other agents that have a toxic effect (e.g., toxic chemicals and ionizing radiation) in that dramatic acute effects cannot be forced and longer-term effects, if real, are subtle.

REFERENCES:

[5.6-1] Tennessee Valley Authority (TVA), 1992, *A Guide for Environmental Protection and Best Management Practices for Tennessee Valley Authority Transmission Construction and Maintenance Activities*, TVA/LR/NRM 92/1.

[5.6-2] GoA Resolution № 961, *On Approval of Technical Procedure Related to Power Transmission and Distribution*, July 12, 2007, Art. 47.

[5.6-3] Goa Resolution № 249, *On Approval of Rules for Maintenance of 1000V and Higher High Voltage Power Network and Main Pipelines*, May 18, 2000.

[5.6-4] Meeting with CJSC "Energy Network Design Institute", April 9, 2008.

[5.6-5] US NRC, May 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, NUREG-1437, Vol. 1, Section 4.5.6.1.

[5.6-6] US NRC, 1999, NUREG-1555, *Standard Review Plans For Environmental Reviews For Nuclear Power Plants*, Section 5.6.1.

[5.6-7] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.6.3.

[5.6-8] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.6.2.

[5.6-9] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.7.

[5.6-10] GoA Resolution № 961, *On Approval of Technical Procedure Related to Power Transmission and Distribution*, July 12, 2007, Art. 48.

[5.6-11] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.4.

[5.6-12] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.4.1.

[5.6-13] US NRC, May 1996, NUREG-1437, Vol. 1, Section 4.5.4.2.

5.7 URANIUM FUEL CYCLE IMPACTS

The fuel for the new ANPP nuclear unit will be purchased from suppliers in other countries (e.g., USA, RF, and Canada) and transported into Armenia. Spent nuclear fuel will be stored in the fuel pool for at least five years, moved to the interim dry storage facility, and then transported out of the country for disposal. The generic environmental impacts of an interim dry storage facility have been reviewed in the Environmental Impact Assessment of the existing dry storage facility at ANPP. The following sections discuss the environmental impacts of the fuel cycle activities in other countries which supply and dispose of the nuclear fuel.

In the US, the results of generic studies of the hazards of the Uranium Fuel Cycle have been used to develop the regulation, 10 CFR 51.51, *Uranium fuel cycle environmental data--Table S-3*. (Ref. [5.7-1]) This regulation provides the annual environmental impacts of the uranium fuel cycle for a 1,000 MWe light water reactor including environmental effects of:

- uranium mining and milling,
- production of uranium hexafluoride,
- isotopic enrichment,
- fuel fabrication,
- reprocessing of irradiated fuel,
- transportation of radioactive materials
- management of low level wastes and high level wastes related to uranium fuel cycle activities.

These fuel cycle impacts have been found to be sufficiently small as to not alter the overall benefit-cost balance of a NPP project. Descriptions of the environmental impact assessment of the uranium fuel cycle as related to the operation of light-water-cooled reactors are well documented by the USNRC (Refs. [5.7-2] and [5.7-3]). The environmental impact from radioactive releases (including radon and technetium) due to the uranium fuel cycle is small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle are acceptable.

The NPP technologies being considered for ANPP Unit 3 include the AP-1000, AES-92, and the EC-6 (Enhanced CANDU 6). These reactor technologies are all light water reactors with uranium dioxide fuel and therefore Table S-3 of 10 CFR 51.51(b) provides the basis for evaluating the environmental effects from the uranium fuel cycle for these reactor technologies. The Table S-3 values are normalized for a 1000 MWe reference reactor. Since the NPP technologies under consideration may be up to 1117 MWe, the fuel cycle impacts resulting from operation of new ANPP unit would be no more than 1.12 times the values of Table S-3 of 10 CFR 51.51(b).

REFERENCES:

[5.7-1] US NRC, 1984/2002/2007,10 CFR 51.51 *Uranium Fuel Cycle Environmental Data--Table S-3.*

[5.7-2] U.S. Atomic Energy Commission, 1974, WASH-1248, *Environmental Survey of the Uranium Fuel Cycle*.

[5.7-3] U.S. NRC, 1976, Supplement 1 to WASH-1248, (also known as NUREG-0116), *Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycl*e.

5.8 SOCIOECONOMIC IMPACTS OF STATION OPERATION

Subsection 5.8.1 describes the physical impacts of station operation, specifically the affects on people, buildings, noise, aesthetics, and air quality.

Subsection 5.8.2 describes the social and economic impacts of station operation, specifically the demographic, economic, infrastructure, and community impacts to the vicinity and region of Unit 3 operation.

Subsection 5.8.3 describes environmental justice concerns, discussing the potential for disproportionate impacts on low-income and minority populations.

Detailed descriptions of the ANPP site, vicinity, and region are provided in Sections 2.1 and 2.2 of this EBID. The site is largely developed, with much of the site occupied by ANPP Unit 1 (shutdown), ANPP Unit 2 (currently operating), radioactive waste storage and disposal facilities, and construction support buildings in place from past activities at the site. Unit 3 will be situated within the boundaries of the site, as shown in Figures 3.1-2 through 3.1-4.

Beyond the immediate site boundary, the area is primarily rural, bounded by undeveloped reforestation land, agricultural land, and desert landscape. The towns of Metsamor and Armavir are nearby, as are a number of villages, as described in Subsection 4.4.1. As shown in Table 2.5-1, the 2006 population for the area within 16 km was 204,245. Population distribution details are given in subsection 2.5.1. Station operation is estimated to begin in 2016. The projected population in 2015 for the communities within 16 km of ANPP is 215,186 increasing to 240,869 in 2055 without new ANPP workers (see Table 2.5-2).

The MoE is performing a tailored collaboration project with the IAEA that will focus on examination of human resources needs for the new NPP. Pending completion of that project, the on-site workforce to support startup and operation of Unit 3 is assumed to be consistent with Table 2.5-4 or the plant population indicated in the Plant Parameter Envelope, Table 3.2A-1, item 17.5.1.

Section 2.1 defines the *Station Region* as the area within 50 km of the station. In Section 5.8, socio-economic impacts are anticipated to be the greatest, and primarily contained, within Armavir marz and Yerevan City; therefore for the purposes of this section, the area within Armavir marz and Yerevan City is defined as the *region of influence*. For the most part impacts will be the greatest on the nearby communities, in other words, within the 16 km zone.

5.8.1 Physical Impacts of Station Operation

The potential physical impacts of station operation on nearby communities include noise, airborne emissions, and aesthetic visual impacts.

5.8.1.1 WORKERS AND THE LOCAL PUBLIC

People who work at or live near the ANPP site will be subject to physical impacts resulting from operation of Unit 3, similar to those currently experienced due to operation of Unit 2. Onsite workers will be impacted the most. People living or working near the site will be impacted significantly less.

Workers within the site boundary experience the most physical impact due to plant operational support activities. Site workers have training and personal protective equipment to minimize the risk of potentially harmful exposures. Emergency first-aid care is available at the site, and regular health and safety monitoring of operational staff are conducted on a regular basis. These activities are performed in compliance with regulations of the RoA, and site-specific permit conditions.

5.8.1.2 BUILDINGS

Except for ANPP Units 1 and 2 and the on-site radwaste facilities no industrial, commercial, or residential buildings will be directly affected by operation of Unit 3. Onsite buildings have been constructed to safely withstand any possible impacts from operations associated with operation of Unit 3.

5.8.1.3 ROADS

Unit 3 will continue to be served by the same two access roads that serve the current site. Noise levels due to traffic on these roads will be similar to those currently experienced due to transportation of personnel, equipment and supplies to support operation of Unit 2.

5.8.1.4 AESTHETICS

There are no parks or recreation areas nearer to the site than those in Metsamor town, over 3.5 km away. Large structures, such as the containment structure and the cooling tower, will be clearly visible from Highway M-5 and nearby villages to the east and south of the site (villages Aknalich, Arshaluys, Haytagh, Ferik, and Tsaghkalanj). The site is also clearly visible from Nor Yedesia to the north of the site. Except for the natural draft cooling tower, which at approximately 170 m tall[10] is approximately 60 m taller than existing cooling towers, all structures will be less visible than the existing four cooling towers, which are 110 m in height. The plume from the new cooling tower will be visible from long distances, depending on weather conditions, much as the plumes from the existing towers.

Figures 3.1-6, -7, -8, and -9 illustrate the visual impact of the new structures, including a natural draft cooling tower.

Residents of the region are generally supportive of ANPP and many residents work or have family members who work at ANPP. The existing facility is looked upon as a beneficial influence in the region and construction of a new unit is welcomed. Based on existing structures and the topographic layout of the vicinity, the impact of structures at the ANPP site on aesthetics is considered to be SMALL and requires no mitigation efforts.

Because the ANPP site is already aesthetically altered by the presence of existing Units 1 and 2 with four natural draft cooling towers along with their visual plumes, only slight adverse impacts on visual aesthetics of the site and vicinity are expected from the operation of a new facility.

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[10] See Plant Parameter Envelope, Table 3.2A-1, Section 2.5.8.

Should opposition to the new unit be raised on the grounds of aesthetics, the condenser cooling water could use mechanical draft cooling towers, which at 18 m high[11] would be smaller and less visible than major structures of the existing Units 1 and 2 and other new structures of Unit 3. (Mechanical draft towers may result in slightly less net energy production from Unit 3 due to the power needed to power the fans that move the air through the cooling tower.)

5.8.1.1 Noise

As discussed in detail in Subsection 4.4.1.5, the RoA Ministry of Health has established noise impact limits for noise in residential areas based on equivalent sound levels and maximal sound levels. Ref. [5.8-1]

For the purpose of this EBID, noise impacts are assessed using the maximum sound level of 50 – 55 dBA as the level below which noise levels would be considered generally acceptable for residential and outdoor recreational uses. Using the Ministry of Health Order № 138 limits, noise levels below 50 – 55 dBA will be considered to be of SMALL significance (hereafter, referred to as “MoH Order 138 guideline levels”). These values are 10 dBA lower than those accepted by the U.S. NRC as noise levels of small significance (60 – 65 dBA – hereafter referred to as “acceptable levels”). Ref. [5.8-2]

Unit 3 will produce noise from the operation of pumps, transformers, turbines, generators, and switchyard equipment. The noise levels will be controlled in accordance with applicable RoA regulations. Most equipment would be located inside structures, reducing the outdoor noise level.

Two types of cooling systems will be considered for Unit 3: a natural draft cooling tower for condenser cooling and spray ponds for essential service water cooling. Alternatives include mechanical draft towers. Natural and mechanical draft cooling towers and spray ponds emit broadband noise. Therefore, the noise associated with the cooling systems would be largely indistinguishable and nonobtrusive. The anticipated noise levels from either of the cooling tower options are not expected to be significantly greater than background levels. Noise levels from spray ponds are expected to be lower than those for cooling towers.

Based on the PPE, natural draft and mechanical draft cooling towers have anticipated noise levels of 55 dBA at 305 m[12]. The proposed location of the cooling tower (as shown in Figures 3.1-2 through 3.1-4) is approximately 315 m from the nearest site boundary[13] and more than 2,500 m from the nearest residence.

The resulting operational noise level from the addition of Unit 3 will not significantly increase the noise level at the property line. In general, power plant sites do not result in offsite noise level increases of more than 10 dBA above background levels.

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[11] See Plant Parameter Envelope, Table 3.2A-1, Section 2.4.8.

[12] Table 3.2A-1, Items 2.4.10, 2.5.10, and 3.3.10.

[13] Based on site boundaries prior to pending transfer of additional “sanitary buffer zone” land to the north of the site to control of CJSC “ANPP”.

Therefore, background noise levels are expected to range from 45 to 55 dBA at the nearest site boundary and to be attenuated to below 50 dBA at the nearest residence.

Metsamor town is the closest major population center near the site (centered 4.6 km from the reactor location – see Section 2.5). The Master Plan of Metsamor Town assesses noise levels in Metsamor. Ref. [5.8-3] The Plan identifies noise sources for the town as the Yerevan-Armavir highway (M-5), local streets, and industries in the industrial district of the town. Noise levels in hospital areas are equal to or less than the standard of 35 dBA. (A limit of 35 dBA is also specified by MoH Order 138 for wards inside hospitals, Ref. [5.8-4].) Operation of Unit 3 will not cause noise levels in Metsamor town to exceed their standards.

As illustrated in Figure 2.5-7, the nearest historic and culturally significant sites are in and near Taronik village, approximately 7 km from the site. Operation of pumps for cooling water makeup from the Sevjur River and/or the groundwater settling pond causes noticeable but unobtrusive noise at the site of the Metsamor Museum.

The impact of noise levels in residential and cultural areas due to operation of Unit 3 will be SMALL to negligible.

5.8.1.5 AIR QUALITY

Required permits, obtained from the Republican and local government agencies, are expected to be in place prior to the commencement of Unit 3 operation. Air pollutant control measures, which may include limits for noted pollutants, will be part of the controls prescribed in these permits (see Subsection 1.2.3).

In addition to the radioactive airborne releases discussed in Section 5.4, non-radioactive emissions to the air will come from the natural-gas-fired auxiliary boiler and the diesel generators. Both of these sources are subject to limited operation during the year; the auxiliary boiler to provide a source for hot water and steam during Unit 3 shutdown periods and the diesel generators during periodic testing.

Bounding values for emission from the auxiliary boiler and diesel generators are given in the Plant Parameter Envelope, Tables 3.2A-4 and 3.2A-5. Emissions will be within regulatory limits.

Impacts to air quality from operation of Unit 3 are considered to be SMALL and do not warrant mitigation.

5.8.2 Social and Economic Impacts of Station Operation

This subsection evaluates the demographic, economic, infrastructure, and community impacts to the vicinity and region as a result of operating Unit 3 at the ANPP site. The evaluation assesses impacts of startup- and operations-related employment and of an in-migrating workforce on population, regional labor, tax revenues, infrastructure and community services, housing, and educational activities within the vicinity and region. As discussed in the introduction to Section 5.8, social and economic impacts are assumed to take place in the *region of influence*, which is taken to be area of Armavir marz and Yerevan city, with the bulk of the impacts focused in the site vicinity, in other words, within Armavir marz.

In evaluating the social and economic impacts of Unit 3 operation, certain basic assumptions are made regarding the workforce for ANPP Unit 3, as follows:

- The ANPP Unit 3 operational staff to support plant startup will number 552 (see Table 2.5-4) to 1,750 (see Table 3.2A-1, PPE Item 17.5.1).
    - Even though many of the 552 workers in Table 2.5-4 are likely to consist of personnel transferred from the Unit 2 staff and new staff from within the *region of influence,* it is conservatively assumed that all will be relocated Armenian workers, 80 % with families and 20 % without families;
    - For the 1,750 from the PPE, half are assumed to be from the existing staff and therefore not relocating, with 80% of those relocating with families and 20 % without families.
- ANPP Unit 3 staff will reside in locations consistent with the residences of the existing ANPP staff (see Subsection 2.5.1 and Table 2.5-4);
- The non-ANPP workforce in 2015-1016 to support plant startup will number approximately 790 (see Tables 2.5-4 and 5.8-1);
- The non-ANPP workforce will reside:
    - 60 % in Armavir town;
    - 20 % in Metsamor town;
    - 20 % in Yerevan.
- Of the construction craft labor and craft supervisors remaining to support startup, 80 % will be Armenian citizens, all of whom already reside in the region with their families;
- 90 % of the indirect labor, quality control inspectors, and state inspectors will be Armenian citizens already residing in the region with their families, the remaining 10 % are Armenians relocating to the region with their families;
- The NSSS vendor and contractor staff will be 100 % from outside Armenia;
- The EPC contractor staff and startup personnel will be 80 % from outside Armenia, the remaining being Armenian citizens already residing in the region;
- Of the foreign workers and Armenians from outside the region, 80% will relocate temporarily without their families, living in dormitories or communal apartments;
- For those relocating to dormitories or communal apartments, there will be an average of four persons per living unit;
- For those workers relocating with their families, the family size will average 4 persons, 20% of which (0.8 persons) will be school-age.

The values in Table 2.5-4 for additional staff in 2015-2016 assume that ANPP Unit 3 will require the indicated percentage of peak construction personnel as indicated in US DOE Report NP2010 (Ref. [5.8-5]). The value for O&M Owner's staff (ANPP Unit 3 employees) is 110% of the unit staff indicated for a VVER-1000 Model AES-91 (Ref. [5.8-6]), but substantially less than the current staffing of ANPP Units 1 and 2 or that given in the PPE. The "Total, First year operation", however, is comparable to the current ANPP staffing. That is the number applied in the analyses below. As

reflected in Table 2.5-4, “O&M Staff Reductions”, it is assumed that ANPP staff for Units 1 and 2 decreases from 1,743 to 550 in 2025 as Units 1 and 2 are in early stages of decommissioning and continues to decrease thereafter. The total numbers imply additional transfers to the ANPP Unit 3 staffing as O&M work on the shutdown units has decreased and contractor staffs are conducting decommissioning tasks. (The socio-economic impacts of the decommissioning activities should be addressed in a separate environmental assessment specific to decommissioning.)

Demographic impacts are also assessed assuming the ANPP Unit 3 staff supporting startup is consistent with the staffing indicated in the PPE, Table 3.2A-1, Item 17.5.1.

5.8.2.1 DEMOGRAPHIC IMPACTS

Population estimates and projections for the region are discussed in Subsection 2.5.1. Industry and unemployment data are discussed Subsection 2.5.2.

At the peak construction of construction activity, there is an on-site construction workforce of 2,880 to 3,600. The additional staff at ANPP Unit 3 in 2015-2016 shown in Table 2.5-4 represents a reduction of 1,130 to 2,260 onsite workers from the workforce at peak construction.

Table 5.8-1 gives the calculated numbers of new residents and new students in the *region of influence* as a result of relocating workers. The table also includes a calculation of percentage increase in population, based on the community populations in 2015 (without new NPP staff) as given in Table 2.5-7, and percentage increase in number of general education students, based on the number of students in these communities in 2006 as shown in Table 2.5-18. Values are provided for comparison for the ANPP O&M staffing of 552 (Table 2.5-4) and 1,750 (PPE Item 17.5.1).

Using the above assumptions relative to relocated workers in Armavir town, this would result in a population increase of 1.7 % to 2.2 % over the predicted 2015 population, an increase of 1.3 % to 1.7 % in the number of students, and would require 148 to 186 housing units. Based on housing statistics in Table 2.5-16, the required number of housing units represents 1.9 % to 2.4 % of available housing stock in Armavir. This represents a SMALL impact on Armavir Town.

For Metsamor town, the assumptions result in a 11.7 % to 17.9 % increase in population, an 13.6 % to 21.2 % increase in number of students, and would require 314 to 482 housing units. The values using Table 2.5-4 ANPP staffing are comparable to the predicted increases for construction in Section 4.4 and Table 4.4-3. Based on housing statistics in Table 2.5-16, the required number of housing units represents 12.7 % to 19.5 % of the stock available in Metsamor. The Metsamor Master Plan states that the maximum possible population of Metsamor is 15,000 (Ref. [5.8-7]); the predicted population in Metsamor (see Table 2.5-3), with addition of relocating operations and maintenance workers and families (see Table 5.8-1) will not exceed that value. The population increase due to Unit 3 operation is a MODERATE to LARGE impact on Metsamor, depending on the size of the Unit 3 O&M staff.

Based on the school capacities listed in Table 2.5-18, both Armavir and Metsamor schools have adequate capacity for the additional students.

Using the given assumptions results in less than 0.1% increases in population and students and housing demand in Yerevan; thus, the impacts on Yerevan are SMALL.

The workforce for ANPP discussed above must be compared with the results of the MoE/IAEA study and assessment of population impacts adjusted accordingly. As recommended in Section 4.4, a survey of vacant housing stock in Armavir and Metsamor towns should be conducted to support the final Environmental Report. If this survey indicates that insufficient housing is available in those communities, or it is desired to reduce the impacts on these communities, relocating workers can be encouraged to locate in Yerevan, as the stress on housing and schools will be substantially less.

Section 4.4 recommends establishing a dormitory or hostel for temporary workers in Armavir or Metsamor. If this were done, temporary workers to support startup of Unit 3 could use this facility and reduce the burden on Metsamor town. In any case, arrangements for housing of workers should be started as early as possible after a decision to build a new unit.

5.8.2.2 ECONOMIC IMPACTS

The economy of the ANPP station's *region of influence*, including industries and employment, is described in Subsection 2.5.2.

The main economic impacts resulting from new workers and their families on the area would be related to taxes, housing, and requirements for goods and services. Economic impacts related to the operation of the new unit or units would be associated mainly with payment of the plant property and profit taxes which will represent a beneficial impact on the *region of influence*.

Export of power produced by ANPP Unit 3 will bring revenue to the Republic. The Initial Planning Study (IPS) indicates that 2,350 GWh of power should be available for export in 2017. The amount of power available for export will decrease over time as domestic load increases and other, older generation resources are retired. The IPS estimates that approximately 1,000 GWh will be available for export in 2030.[14] Ref. [5.8-8]

If Armenia charges $0.036/kWh for exported power (see Ref. [5.8-9]) gross revenues would be between USD 84.6M (in 2017) and USD 36M (in 2030).[15] The National Statistical Service of Armenia reports a GDP of USD 6.4B in 2006 (Ref. [5.8-10]); this indicates that the revenues from export of power from ANPP Unit 3 could contribute approximately 1% to the GDP of Armenia; this represents a SMALL beneficial impact on Armenia's economy, which would extend beyond the *region of influence* to other portions of Armenia. This also strengthens Armenia's energy security position and supports regional integration.

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[14] The decrease in power available for export between 2017 and 2030 is due to the increase in power demand within Armenia.

[15] This does not account for cost recovery for construction of new transmission lines needed to export the power, nor the expected generation costs for power from Unit 3 – see IPS Chapter 3 for further discussion.

5.8.2.2.1 Employment

The 2015-2016 additional staff of 1,340 to 2,540 to support startup of Unit 3 represents approximately 1 % to 2 % of the total number of employed people in Armavir marz in 2005 (see Table 2.5-15) which represents a slight beneficial impact on the area.

Although completion of construction will result in a substantial reduction in employment of construction crafts and craft supervision, it will be partially offset by full O&M staffing of ANPP Unit 3. (Although not assessed in this EBID, some of the construction workforce reductions may also be offset by workforce demands to support decommissioning of Units 2 and 3; thereby leveling out the impacts on nearby communities.)

Because Armenia has a single nuclear station and has no mobile workforce to support plant outages, it must keep a relatively large number on staff year round; thus the ANPP operating staff is much larger than NPPs in other locations (see Table 2.5-4). A portion of the more than 1,700 people on the ANPP staff may be available to support operation of Unit 3, especially if they have critical skills and training.

Presence of additional workforce to support startup and operation of Unit 3 will result in indirect employment to provide services and support to the new workers. Using a ratio of indirect to direct employment for ANPP Unit 3 of 500 indirect jobs per 1,000 relocating workers (see Section 4.4) predicts another 380 to 600 indirect jobs in the region. Assuming this employment is in the sectors of transport and communications and trade in Armavir marz, this would be an approximate 4% to 6 % employment increase over the employment in those sectors in 2005 (as shown in Table 2.5-15) – a SMALL to MODERATE beneficial impact.

5.8.2.2.2 Taxes

Taxation is discussed in Subsection 2.5.4.2. Property and land taxes for the ANPP site are paid into the local budget of Metsamor Town. Enterprise profit and value added taxes go into the state budget of Armenia.

The actual monetary value of revenues generated by operation of Unit 3 cannot be precisely estimated because the type of reactor has not been selected and the means of financing construction and cost recovery have not yet been established. The specific methods of determining taxes owed were not determined during preparation of this EBID; therefore, no calculation of tax revenues is provided. Although the taxes cannot be quantified at this time, the impact of increased business volumes and property values should be beneficial to the site vicinity and to the Government of Armenia.

Since Unit 3 will substantially increase the asset value of the ANPP site and its structures, property and land taxes paid into the budget of Metsamor Town should also increase substantially and provide a beneficial impact to the town. The Metsamor Master Plan (Ref. [5.8-11]) reflects plans for improvement of existing housing, development of additional residential areas, and for improvement of utilities and other infrastructure within the town.

5.8.2.2.3 Cost of Housing

The numbers of personnel attracted to the site vicinity to support operation of Unit 3 represent a small increase in population in the *region of influence*, but a moderate increase, on the order of 10 % to 20 %, in the town of Metsamor. This may result in pressures for increased costs of housing, but such cost increases may have already taken place due to the pressures of the in-migrating construction workforce. As with the construction workforce, pressures for increases in housing costs can be mitigated by providing housing for temporary workers.

5.8.2.3 IMPACT ON SOCIAL SERVICES AND GOVERNANCE

The increases in population due to the operational workforce will have an impact on social services and governance in the *region of influence*.

5.8.2.3.1 Police and Traffic Control Services

The increase in population in Metsamor may result in demands for increased police and traffic control services over those provided currently; however substantially less than those predicted in Section 4.4 due to the influx of construction workers. Since new O&M staff will become permanent residents of the area, they are less likely to represent a burden on police and traffic control. Impacts are anticipated to be SMALL and without need for mitigation.

5.8.2.3.2 Potable and Fire Water Supplies and Sanitary Waste Treatment

Water supplies and sanitation in the station region (50 km zone) are discussed in Subsection 2.5.2.4, with statistics in Table 2.5-19. Potable water supply to ANPP and Metsamor are discussed in Subsection 3.3.1.4, and further in this section. Sanitary waste treatment for the ANPP site, the towns of Metsamor and Armavir and village of Norapat are discussed in Subsection 3.6.2 and further in this section.

<u>Potable and Fire Water Supplies for Metsamor</u>

Potable water supplies for Unit 3 are addressed in Subsection 3.3.1.4. As indicated in that subsection, the Unit 2 Safety Analysis Report (SAR) describes the existing water source, referred to as the household and drinking water supply and coming from Upper Zieva Springs, as also supplying Metsamor town. Ref. [5.8-12]

The Metsamor Master Plan describes the potable water supply to Metsamor town as coming from a single well with capacity of 120 m^3/h using water pumps, pumping into a basin of daily regulation. Ref. [5.8-13]

A recent clarification from ANPP indicates that the ANPP household and drinking water system no longer supplies Metsamor. Ref. [5.8-14]

The water supply for Metsamor also is used as the source for fire fighting water and guidelines for supplies of fire fighting water indicate that the capacity of the basin of daily regulation should be increased and water supply pipelines should be through two independent piping systems in order to serve a population of 10 to 25 thousand. In addition, the Plan recommends a second well be drilled and more than a single drinking water supply system be provided. Ref. [5.8-15]

As discussed in Section 4.4 the increase in tax revenues due to plant construction should allow Metsamor Town to implement such infrastructure projects and therefore no additional improvements should be necessary to support startup and operation of Unit 3.

Sanitary Waste Treatment for Armavir and Metsamor Towns and Norapat Village

As discussed in Subsection 3.6.2, the original waste water plant for ANPP also served Metsamor and Armavir Towns and Norapat village. To meet sanitary needs of the Unit 3 operating staff and the staff of Units 1 and 2, Subsection 3.6.2 commits to completing construction of a new waste water treatment plant.

As committed in Section 4.4, the rehabilitated waste water treatment plant discussed in the Metsamor Master Plan will be sized to serve the predicted populations of these communities and the rehabilitation will be completed prior to startup and operation of Unit 3; thus no further measures are required.

5.8.2.3.3 Hospitals and Medical Services

Healthcare institutions are discussed in Subsection 2.5.2.3. According to Table 2.5-16, there were nearly 18,000 doctors and paramedical personnel and over 8,000 hospital beds in the *region of influence* in 2005. According to Table 2.5-18, Armavir marz, and the towns of Armavir and Metsamor in particular, have excess hospital capacity, with hospital bed occupancy at less than 40%. Yerevan City's average occupancy of hospital beds in 2006 was less than 60%. Sufficient capacity appears to exist within the *region of influence* and the impacts of the relocating O&M workforce on hospitals and medical facilities will be SMALL.

5.8.2.3.4 Local Governance

The political structure of Armenia is described in Subsection 2.5.4.1. Local administration of services and infrastructure will be the responsibility of the mayors of the urban centers (Armavir, Metsamor, Vagharshapat, and Yerevan) and the community heads for rural villages.

Evidenced by the recent publication of the Master Plan for Metsamor Community (Ref. [5.8-11]), Metsamor town is setting the pace for community development planning. Such a master plan for Armavir Town would be helpful in defining impacts on that community.

As discussed above, the town of Metsamor and the Government of Armenia will benefit from tax revenues as a result of operation of Unit 3. The Government of Armenia should consider a program of revenue sharing to support the increased burden on governing authorities of Armavir Marz, Armavir town, and Yerevan city. In any case, the impact on these governing authorities is expected to be SMALL.

5.8.3 Environmental Justice Impacts

Subsection 2.5.1.3 describes the demographics of the Republic of Armenia in the site region (50 km zone). Table 2.5-10 provides the income, poverty, and education demographics data for each marz within 50 km of the site.

Pathways for radiation exposures due to normal operation are discussed in Subsection 5.4.2. Pathways for exposures during and following accidents involving

radioactive materials are similar to those described in 5.4.2. As noted in Subsection 5.4.3, no specific census of farm animals was conducted, but will be necessary, along with food sources, to complete accurate dose estimations for members of the public. Such a census is also necessary to determine if any of the population in the region is dependent on subsistence agriculture, hunting or fishing and thereby subject to disproportionate impacts from radioactive releases during Unit operation.

5.8.3.1 IMPACTS ON LOW INCOME POPULATION

As discussed in EBID Section 4.4, a majority of the population in Armavir marz falls into the lower two quintiles of income. This could be taken as an indication that the impacts of station operation will affect predominately low income individuals. As analyzed in Subsection 4.4.3, the relative income distribution in Armavir marz is similar to that for rural areas of the RoA. Thirty six percent (36 %) of the population in Armavir marz resides within the three defined urban areas of Armavir, Metsamor, and Vagharshapat (data available in Table 2.5-5), all three of which fall within 16 km of the site. In 2006, almost half (48.6%) of the population of the 16-km zone resided in these urban areas (data in Table 2.5-1); therefore it is expected that the overall income distribution within the station vicinity will fall between that for the RoA urban and rural populations. This is illustrated in Figure 5.8-1, where the turquoise-colored bar represents the expected income distribution within the 16-km zone. As seen in Table 2.5-15, the average monthly wages/salaries in Armavir marz exceeds that of Armenia as a whole. Based on this, impacts of station operation will affect a population with income statistics higher than the overall Republic of Armenia population.

As shown in Figure 5.8-1, rural areas tend to have lower income populations. The predominant land use in rural areas around the site is agriculture (see Section 2.2). The agricultural land around the site could be impacted by diversion of irrigation water for plant operation. As discussed in Section 5.2, issuance of water use permits to support operation of Unit 3 will require the GoA to allocate water among the ANPP and other water users that depend on water from the Sevjur River. Governmental actions recommended in Section 1.1.3.3 may result in improvement of irrigation system efficiency and/or compensation of other water users, thereby resulting in beneficial impacts on the agricultural population in the plant vicinity.

The impacts of machinery noise and traffic noise in the agricultural areas around the site during operation of Unit 3 will be substantially less than those during construction and are expected to be comparable to current levels during operation of Unit 2. Even though rural populations tend to be engaged in agriculture, they live primarily in established villages and will not be impacted significantly from the operation and traffic noise that may be of greater impact in the fields immediately surrounding the site.

The impacts of station operation are not expected to fall disproportionately on low income population in the *region of influence* and no measure for mitigation, beyond those identified in Subsections 5.8.1 through 5.8.2, are necessary.

The populations in the plant vicinity may benefit from increased direct and indirect employment associated with activities at the ANPP site. It is expected that this will be a SMALL impact, but that the low-income population will not benefit disproportionately relative to other income groups in the communities of the plant vicinity.

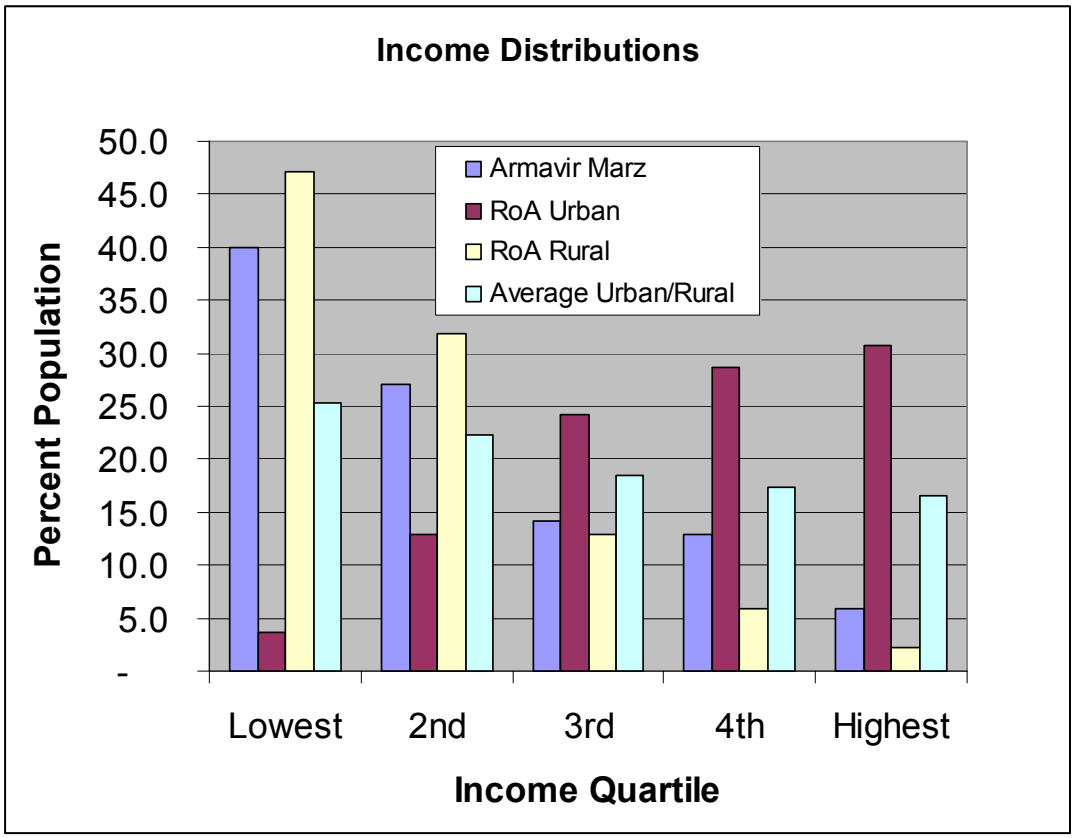
5.8.3.2 IMPACTS ON ETHNIC MINORITY POPULATION

Ethnic groupings in Armenia and in the 50 km zone are discussed in Subsection 2.5.1.4. As discussed in that Subsection and shown in Figure 2.5-5, it appears that there is a concentration of the Kurdish ethno-linguistic group in southwestern Armavir marz, near the Araks River, which most likely consists of peoples identified in the Armenian census as Yezed. Since this population is remote from the ANPP site, and outside the 16 km zone, the impacts of station operation on this ethnic minority are expected to be minimal and not disproportionate; no mitigating measures are needed.

Table 5.8-1, Relocated Workers and Families 2015-2016

ANPP Staff Source		Total	Armavir	Metsamor	Yerevan
	New Residents / Students				
Table 2.5-4	Residents	2,293	589	1,254	450
	Students	388	85	227	76
PPE 17.5.1	Residents	3,315	742	1,924	649
	Students	579	113	353	113
	Housing Units Required / % of Available Stock				
Table 2.5-4	Units	575	148	314	113
	% 2006 stock	0.22%	1.9%	12.7%	0.05%
PPE 17.5.1	Units	831	186	482	163
	% 2006 stock	0.32%	2.4%	19.5%	0.07%
	Relocated Workers				
Table 2.5-4	Workers	878	272	575	103
PPE 17.5.1	Workers	1201	196	371	65
	Percent Increase				
Table 2.5-4	% over pred. 2015 pop.		1.7%	11.7%	0.04%
	% over 2006 students		1.3%	13.6%	0.06%
PPE 17.5.1	% over pred. 2015 pop.		2.2%	17.9%	0.06%
	% over 2006 students		1.7%	21.2%	0.08%
	Total Population with New Residents				
Table 2.5-4	Total Pop.	1,209,641	34,609	11,997	1,163,035
PPE 17.5.1	Total Pop.	1,210,663	34,762	12,667	1,163,234

Figure 5.8-1, Income Distributions



REFERENCES:

[5.8-1] RoA Ministry of Health Order № 138, 6 March 2002, *Sanitary Standards N 2 III-11.3 for Noise at Work Place, in Residential and Public Buildings and Residential Construction Sites*.

[5.8-2] U.S. Nuclear Regulatory Commission, 1996, *Generic Environmental Impact for License Renewal of Nuclear Plants,* NUREG-1437, Vol. 1 and Vol. 2.

[5.8-3] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007; Section 4.3.5.

[5.8-4] RoA Ministry of Health Order № 138, 6 March 2002, *Sanitary Standards N 2 III-11.3 for Noise at Work Place, in Residential and Public Buildings and Residential Construction Sites*, Table 3.

[5.8-5] U.S. Department of Energy, 2005, DOE NP2010, *Nuclear Power Plant Construction Infrastructure Assessment*, MPR-2776, Rev. 0, dated October 21, 2005, prepared for Department of Energy, Washington D.C., under Order No. DE-AT01-020NE23476.

[5.8-6] AtomStroyExport letter No. 7700/01-347 dated 05.06.2008 to the Head of Atomic Energy Department, Ministry of Energy of Republic of Armenia.

[5.8-7] Metsamor Town, 2007, *Master Plan …*, Section 5.2.1.

[5.8-8] PA Consulting, 2008, *Initial Planning Studies (IPS) for New Nuclear Generation in Armenia*, Section 3.1.

[5.8-9] PA Consulting, 2008, *IPS*, Section 3.2.

[5.8-10] http://www.armstat.am/Arm/StatData/Taregirq_07/TAREGIRQ_07_12.pdf, accessed 8 April 2008.

[5.8-11] Metsamor Town, 2007, *Master Plan of Metsamor Urban Community, Armavir Marz of the Republic of Armenia*, Approved by GoA Resolution № 1592, dated 27 December 2007.

[5.8-12] CJSC “Armenian Nuclear Power Plant”, 2007, *Safety Analysis Report on Power Unit № 2 at the ANPP*, Section 1.4.10.

[5.8-13] Metsamor Town, 2007, *Master Plan …*, Section 3.2.14.1.

[5.8-14] Letter dated August 12, 2008, CJSC “ANPP” to Head of Atomic Energy Department of the Ministry of Energy and Natural Resources.

[5.8-15] Metsamor Town, 2007, *Master Plan …*, Sections 5.2.8.1 through 5.2.8.3.

5.9 DECOMMISSIONING IMPACTS

Studies of social and environmental effects of decommissioning large commercial power generating units in the US have not identified any significant impacts beyond those considered in the Final Generic Environmental Impact Statement (GEIS) on decommissioning (Ref [5.9-1]). The GEIS evaluates the environmental impact of the following three decommissioning methods:

- DECON – The equipment, structures, and portions of the facility and site that contain radioactive contaminants are removed or decontaminated to a level that permits termination of the license shortly after cessation of operations.
- SAFSTOR – The facility is placed in a safe stable condition and maintained in that state until it is subsequently decontaminated and dismantled to levels that permit license termination. During SAFSTOR, a facility is left intact, but the fuel has been removed from the reactor vessel and radioactive liquids have been drained from systems and components and then processed. Radioactive decay occurs during the SAFSTOR period, thus reducing the quantity of contaminated and radioactive material that must be disposed of during the decontamination and dismantlement.
- ENTOMB – This alternative involves encasing radioactive structures, systems, and components in a structurally long-lived substance, such as concrete. The entombed structure is appropriately maintained, and continued surveillance is carried out until the radioactivity decays to a level that permits termination of the license.

The GEIS concludes that decommissioning of a nuclear facility that has reached the end of its useful life has a positive environmental impact (Ref [5.9-1]). The major impact, regardless of the specific decommissioning option selected, is the commitment of small amounts of land for waste burial in exchange for the potential re-use of the land where the facility is located. Experience with decommissioned power plants has shown that the occupational exposures during the decommissioning period are comparable to those associated with refueling and plant maintenance when it is operational.

Each potential decommissioning alternative would have radiological impacts from the transport of materials to their disposal sites. The expected impact from this transportation activity would not be significantly different from normal operations.

For the new ANPP unit, decommissioning would begin when the unit is shutdown after 60 years of operation. Decommissioning activities may take up to 65 years, depending on the decommissioning method selected.

The total costs of decommissioning a NPP have been estimated by NPP designers to be between $400 and $500 million. To fund the decommissioning activities of an NPP, money should be collected each year and accumulated in a separate account. In general, these funds are created from revenues of the NPP operation. The size of the necessary decommissioning fund is reviewed on a regular basis, generally between 1 and 5 years. The calculated sum is accumulated year by year over the planned lifetime of the facility.

The RoA Government Decree № 1637 on *Opening a Special Account for Financial Resources for the ANPP Decommissioning* (Ref [5.9-2]) defines a process for collection and management of decommissioning funds for the existing ANPP. The decommissioning funds for new unit will be collected and managed in a similar manner to that defined in RoA Government Decree № 1637.

REFERENCES:

[5.9-1] U.S. Nuclear Regulatory Commission, 2001, *Final Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities*, NUREG-0586.

[5.9-2] RoA Government Decree N 1637, October 12, 2006, *on Opening a Special Account for Financial Resources for the ANPP Decommissioning.*

5.10 MEASURES AND CONTRLS TO LIMIT ADVERSE IMPACTS DURING OPERATION

This section summarizes the potential adverse environmental impacts of station operation and describes the measures and controls to limit those adverse impacts. The potential impacts and measures and controls to limit those impacts are summarized in Tables 5.10-1 through 5.10-9.

The tables list the potential impacts associated with operation of the facility as described in Sections 5.1 through 5.9. The tables identify, from the categories listed below, which adverse impact(s) may occur as a result of facility operation:

- Erosion and Sedimentation (ES)
- Air Quality (dust, air pollutants) (AQ)
- Wastes (effluents, spills, material handling) (WS)
- Surface Water (SW)
- Groundwater (GW)
- Land Use (L)
- Water Use and Quality (W)
- Terrestrial Ecosystems (TE)
- Aquatic Ecosystems (AE)
- Socioeconomic (S)
- Aesthetics (A)
- Noise (N)
- Traffic (T)
- Radiation Exposure (R).

The tables identify a relative significance rating (i.e., [S]mall, [M]oderate, or [L]arge) following implementation of associated measures and controls. These relative significance ratings are defined in the introduction to Chapter 4. Tables 5.10-1 through 5.10-9 also include a brief description, by EBID Section, of each potential impact and the measures and controls, if needed, to minimize the impact.

5.10.1 Land-Use Impacts

Land-use impacts and control measures are summarized in Table 5.10-1. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the operation of ANPP Unit 3 are anticipated to be SMALL for all categories.

5.10.2 Water-Related Impacts

Water-related impacts and control measures are summarized in Table 5.10-2. Based on existing site conditions, as well as the measures and controls proposed, the potential

adverse impacts identified from the operation of ANPP Unit 3 are anticipated to be MODERATE for the categories of Water Use and Quality and Aquatic Ecosystems. If the project proceeds with an evaporative cooling water system, during low flow periods it may be necessary for agricultural water users to curtail their use.

Aquatic ecosystems may be impacted because an adequate environmental flow can not be maintained. Failing to provide an adequate environmental flow will cause a MODERATE impact.

5.10.3 Cooling System Impacts

Cooling system impacts and control measures are summarized in Table 5.10-3. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the operation of ANPP Unit 3 are anticipated to be SMALL.

Potential losses due to entrainment and impingement of fish eggs, larvae, and juveniles will be avoided by the design of the cooling water intake to include screens and filters and to ensure a low approach velocity to the screens. These mitigative actions are necessary to ensure that the intake losses will be SMALL.

5.10.4 Radiological Impacts of Normal Operation

Radiological impacts of normal operation of ANPP Unit 3 are summarized in Table 5.10-4. Based on existing site conditions, the estimated radiological impacts of normal operation are anticipated to be SMALL.

5.10.5 Environmental Impacts of Waste

The environmental impacts of waste due to operation of ANPP Unit 3 are summarized in Table 5.10-5. Based on existing site conditions and expected wastes from candidate reactors, the impacts are anticipated to be SMALL for all categories, except for water quality, which may have a moderate impact due to release of chemicals to the Sevjur River in excess of current RoA water quality standards. Cooling system makeup water from the Sevjur River currently exceeds water quality standards for sulfates and after concentration in cooling towers/ponds, will be discharged in concentrations also exceeding these standards. At low river flow conditions, plant discharges could result in concentrations of other substances in the Sevjur River downstream of the plant discharge that exceed water quality standards; these substances include copper, oil and grease, and ammonia nitrogen.

5.10.6 Transmission System Impacts

The impacts of transmission system operation associated with ANPP Unit 3 are summarized in Table 5.10-6. Based on existing conditions and assumed routing of the new 400 kV transmission line from ANPP to Hrazdan, the potential adverse impacts are anticipated to be SMALL, if any.

5.10.7 Uranium Fuel Cycle Impacts

The impacts of the Uranium fuel cycle associated with ANPP Unit 3 are summarized in Table 5.10-7. Based on existing fuel cycle technologies, the impacts are anticipated to be

within the bounds of the fuel cycle impacts determined to be acceptable by the US Nuclear Regulatory Commission. Impacts within those bounds can be considered to be SMALL

5.10.8 Socioeconomic Impacts of Station Operation

Socio-economic impacts and control measures are summarized in Table 5.10-8. Based on existing site conditions, as well as the measures and controls proposed, the potential adverse impacts identified from the operation of ANPP Unit 3 are anticipated to be SMALL, if any, for all categories evaluated except:

- Population increases in Metsamor Town due to new operating staff for Unit 3.
- Increases in costs of housing in Metsamor Town due to new residents (impacts may have already occurred due to pressures during the construction phase).
- Potential environmental justice impacts on any of the low income population dependent on use of Sevjur River water for irrigation.

5.10.9 Decommissioning

The impacts of decommissioning ANPP Unit 3 are summarized in Table 5.10-7. The environmental impacts of decommissioning of ANPP Unit 3 should be evaluated again when the plan for decommissioning is available. The USNRC has evaluated alternatives for decommissioning and has found that decommissioning can be accomplished with impacts at acceptable levels. Based on potential decommissioning technologies, the adverse impacts of decommissioning of Unit 3 are expected to be SMALL.

Table 5.10-1, Measures and Controls to Limit Land Use Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
5.1 Land Use Impacts	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
		S				S		S				S	S		
5.1.1 Land Use	Land use impacts at Unit 3 will be comparable to impacts from the existing operating unit. Traffic will be comparable to Unit 2 traffic. (L),(TE)														No mitigation necessary.
5.1.2 Noise impacts to members of public	Noise will be within standards to avoid interference with normal activities beyond 300 m of the noise sources. (L),(TE)														No mitigation necessary.
5.1.2 Noise impact on wildlife	Noise level will be lower than limit that would affect wildlife beyond the site boundary. (TE)														No mitigation necessary.
5.1.3 Air Quality	The quantity of fossil fuels to be burned on site is small. Air quality at the site is not limited by combustion products. (AQ)														No mitigation necessary.
5.1.3 Air Quality - Greenhouse Gases	The quantity of greenhouse gases emitted from auxiliary equipment is small. (AQ)														No mitigation necessary.
5.1.4 Terrestrial Ecology	Bird impaction at the cooling tower will be small. (TE)														No mitigation necessary.
5.1.5 Historic Properties and Cultural Resources	There are no properties of concern on or adjacent to the site. (L)														No mitigation necessary.

Table 5.10-2, Measures and Controls to Limit Water-Related Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
5.2 Water-Related Impacts							S		S						
5.2.2 Impact on the Water Budget of Armenia	The consumptive use of water at Unit 3 will be less than 1% of the water consumed nationwide in 2006. (W)														No mitigation necessary.
5.2.3 Impact on Other Water Users due to reduction in flow	Under low river flow conditions it will be necessary for agricultural users to reduce usage. (S)														A rigorous allocation of water will be necessary. Dry cooling towers would eliminate the impact of the new unit.
5.2.4 Impact to the Aquatic Ecosystem due to failure to provide adequate environmental flow	The RoA will determine the environmental flow that must be maintained. They will re-examine water allocation in conjunction with issuance of a water use permit. This impact will be small. (W)(AE)														A study should be performed to determine the environmental flow that should be maintained in the river. The RoA must determine how water will be allocated from the Sevjur River. Dry cooling towers would eliminate the impact of the new unit.

Table 5.10-3, Measures and Controls to Limit Cooling System Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
5.3 Cooling System Impacts		S				S		S	S	S					
5.3.1 Impacts due to Entrainment and Impingement	Because Unit 3 will withdraw more than 18% of the flow, losses of fish eggs, larvae, and juveniles by impingement and entrainment will be controlled with the use of the mitigating features. (AE)														The velocity in the intake canal will be controlled by design to be low enough to allow larger fish to escape. Impingement of smaller fish will be further reduced by use of intake screens. The design of the screens will include a method for returning impinged fish to the river. Fine mesh screens will filter fish eggs and larvae if studies show them to be necessary.
5.3.2 Impacts due to scouring of the river bed at the discharge.	This impact is controlled by design of the discharge and will be small. (ES)(AE)														No mitigation necessary.
5.3.2 Impacts due to discharge of heated water.	The discharge temperature will not be greatly different from the river water temperature. The discharge location is in the free flowing section of the Sevjur where mixing will occur rapidly,														No mitigation necessary.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
	minimizing the size of the area of temperature difference. (W) (AE)	
5.3.3 Impacts due to cooling tower operation.		
5.3.3.1 Impacts due to fogging.	Because of the height of the cooling tower and the height to which the plume will rise above the tower, little if any ground level fogging is expected. (S)(TE)	No mitigation necessary.
	The potential to impact agricultural crops is small. (TE)	
5.3.3.2 Impacts due to icing	A study of 40 cooling towers in the US found the potential for ice formation to be small. (S)	No mitigation necessary.
5.3.3.3 Impact due to induced cloud formation	At one US plant, computer modeling showed the length of the plume exiting the tower could be as long as 5 km under certain conditions. A study of 40 cooling towers found that increased cloud cover has little potential to impact crops. (TE)	No mitigation necessary.
5.3.3.4 Impact due to drift deposition	Deposition will be less than values shown to have potential to impact vegetation. (TE)	No mitigation necessary.
	A small increase in soil salinity may occur close to the plant. (TE)	No mitigation necessary.
	Impact to switchyard equipment will be small.	Rinsing of switchyard equipment may be necessary.

Table 5.10-4, Measures and Controls to Limit Radiological Impacts of Normal Operation

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
5.4 Radiological Impacts of Normal Operation						S	S	S	S					S[16]	
5.4.4 Radiation Doses to Members of the Public															
5.4.4.1 External Dose	External doses to members of the public in excess of regulatory limits. (R)														No mitigation necessary.
5.4.4.2 Inhalation Dose	Inhalation doses to members of the public in excess of regulatory limits. (R)														No mitigation necessary.
5.4.4.3 Ingestion Dose	Ingestion doses to members of the public in excess of regulatory limits. (R)														A census of subsistence farming, fishing and hunting is necessary to determine if any members of the public will receive limiting doses due to ingestion of radionuclides from ANPP Unit 3.

[16] Pending evaluation of critical receptors (any subsistence farmers, fishers, or hunters) and radioactive material dispersion analyses.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.4.6 Impacts to Members of the Public	Exposures of members of the public to radiation doses in excess of regulatory requirements. (R)	A more accurate estimate of limiting individual and collective doses must be done when all relevant parameters, data, and calculational resources are available to predict doses for each compass sector and distance segment.
5.4.7 Impacts to Biota other than Members of the Public	Exposure of biota to levels of contamination or radioactive dose at sufficient levels to endanger biota. (R)	No mitigation necessary.

Table 5.10-5, Measures and Controls to Limit Environmental Impacts of Waste

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
5.5 Environmental Impacts of Waste	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
			S	S	S		S	S	S						
5.5.1.1 Impacts of Discharges to Water															
5.5.1.1.1 Industrial Wastewater and Rainwater Discharges	Discharge of chemicals in excess of RoA limits. (WS)(SW)(W)														Evaluate system chemical additions against water quality standards after system design is complete. If concentrations exceed discharge limits, flow will be directed to the blowdown pond.
5.5.1.1.1, continued	Discharge of chemicals in excess of RoA limits. (WS)(SW)(W)														If water in the blowdown pond exceeds discharge limits, it will be directed to the neutralizer pool and evaporator pool for treatment.
5.5.1.1.2 Contaminated Wastewater Network	Discharge of oil and grease to water bodies. (WS)(GW)(SW)(W)														Collect drains in sumps that can be sampled before pumping to contaminated wastewater network. Treat wastewater with mechanical filters, and expanded perlite.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.5.1.1.3 Sanitary System Effluents	Discharge of sanitary wastes with water quality exceeding RoA limits. (WS)(GW)(SW)(W)	Install new sanitary waste treatment system prior to plant operation.
5.5.1.2 Impacts Of Discharges To Land		
5.5.1.2.1 Non-radioactive Solid Waste	Impacts on site terrestrial ecology and soils. (TE)	No mitigation necessary
	Impacts on ground water. (GW)	No mitigation necessary
5.5.1.2.2 Hazardous Wastes	Release of hazardous substances to the environment. (WS)(GW)(SW)(TE)(AE)	Design systems to minimize production of hazardous wastes.
		Collect wastes and dispose off site using licensed contractor.
5.5.1.2.3 Petroleum Waste	Release of petroleum products to the environment. (WS)(GW)(SW)(TE)(AE)	Implement recycling program for petroleum wastes.
5.5.2 Solid Radiological Waste System Impacts		
5.5.2.1 Low Level Radioactive Wastes	Contamination of the environment by release of radioactive wastes. (TE)(AE)(R)	Implement international waste management principles in a national waste management program.
5.5.2.2 Intermediate Level Wastes		
5.5.2.3 Mixed Wastes	Contamination of the environment by release of mixed radioactive and hazardous wastes. (WS)(TE)(AE)(R)	Design systems to minimized generation of mixed wastes.
		Collect and package mixed waste for disposal in accordance with national waste management program.
	Create hazardous conditions by storage of mixed waste. (WS)(R)	Design systems to minimized generation of mixed wastes.
		Collect and package mixed waste for disposal in accordance with national waste management program.

Table 5.10-6, Measures and Controls to Limit Transmission System Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
5.6 Transmission System Impacts	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
	S							S	S			S			
5.6.1 Terrestrial Ecosystems															
5.6.1.1 Transmission system maintenance practices	Loss of habitat due to vegetation clearance. (TE)														Mitigation not required.
	Damage to agricultural crops and gardens. (TE)														Mitigation not required.
5.6.1.2 Special Practices in Important Habitats	Damage to important habitats. (TE)														No important habitats involved. Mitigation not required.
5.6.1.3 Wildlife Management in Transmission Corridors	Damage to wildlife in transmission corridors. (TE)														Armenia has no wildlife management program.
5.6.1.4 Impacts on Important Terrestrial Species	High voltage transmission impacts caused by electromagnetic fields, corona, and ozone formation. (TE)														Voltages not high enough to cause concern. Mitigation not required.
	Impacts on wildlife habitats and flyways. (TE)														Mitigation not required.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.6.2 Aquatic Ecosystems	Impacts on aquatic ecosystems or important species. (AE)	Mitigation not required.
5.6.3 Impacts to Members of the Public		
5.6.3.1 Shock hazards	Direct contact with conductors	Design standards limit the potential for these impacts. Mitigation not required.
	Contact with capacitively charged bodies	
	Contact with magnetically linked metallic structures	
5.6.3.2 Chronic effects of electromagnetic fields	Biological and physical impacts of chronic exposure to electromagnetic fields.	No consistent evidence of dramatic acute effects of exposure. No mitigation required.

Table 5.10-7, Measures and Controls to Limit Uranium Fuel Cycle Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
5.7 Uranium Fuel Cycle Impacts	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
		S	S	S		S	S							S	
	Uranium Mining and Milling (AQ), (WS),(SW),(L),(R),(W)														No mitigation necessary
	Production of Uranium (AQ), (WS),(SW),(L),(R),(W)														No mitigation necessary
	Transportation of Radioactive Materials (AQ), (WS),(SW),(L),(R),(W)														No mitigation necessary
	Management of Low and High Level Radioactive Wastes (AQ), (WS),(SW),(L),(R),(W)														No mitigation necessary

Table 5.10-8, Measures and Controls to Limit Socioeconomic Impacts

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
5.8 Socioeconomic Impacts of Operation		S				S	S			M-L	S	S	S		
5.8.1 Physical Impacts of Station Operation															
5.8.1.1 Workers and the Local Public	Exposure to heat, noise, work at heights, exposure to radiation and contamination, etc. (S)														Provide training to site workers. Provide personal protective equipment. Provide emergency first-aid care on site. Conduct periodic health screening and physical exams. Comply with RoA regulations and site permit conditions.
5.8.1.2 Buildings	Physical impacts due to vibration, noise, and radiation. (S)														No mitigation needed – buildings are designed to withstand impacts.
5.8.1.3 Roads	Noise and traffic impacts due transportation of staff and supplies. (S)														No mitigation necessary.
5.8.1.4 Aesthetics	Visual impact of cooling tower and tower plume. (A)														Change in cooling system technology in the event of opposition.
5.8.1.5 Noise	Noise of operating machinery, cooling towers, etc. (S)														No mitigation necessary.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.8.1.6 Air Quality	Emissions from diesel generators, auxiliary boiler, and radioactive ventilation releases. (AQ)	No mitigation necessary, assuming emissions meet permitted limits.

EBID Reference Section	Potential Impact Category and Description	Proposed Measures and Controls or Mitigating Circumstances
5.8.2 Social and Economic Impacts		
5.8.2.1 Demographic Impacts	Increased pressure on housing and services of resident population. (S)	Use of dormitory or hostel for housing of temporary workers.
		No mitigation necessary for Armavir or Yerevan.
		Increased investment in services of Metsamor Town using tax revenues.
5.8.2.2 Economic Impacts	Increased employment. (S)	Institute training and recruitment programs to increase availability of skilled workers.
	Increased taxes. (S)	Use tax revenues to support improvement of social services, potable water supply, and sewage treatment plant.
	Increased housing costs. (S)	Provide hostel or dormitory housing for temporary workers
		Provide subsidized housing for unit staff.
5.8.2.3 Impacts on Social Services and Governance	Increased demands on police and traffic control. (S)(T)	Mitigation not necessary
	Potable Water, Fire Water, and Sewage Treatment. (S)	Use increased tax revenues to implement improvements in systems for Metsamor Town.
	Hospitals and medical services. (S)	No mitigation necessary.
	Local governance. (S)	Develop a system of revenue sharing to support improvements in Armavir and other nearby communities.
5.8.3 Environmental Justice Impacts		
5.8.3.1 Low Income Population	Disproportionate Impacts due to noise and water availability on nearby agricultural lands. (S)	Conduct census of agricultural land users to determine degree of impact; implement remunerations if necessary..
5.8.3.2 Minority Populations	Disproportionate impacts on minorities. (S)	No mitigation necessary.

Table 5.10-9, Measures and Controls to Limit Impacts of Decommissioning

EBID Reference Section	Potential Impact Category and Description														Proposed Measures and Controls or Mitigating Circumstances
5.9 Decommissioning	Erosion/Sediments (ES)	Air Quality (AQ)	Wastes (WS)	Surface Water (SW)	Ground Water (GW)	Land Use (L)	Water Use & Quality (W)	Terrestrial Ecosystems (TE)	Aquatic Ecosystems (AE)	Socioeconomics (S)	Aesthetics (A)	Noise (N)	Traffic (T)	Radiation Exposure (R)	
		S					S	S	S	S		S	S	S	
	Onsite Decommissioning Activities and Transport of Wastes (N), (T),(R)														No mitigation necessary
	Socioeconomic Impacts. (S)														No Mitigation Necessary
	Impacts to Air and Water Quality and to Ecology (AQ)(W)(TE)(AE)														No Mitigation Necessary

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6. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

Reviews in the other Sections of the EBID identify needs for additional environmental data and for monitoring programs to be used by the design engineers early in the design stage of the new unit.

After the design is complete, monitoring will be necessary to ensure that environmental impacts are, in fact, within and remain within the range of acceptable values. Monitoring results may identify the need for corrective actions to be taken to limit impacts. Some of the monitoring programs included in this section may be done only once. Other monitoring programs may be continued for the operating life of Unit 3.

These monitoring programs will be established by the plant construction and operating organizations to evaluate potential impacts to the environment that may result from plant construction and operation. Monitoring programs must meet requirements of national regulations as well as international guidelines and good practices.

Some additional studies may be necessary to provide a more complete baseline to allow impacts to be assessed after construction begins and again after the new unit is placed in operation. Pre-operational monitoring may continue during construction if necessary.

Monitoring of construction activities will be necessary to ensure that impacts of construction are kept small. After construction is complete and Unit 3 is placed into service, operational monitoring will become more focused on potential impacts that will be mitigated by actions taken in response to the data.

This EBID was prepared using information available in the records of various RoA organizations. Information was also obtained from numerous reports prepared by contractors, usually in assistance to the RoA agencies. The ANPP provided valuable information from records related to the existing plant. Some of the information needed for the planning of the existing plant could not be made available. Other information was found in published technical journals. Because of time constraints, no field studies were done to support the preparation of this EBID. There are instances where specific information was not available to complete the review. Measurements and monitoring to solely to resolve open environmental assessment items are summarized in Chapter 10 and are not included here.

The measurements and monitoring discussed in this Section have been identified in the other chapters of this EBID. Environmental monitoring may also be required by law or resolution of the RoA. Section 1.3 identifies laws and resolutions of the RoA and standards and guides developed by international organizations that were used as source documents in the preparation of this EBID. A preliminary assessment of documents specifically applicable to monitoring are reflected under the EIA Section 6 heading of Table 1.3A-1, “Matrix of EBID Sections vs. Source Document Requirements/Guidance.” Significant guidance applicable to meteorological and radiological monitoring is available. Guidance applicable to ecological monitoring is limited. The applicable laws, resolutions and standards should be consulted when planning monitoring programs.

6.1 MEASUREMENTS AND MONITORING TO SUPPORT ENGINEERING

The design of plant systems and components that potentially impact the environment should be based on site specific measurements and monitoring. This is true, for example, for cooling water intake and discharge structures. Environmental data needed during the design phase is discussed in this Section.

The laws applicable to obtaining water use permits require site specific data. That data will useful in engineering of new intake and discharge structures for the new unit, if required. The segment of the river where the intake is located is a pool backed up by the Zeiva irrigation diversion dam. The discharge is on a free-flowing stretch of the river. It is likely that the aquatic communities at these two locations are significantly different. Published information on aquatic species in the river does not indicate where samples were collected. A study of the fish species in the pool above the Zeiva diversion dam should be performed to determine whether Unit 3 intake flow velocity should be limited and whether screens and fine mesh nets are necessary to minimize impacts to fisheries. (See 5.3.1)

Topographic studies will needed for developing the initial plan for site grading. The plan for additional grading of the site should give attention to the potential impact of storm water drainage from and across the construction site should be evaluated. (See 4.2.1, 4.6.2)

A survey of traffic on Highway M-5 is needed to obtain information about potentially hazardous cargoes shipped past the ANPP site. (See 8.6) This information will be used to determine whether additional protection systems are needed at the plant.

6.2 PRECONSTRUCTION MONITORING

Monitoring prior to the start of construction activities provides a baseline for assessing and mitigating construction impacts if and when they occur.

6.2.1 Impacts to the Human Environment

Some additional monitoring is needed to limit impacts to the human environment. Monitoring of traffic on roads in the vicinity of the plant should be conducted in order to prepare for the influx of construction traffic. (See 4.4.1.3, 4.4.1.5.1). A traffic flow study and measurement of resulting noise levels should be performed to allow quantification of the impacts and to support decision making regarding mitigation measures for increased traffic in the area during construction. (See 4.4.1.3, 4.4.1.5.1)

Surveys of ambient noise levels and census of noise receptors should be conducted to support the analysis of noise impacts of construction. (See 4.4.1.5) The Constructor should survey noise levels from construction equipment to be used at the site (including simultaneous operation of multiple pieces of equipment), compare with the levels in EBID Table 4.4-1, and prepare mitigation plans where noise levels could exceed the guidelines of MoH Order 138. (See 4.4.1.5). A survey and assessment of noise abatement features of the local terrain should be completed to determine if additional measures, such as earthen berms, should be employed near the construction site. (See 4.4.1.5).

6.2.2 Radiological Monitoring

The ANPP has an on-site monitoring program. This generally provides a baseline for planning to minimize exposure of construction workers to radiation. The monitoring program should be reviewed and revised as necessary to ensure that it is consistent with IAEA and other international Safety Standards.

A detailed radiation survey of the construction zones and construction support area shown on EBID Figure 2.1-4 (or as determined by initial site arrangement studies) should be conducted (including along the fences surrounding the buildings near item 78 in that figure) to confirm that the predicted doses in EBID 4.5 are bounding. (See 4.5.2)

Prior to any construction activities on the plant discharge pipe or the project to extend the discharge pipe to the Sevjur River, surveys of dose rates and contamination by radioisotopes of concern will be conducted. Especially, contamination will be measured in the Kosh-Ujan storm water drainage canal downstream of the current plant discharge point. (See 4.5.5, 4.6.5)

6.3 CONSTRUCTION IMPACTS MONITORING

Construction of the new unit will be a massive effort spanning more than 5 years. In spite of the lengthy construction period, many activities will be of short duration. It is not practical to look for construction impacts and then take steps to limit the impacts in a timely manner. Instead, for each construction activity, practices that potentially impact the environment should be avoided. During construction planning, construction practices that are known to have minimal environmental impacts should be identified and used where practicable. Collectively, this set of practices are often called Best Management Practices because the impacts of construction are controlled by proper management of the project rather than by the provision of mitigation features. (See 4.6, 4.2.3, 4.3.1, 4.3.2, 4.3.4, 4.6.2, 4.6.3). The practices identified in Chapter 4 are summarized in the text and tables of EBID 4.6.

The use of Best Management Practices should be a requirement of the construction contract and the bidders should participate in the development of the set of practices to be implemented. Construction practices that should be adopted to minimize impacts are discussed in Chapter 4 sections.

Environmental monitoring of construction activities during construction should ensure that the best practices are used.

There are some potential impacts of construction for which monitoring will be necessary.

6.3.1 Impacts to the Human Environment

Monitoring of noise levels will be necessary to ensure that guidelines and regulations are met. Noise levels should be monitored for both stationary and mobile equipment. Monitor noise from stationary equipment for compliance with MoH limits. (See 4.4.1.5, 4.6.4)

6.3.2 Radiological Monitoring

Some Unit 3 construction activities will take place in parts of the site where radiation levels may be elevated because of Unit 2 operation or other facilities on the site. Monitoring will be required to protect construction workers in those areas.

A dosimetry program must be in effect in areas of potentially high exposure during construction (See 4.5.2, 4.5.5)

Most Unit 3 construction activities will be outside of the Unit 1 and 2 protected area fence. The ANPP will establish a continuous monitoring program to measure exposures at the Unit 1 and 2 protected area fence and at nearest points of approach to the sources of radioactivity listed in Subsection 4.5.2, and at selected locations throughout the construction and construction support building areas. (See 4.5.5, 4.6.5)

6.4 PRE-OPERATIONAL MONITORING

Monitoring will be required in several disciplines to establish a better baseline for evaluating environmental impacts due to Unit 3 operation.

6.4.1 Meteorological Monitoring

The equipment for determining wind-speed and direction at the on-site meteorological station is old and functioning erratically. Data at the nearby Hydromet meteorological stations do not record data at the intervals required for the dose assessment computer models. The airborne dose analyses in EBID Chapter 7 were done using data from the Zvartnots airport. This data is not fully compatible with airborne dose models and Zvartnots is distant from the site. New meteorological monitoring equipment should be installed at the site. Data should be collected and logged digitally to meet the specifications of an approved computer dispersion model. This is necessary to perform accurate dose analyses.

Software for determining atmospheric dispersion factors require a minimum of two continuous years of reliable data. Monitoring should begin as soon as possible after the project is approved and funding is secured.

6.4.2 Ecological Monitoring

Data collected to support the engineering design and data collected to support permit applications will supplement existing data and will provide a pre-operational baseline for ecological systems.

6.4.3 Radiological Monitoring

The existing Unit 2 radiological monitoring program (Ref. [6-1]) collects a substantial amount of data for the site, the “observation zone” (within 10 km), and monitoring wells that should provide an adequate pre-operational baseline. Parameters monitored in the monitoring program are summarized in Table 6-1. The Unit 2 program should be reviewed and revised as necessary to ensure that it is consistent with IAEA and other international Safety Standards.

6.4.4 Water Quality Monitoring including Thermal and Chemical

The available pre-operational data for the quality of water in the Sevjur River is that collected by the RoA Environmental Impact Monitoring Center (EIMC). They collect samples manually and measure a large number of parameters. (See 2.3.6). The frequency of sample collection is irregular. They are providing data that need not be duplicated by the Unit 3 staff. However, the data would be more valuable if samples were collected monthly at regular intervals.

Water quality data for the Unit 2 intake and discharge flow streams at three month intervals were provided by the ANPP staff. Water temperature data should be collected and logged at least daily to be useful in detecting extreme values.

6.5 OPERATIONAL MONITORING

Following startup of Unit 3, some initial monitoring may be necessary to document that impacts are acceptable and within limits. Monitoring of waste streams is important to document what is being discharged and to help understand any ecological impacts that are later detected.

6.5.1 Meteorological Monitoring

The meteorological monitoring program established prior to construction should continue for the operating life of Unit 3.

6.5.2 Ecological Monitoring

Ecological monitoring programs will be identified by the RoA and should be done in conjunction with review of applications for required permits.

Monitoring of the performance of the intake screens should be performed early in the life of Unit 3 to verify that losses of fish eggs, larvae and juveniles at the intake are within an acceptable range. After a reasonable study period, monitoring need only ensure that the intake screens and nets are operating a designed.

6.5.3 Radiological Monitoring

An operational radiological monitoring program will be implemented when Unit 3 starts up. The program will be consistent with IAEA guidance. Revisions to the Unit 2 radiological monitoring will be necessary to encompass new areas around Unit 3.

All discharge flow paths will be monitored for radiation with online monitors. Streams containing levels of concern can be diverted for treatment if necessary. The steam generator blowdown will be monitored for radiation (see 3.5.1.1.5). The service water system water quality (see 3.4.2, 3.6.1.3) and the blowdown pond water quality (see 3.6.1.3) will also be monitored before discharge.

6.5.4 Water Quality Monitoring Including Thermal and Chemical

Water quality in the discharge is controlled by initial design along with management practices and should remain within permit limits. Weekly or monthly testing of the water quality of the discharges should be adopted as a standard practice to document the

discharges in case there are changes in the ecosystem of the Sevjur River. If there is particular concern about the quantity of toxic materials discharged or about the concentration of toxics in the discharge streams, samples should be collected and analyzed more frequently. This might apply, for example, to toxic metals and to biocides. It would be preferable to design Unit 3 to avoid such discharges.

The water quality monitoring program implemented by the RoA Environmental Impact Monitoring Center (EIMC) should be continued during the operation of ANPP Unit 3.

Several internal waste streams will be monitored for radionuclides and for oil and grease. Unit 3 will have the potential for oil to contaminate drains from the turbine building, diesel generator buildings, auxiliary boiler, and transformers and oil circuit breakers. Drains that could have oil contamination will be routed to the Phase 1 contaminated treatment system for cleaning with expanded perlite. (See 3.6.1.2.1).

Table 6-1, Parameters Monitored by the ANPP Radiological Monitoring Program (Ref. [6-1])

Parameter	Type of Measurement	Frequency
Airborne activity	Gross β activity, Bq/l	Monthly
	Cs-137 activity, Bq/l	Quarterly
	Sr-90 activity, Bq/l	Quarterly
Atmospheric precipitates (fallout)	Gross β activity, Bq/km^2-mo	Every 14 days
	Cs-137 activity, Bq/km^2-mo	Every 14 days
	Sr-90 activity, Bq/km^2-mo	Quarterly
Liquid activities in sanitary and industrial sewage	Gross β activity, Bq/l	Weekly
	Cs-137 activity, Bq/l	Monthly
	Sr-90 activity, Bq/l	Monthly
Dose rate	Total gamma, μSv/h	Every 14 days
Soil activity	Gross β activity, Bq/kg	Semi-annual
	Cs-137 activity, Bq/kg	Semi-annual
	Sr-90 activity, Bq/kg	Semi-annual
Activity in Vegetation	Gross β activity, Bq/kg	Semi-annual
	Cs-137 activity, Bq/kg	Semi-annual
	Sr-90 activity, Bq/kg	Semi-annual
Activity of water in lakes and reservoirs	Gross β activity, Bq/l	Semi-annual
	Cs-137 activity, Bq/l	Semi-annual
	Sr-90 activity, Bq/l	Semi-annual
Activity in deep monitoring wells	Gross β activity, Bq/l	Semi-annual
Activity in bottom sediments and algae	Gross β activity, Bq/kg	Semi-annual
	Cs-137 activity, Bq/kg	Semi-annual
	Sr-90 activity, Bq/kg	Semi-annual
Activity in discharged water	Gross β activity, Bq/l	Monthly
	Cs-137 activity, Bq/l	Semi-annual
Dose rate in observation holes around Unit 1 and 2 Main Building and special equipment building	Gamma exposure rate, μR/h	Every 14 days
Dose rates in pedestrian areas and highways	Gamma exposure rate, μSv/h and μR/h	Monthly
Dose rate from Low Level waste storage	Gamma exposure rate, μSv/h and μR/h	Monthly
Radionuclide concentration in observation wells around Low Level waste storage	Cs-137 activity, Bq/l	Quarterly
	Co-60 activity, Bq/l	Quarterly
	Mn-54 activity, Bq/l	Quarterly
Activity in edible produce	Gross β activity, Bq/kg	Annual
	Cs-137 activity, Bq/kg	Annual
	Sr-90 activity, Bq/kg	Annual

REFERENCES

[6-1] CJSC “ANPP”, 2004, *Procedure for Radiological Monitoring of ANPP*, УЭ.ЭТД.05.ОРБ–001, Table 16.

Environmental Background Information Document

Chapter 7: Impacts of Postulated Accidents Involving Radioactive Materials

October 2008

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7. IMPACTS OF POSTULATED ACCIDENTS INVOLVING RADIOACTIVE MATERIALS

This chapter assesses the environmental impacts of postulated accidents involving radioactive materials associated with ANPP Unit 3. The chapter is divided into four sections that address acceptance criteria and evaluation method, design basis accidents, severe accidents, and transportation accidents.

Since the reactor design has not yet been selected and sufficient data on site conditions, specifically inputs to atmospheric dispersion calculations, are not available, the assessment of environmental impacts of postulated accidents at ANPP Unit 3 is based on the extensive analyses done for the AP1000 units proposed for construction in the U.S. The assumed site conditions for these plants are compared with known or expected site conditions for ANPP in order to assess the applicability of accident consequences predicted for the U.S. AP1000 plants.

Section 7.1 discusses acceptance criteria and the evaluation method applied to assess radiological impacts of design basis accidents.

Section 7.2 identifies the environmental risks of design basis accidents involving radioactive material that can be postulated for ANPP Unit 3 by providing offsite dose consequences of such accidents based on the AP1000. The offsite dose consequences and resulting health effects for design basis accidents (DBAs) are compared against intervention levels in RoA and U.S. NRC regulations.

Section 7.3 discusses severe accidents. In the final environmental assessment, this Section would contain the results of detailed risk analyses for the selected reactor type.

Section 7.4 discusses transportation accidents involving radioactive materials based on information provided in EBID Section 3.8.

7.1 RADIOLOGICAL IMPACT ACCEPTANCE CRITERIA AND EVALUATION METHODS

This section discusses acceptance criteria to be applied when evaluating the impacts of accidents involving radioactive material.

7.1.1 Republic of Armenia Acceptance Criteria

Government of Armenia Resolution № 1219-N, dated August 18, 2006, (Ref. [7-1]) sets dose limits for the public, as follows:

> In emergency cases, if the anticipated dose during a short period of time may reach such levels (Table No 20) which may result in effects disclosed by clinical methods, then it is necessary to make an immediate intervention. (¶ 44) Table 20 sets limits for absorbed dose during two days for the whole body and specific organs of the body, as follows:
> - Whole body and bone marrow – 1 Gy;
> - Lungs – 6 Gy;
> - Skin – 3 Gy;
> - Thyroid – 5 Gy;
> - Retina of the eye – 2 Gy;
> - Gonads – 3 Gy.

> For the purpose of ensuring protection of people during emergency response and implementation of protective measures, criteria shall be defined in accordance with Tables 22-28 (¶ 44, continued). Tables 22-28 correspond to guidance in IAEA TECHDOC 953, which is discussed below.

Irradiation of more than 200 mSv effective dose annually shall be treated as potentially dangerous (¶ 49).

In the absence of clearly defined criteria in Resolution № 1219-N for limiting doses to population during evaluations of reactor siting that account for accidents likely to occur once in 1,000,000 reactor years, the value of 200 mSv will be applied as the acceptance criterion for evaluation of radiological impacts of accidents involving radioactive materials. A predicted dose below 200 mSv will be considered a SMALL impact.

It is recommended that the RoA clearly establish criteria applicable to evaluation of design basis accidents that are unlikely to occur during the lifetime of a facility but that should be taken into account during facility siting and design.

7.1.2 International Atomic Energy Agency (IAEA) Acceptance Criteria

IAEA does not set specific, numerical, acceptance criteria for accidental doses to the public, but does provide guidance for how such doses are to be determined, as discussed below.

IAEA guidance for siting of nuclear reactors, NS-R-3, states: “The radiological risk to the population associated with accident conditions, including those that could lead to emergency measures being taken, [must be] acceptably low.” Ref. [7-2]

IAEA NS-R-3 does not quantify what level of radiological risk is “acceptably low.” IAEA NS-R-3 refers to the Basic Safety Standards (BSS) for protection against ionizing radiation in IAEA Safety Series № 115, which, although it requires safety assessments that determine the probabilities and determine the expected magnitudes of potential exposures (exposures due to accidents) (Ref. [7-3]), does not provide numerical values applicable to potential exposures.

NS-R-3 requires an evaluation of the potential radiological impacts of accidental releases of radioactive material, including reasonable consideration of releases due to severe accidents, with the use of site specific parameters as appropriate. The atmospheric dispersion of radioactive material released shall be assessed with the use of appropriate models. These models shall include all significant site specific and regional topographic features and characteristics of the installation that may affect atmospheric dispersion. The site specific information includes data from at least one full year of meteorological measurements carried out at or near the site with the use of instrumentation capable of measuring and recording the main meteorological parameters at appropriate elevations and locations. Ref. [7-4]

IAEA TECHDOC 953 sets generic intervention and action levels that correspond to tables in GoA Resolution № 1219-N (Ref. [7-5]).

The IAEA does not set numerical values for criteria suitable for application to evaluation of accident doses, but defers to countries (states) to define acceptable levels.

7.1.3 U.S. Nuclear Regulatory Commission Acceptance Criteria

NUREG-1555 acceptance criteria for the review of environmental impacts of postulated accidents involving radioactive material and related to the plant are based on the relevant requirements of 10 CFR 50.34. Ref. [7-6]

10 CFR 50.34 (Ref. [7-7]) states that an application for a construction permit must include the results of an evaluation and analysis of the postulated fission product release which demonstrates that:

> (1) An individual located at any point on the boundary of the exclusion area for any 2 hour period following the onset of the postulated fission product release, would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).
>
> (2) An individual located at any point on the outer boundary of the low population zone, who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE).

A whole body dose of 25 rem has been stated to correspond numerically to the once in a lifetime accidental or emergency dose for radiation workers which, according to National Council on Radiation Protection and Measurements (NCRP) recommendations at the time could be disregarded in the determination of their radiation exposure status. However, its use is not intended to imply that this number constitutes an acceptable limit for an emergency dose to the public under accident conditions. Rather, this dose value has been set forth as a reference value, which can be used in the evaluation of plant design features with respect to postulated reactor accidents, in order to assure that such designs provide assurance of low risk of public exposure to radiation, in the event of such accidents. Ref. [7-8]

Thus, the limiting dose for a member of the public on the exclusion area boundary (EAB) for any 2-hour period following an accident or for a person at the boundary of the low population zone (LPZ) exposed to the radioactive cloud is 25 rem = 250 mSv.

NUREG-1555 refers to Regulatory Guide 4.2 with respect to the calculation of dispersion factor (χ/Q)[1] values for determining offsite dose consequences from postulated accidents. Regulatory Guide 4.2 (Ref. [7-9]) specifies that χ/Q values may be determined from onsite meteorological data at the 50% probability level.

7.1.4 Evaluation Approach and Acceptance Criteria Applied

Without specificity in Armenian regulations relative to the acceptability of radiation doses in evaluation of site suitability, the values of 200 mSv and 250 mSv discussed above are applied to the doses predicted for ANPP Unit 3.

The analysis methodologies applied in the U.S. for accident analyses are used, with modifications as discussed below. Although accident consequences are design- and site-specific, the approach taken to estimate accident doses that might be expected from

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[1] Dispersion factor, or χ/Q, is a measure of the degree of dispersion of material at a rate Q (curies/s), where χ (Greek letter Chi) represents the value of ground level concentration in the centerline of the radioactive plume (curies/m^3); the units of χ/Q are s/m^3.

ANPP Unit 3 is done using predicted doses from accidents at an AP1000 reactor. For this purpose information is taken from the Westinghouse Design Control Document (DCD) for the AP1000, Revision 16 (Ref. [7-10]).

The accident doses are calculated based on the results of accident analyses performed for the AP1000 and documented in the DCD, Chapter 15.

The distance to the exclusion area boundary (EAB) is assumed to be 800 m and to the boundary of the low population zone (LPZ boundary) is assumed to be 3,200 m (3.2 km). The reactor location given in EBID Section 2.1 is less than 800 m from the current ANPP site boundaries in several locations. Measured distances to the site boundary, or Owner-Controlled Area (OCA) are given in Table 7.1-1. As can be seen in Table 7.1-1, there are five sectors where the distance to the ANPP site boundary (OCA) is less than the 800 m distance used as the exclusion area boundary. The distances to the OCA boundary in other sectors are much greater than 800 m. This situation is discussed further below.

7.1.4.1 ATMOSPHERIC DISPERSION COEFFICIENTS

In U.S. practice, atmospheric dispersion factors (χ/Q values) are determined based on one or more years of meteorological data for the reactor site, consistent with the requirements in IAEA NS-R-3 discussed above.

The meteorological equipment installed at ANPP is not adequate to provide the required data. U.S. NRC Regulatory Guide 1.23 (Ref. [7-11]) specifies the following as inputs for calculation of dispersion factors:

- Wind speed and direction measurements at two separate elevations, with measurements at a third elevation if radiological releases will be from a stack higher than 85 m. The ANPP station has only one wind speed and direction anemometer and reported data indicate that it is probably not accurately recording wind speeds and direction, especially at low wind speeds.
- Temperature measurements at two or three elevations in order to determine atmospheric stability. The ANPP station reports only one reading.
- Digital sampling and generation of hourly values. The readings from the ANPP meteorological station are recorded manually at 3 hour intervals.
- At least 24 months of data is necessary, and three years is preferred. The two years of readings provided for the ANPP station contain a gap of nine months right in the middle of that time, such that twelve continuous months of readings are not available.

{For the final environmental assessment, dose analyses should be supported by two years of meteorological data collected with proper equipment installed at or near the ANPP Unit 3 location.}

For this EBID assessment, two year's worth of meteorological data was obtained from the Zvartnots International Airport. Although the equipment at Zvartnots and the resulting data would not meet the US NRC requirements, they are sufficient to allow estimation of atmospheric dispersion factors that *may* apply to the ANPP site. Although the proximity of ANPP to Mount Aragats and other terrain factors may cause differences between wind

direction and speed at Zvartnots and ANPP, the Zvartnots data are the best available. {It is recommended that suitable meteorological equipment be installed at or near the ANPP site to provide inputs to safety and environmental assessments for ANPP Unit 3.}

The computer code ARCON96 was used to calculate the dispersion factors for ANPP.

ARCON96 implements a straight-line Gaussian dispersion model with dispersion coefficients that are modified to account for low wind meander and building wake effects. Hourly, normalized concentrations (χ/Q) are calculated from hourly meteorological data. The hourly values are averaged to form χ/Qs for periods ranging from 2 to 720 hours in duration. The calculated values for each period are used to form cumulative frequency distributions. Ref. [7-12]

ARCON96 is documented in NUREG/CR-6331 (Ref. [7-13]). Additional guidance on application of ARCON96 is provided in US NRC Regulatory Guide 1.194 (Ref. [7-14]). ARCON96 was run to generate χ/Q values for the sectors and distances shown in Table 7.1-1. The limiting (maximum) ANPP χ/Q values for given time periods are given in Table 7.1-2. Table 7.1-2 also compares the calculated ANPP χ/Q values with those assumed in the Westinghouse analyses documented in the DCD and gives an ANPP/DCD χ/Q ratio for each location and time period of interest. An example of the ARCON96 output for ANPP is provided as Table 7.1-3.

7.1.4.2 ACCIDENT SOURCE TERMS

The design basis accident source terms, methodology, and assumptions in the DCD are based on the alternative source term methods outlined in NRC Regulatory Guide 1.183 (Ref. [7-15]). The activity releases and doses are based on 102 percent of the rated core thermal power of 3400 megawatts thermal (MWt). The core inventory for the AP1000 is provided in Appendix 15A of the DCD. The core fission product inventory was determined by the use of the ORIGEN code developed by the Oak Ridge National Laboratory[2].

7.1.4.3 ANPP UNIT 3 DOSE PREDICTIONS

The basic scenario for each accident is that some quantity of activity is released at the accident location inside a building, and this activity is eventually released to the environment. In addition to the source term, the transport of the activity within the plant is independent of the site and specific to the AP1000 design. The dose to an individual located at the exclusion area boundary (EAB) or the low population zone (LPZ) is calculated based on the amount of activity released to the environment, the atmospheric dispersion of the activity during the transport from the release point to the off-site location, the breathing rate of the individual at the off-site location, and activity-to-dose conversion factors.

The only site-specific parameter in these calculations is atmospheric dispersion. Therefore, site-specific doses are predicted by adjusting the DCD doses to reflect the site-specific atmospheric dispersion factors (χ/Q values) given in Table 7.1-2. Because the site-specific χ/Q values are bounded by the DCD χ/Q values, this approach demonstrates that the site-specific doses are within those calculated in the DCD. As can be seen in Table 7.1-2, the χ/Q values for those sectors where the OCA boundary is less than 800 m,

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[2] See URL: http://www.ornl.gov/sci/origen-arp/index.htm

is more limiting than the EAB values. The ANPP accident dose predictions will apply the most limiting value.

The DCD presents the radiological consequences for design basis accidents. The DCD design basis analysis results are updated with calculated ANPP dispersion factors to demonstrate that the DCD analyses are bounding for the ANPP Unit 3.

7.2 DESIGN BASIS ACCIDENTS

This section identifies the environmental risks of accidents involving radioactive material that can be postulated for ANPP Unit 3 by providing offsite dose consequences of such accidents. The offsite dose consequences and resulting health effects for design basis accidents (DBAs) are compared against RoAlimits and US NRC siting guidelines, as discussed above.

7.2.1 Selection of Accidents

The DBAs considered in this section come from the AP1000 DCD. Table 7.2-1 lists the DBAs that have the potential to release radioactivity to the environment and shows accident descriptions. The DBAs cover a spectrum of events, including those of relatively greater probability of occurrence and those that are less probable but have greater severity. The radiological consequences of the accidents listed in Table 7.2-1 are assessed to demonstrate that Unit 3 can be operated at the ANPP site without undue risk to the health and safety of the public.

7.2.2 Evaluation Methodology

Details about the methodologies and assumptions pertaining to each of the accidents, such as activity release pathways and credited mitigation features, are provided in the DCD. The postulated loss-of-coolant accidents (LOCA) are expected to more closely approach regulatory limits than the other DBAs of greater probability of occurrence but lesser magnitude of activity releases.

The accident analyses presented in DCD Chapter 15 use conservative assumptions to perform bounding safety analyses that substantially overstate the environmental effect of the identified accidents. Among the conservative assumptions in DCD Chapter 15 is the use of time-dependent χ/Q values corresponding to the top fifth percentile of meteorology, meaning that conditions would be more favorable for dispersion 95 percent of the time. In addition to the use of atmospheric dispersion factors corresponding to adverse conditions, the DCD Chapter 15 design basis analyses also used conservative assumptions on the core and coolant source terms, the types of radioactive materials released, and the release paths to the environment. These conservative assumptions are maintained for the dose assessments presented in this section except that realistic atmospheric dispersion factors are used. The doses in this EBID chapter are also calculated based on the fifth percentile χ/Q values calculated for the ANPP site, even though NRC guidance would allow use of 50th percentile values which would reflect more realistic meteorological conditions using ARCON96, as discussed above.

The accident doses are expressed as total effective dose equivalent (TEDE). The TEDE consists of the sum of the committed effective dose equivalent (CEDE) from inhalation and the effective dose equivalent (EDE) from external exposure. Appendix 15A of the DCD provides information on the methodologies used to calculate CEDE and EDE values for the various postulated accidents.

7.2.3 Radiological Consequences of Design Basis Accidents

For each of the accidents identified in Table 7.2-1, the site-specific dose for a given time interval is calculated by multiplying the DCD dose by the ratio of the ANPP χ/Q value to the DCD χ/Q value. The time-dependent DCD χ/Q values, time-dependent ANPP χ/Q values, and their ratios are shown in Table 7.1-2. As all ANPP χ/Q values are bounded by DCD χ/Q values, site-specific doses for all accidents are also bounded by DCD doses. The total doses are summarized in Table 7.2-2, based on individual accident doses presented in Tables 7.2-3, 7.2-4, 7.2-5, 7.2-6, 7.2-7, 7.2-8, 7.2-9, 7.2-10, 7.2-11, and 7.2-12. For each accident, the EAB dose shown is for the 2-hr period that yields the maximum dose, in accordance with NRC Regulatory Guide 1.183 (Ref. [7-15]).

The results of the ANPP Unit 3 analysis contained in the referenced tables demonstrate that all accident doses meet the site acceptance criteria of 200 mSv and 250 mSv TEDE. The acceptance criteria apply to accidents with an exceedingly low probability of occurrence and a low risk of public exposure to radiation. For events with a higher probability of occurrence, the dose limits indicated in Table 7.2-2 are taken from NRC Regulatory Guide 1.183 (Ref. [7-15]) Table 6, for all formally designated accidents except the Reactor Coolant Pump Shaft Break and the Failure of Small Lines Carrying Primary Coolant Outside Containment. Although NRC Regulatory Guide 1.183 does not address these two accidents, the NRC's Standard Review Plan indicates that the dose limit is a "small fraction" or 10 percent of the guideline of 25 rem, meaning a limit of 2.5 rem for these accidents. The equivalent RoA limit is calculated as by multiplying the given U.S. acceptance criterion by a ratio of 200/250 = 0.8. As seen in Table 7.2-2, all doses are within these acceptance criteria.

7.3 SEVERE ACCIDENTS

Typically this section of the environmental assessment would consider the probabilities and consequences of severe accidents (accident conditions more severe than a design basis accident and involving significant core degradation). Severe accidents are of lower probability than design basis accidents, but have the potential for greater consequences. An assessment of severe accidents is highly design- and site-specific involving computer codes that model transport of radioactive materials and exposure pathways from the damaged plant to individual receptors.

The reactor design for ANPP Unit 3 has not yet been selected, thus design-specific factors are unknown at this time. An approach similar to the evaluation of design basis accident doses discussed above might be possible.

Studies by the U.S. NRC concluded that the primary factors affecting risk of severe accidents are the site population, which reflects the number of people potentially at risk of severe accident exposure, and wind direction (Ref. [7-16]). Given the uncertainties introduced by the use of meteorological data from Zvartnots International Airport rather than a sufficient amount of ANPP site-specific data (see discussion above in subsection 7.1.4.1, and the lack of current exposure pathway data and inventory of receptors specific to the site vicinity (see discussion in EBID Section 5.4), predictions of the risks of severe accidents would be speculative and possibly result in incorrect conclusions.

For these reasons, no attempt has been made to estimate the risks of severe accidents at the proposed ANPP Unit 3. Such estimates can be made when the reactor design parameters are better known, a sufficient set of meteorological data for the ANPP site has been collected, exposure pathway data are collected, and a suitable inventory of receptors conducted.

7.4 TRANSPORTATION ACCIDENTS

Transportation of radioactive materials is covered in EBID Section 3.8. Consistent with the recommendations of IPS Chapter 5 (Ref. [7-17]), it is assumed that solid waste storage and solid waste disposal facilities will be established within the boundaries of the ANPP site. In addition, onsite dry spent fuel storage (similar to the NUOHMs dry storage facility for fuel from Units 1 and 2) will be provided to accommodate up to sixty years of spent reactor fuel within the site boundaries.

7.4.1 Onsite Transportation of Solid Radwaste and Spent Nuclear Fuel

Solid radioactive waste from Unit 3 will be packaged for transport and disposal inside Unit 3 buildings. Unit 3 spent nuclear fuel will be stored in the spent fuel pool for a minimum of five years before being placed in canisters designed for dry storage. Onsite transportation of spent fuel canisters and packaged radioactive waste will be performed in special vehicles on engineered roads over very short distances (the site is less than 3 km wide at its widest point). In light of this, no transportation accidents are expected to take place within the site boundaries. In any event, the consequences of a transportation accident onsite should be bounded by those of the fuel handling accident, as reflected in Table 7.2-2.

7.4.2 Offsite Transportation of Irradiated (Spent) Fuel

As discussed in IPS Chapter 5, it is expected that spent nuclear fuel from ANPP Unit 3 will be shipped to an internationally sanctioned site for processing and disposal of the resulting high-level radioactive waste in a manner and location that has not yet been determined.

Once international facilities are available and requisite provisions have been established in laws and regulations, the Unit 3 spent nuclear fuel will be shipped out of the country. Without details of the packaging and transportation methods to be used, a suitable assessment of impacts is not possible. Environmental assessments related to these future arrangements must take into account the impacts of accidents during transportation of the spent nuclear fuel.

7.4.3 Transportation of Un-irradiated Fuel

In the U.S., the NRC's generic environmental impact assessment for transportation of reactor fuel and waste assume that shipments are by truck (no more than one per day) of less than 73,000 lb (33,100 kg) or by less than three rail car shipments per month of less than 100 tons (91.7 t) per cask per rail car. (Ref. [7-18]). No provisions are made within the impact assessment for shipment by other means, such as by air.

The specifics of transportation of un-irradiated reactor fuel will have to be assessed when the specific reactor is selected and the potential fuel vendors are identified, along with transportation means available from those vendors. Although road or rail shipments would be preferred, restrictions of countries through which the fuel may have to pass must be taken into account, and at this time, air transport cannot be ruled out as a possibility. If air shipments are considered, the size of the shipments may need to be set based on the potential impacts of transportation accidents.

Table 7.1-1, Distances to area boundaries

Compass Sector	Distance (in meters) to the: OCA[a]	EAB[b]	LPZ[c]
N	1480	800	3200
NNE	1660	800	3200
NE	1930	800	3200
ENE	1650	800	3200
E	1270	800	3200
ESE	870	800	3200
SE	730	800	3200
SSE	670	800	3200
S	720	800	3200
SSW	700	800	3200
SW	640	800	3200
WSW	1150	800	3200
W	2160	800	3200
WNW	1990	800	3200
NW	1590	800	3200
NNW	1430	800	3200

[a] Owner Controlled Area, based on Site Map and/or Land Cadastre Data
[b] Exclusion Area Boundary, given as 800 m
[c] Low Population Zone boundary, given as 3,200 m (3.2 km)

Table 7.1-2, Limiting Atmospheric Dispersion Factors

Location	Time hr	DCD χ/Q s/m^3	ANPP χ/Q s/m^3	χ/Q Ratio (ANPP/DCD)
OCA-1[a]	0 - 2	1.00E-03	3.74E-05	3.74E-02
OCA-2[b]	0 - 2	1.00E-03	3.69E-05	3.69E-02
OCA-3[c]	0 - 2	1.00E-03	3.69E-05	3.69E-02
OCA-4[d]	0 - 2	1.00E-03	3.69E-05	3.69E-02
OCA-5[e]	0 - 2	1.00E-03	3.38E-05	3.38E-02
EAB[f]	0 - 2	1.00E-03	3.37E-05	3.37E-02
LPZ[g]	0 - 8	5.00E-04	8.24E-06	1.65E-02
LPZ	8 - 24	3.00E-04	2.50E-06	8.33E-03
LPZ	24 - 96	1.50E-04	2.97E-06	1.98E-02
LPZ	96 - 720	8.00E-05	2.78E-06	3.48E-02

[a] Nearest Site Boundary, = 640 m (SW Sector)
[b] Second Nearest Site Boundary, = 670 m (SSE Sector)
[c] Third Nearest Site Boundary, = 700 m (SSW Sector)
[d] Fourth Nearest Site Boundary, = 720 m (S Sector)
[e] Fifth Nearest Site Boundary, = 730 m (SE Sector)
[f] Nominal EAB = 800 m
[g] Nominal LPZ outer boundary = 3.2 km

Table 7.1-3, ARCON96 output for ANPP

```
Program Title:  ARCON96.

Developed For:  U.S. Nuclear Regulatory Commission
                Office of Nuclear Reactor Regulation
                Division of Reactor Program Management

Date:           June 25, 1997    11:00 a.m.

NRC Contacts:   J. Y. Lee        Phone: (301) 415 1080
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Code Developer: J. V. Ramsdell   Phone: (509) 372 6316
                                 e-mail: j_ramsdell@pnl.gov

Code Documentation:  NUREG/CR-6331 Rev. 1

The program was prepared for an agency of the United States Government. Neither
the United States Government nor any agency thereof, nor any of their
employees, makes any warranty, expressed or implied, or assumes any legal
liability or responsibilities for any third party's use, or the results of such
use, of any portion of this program or represents that its use by such third
party would not infringe privately owned rights.

Program Run   8/25/2008  at  17:24:34

 ******* ARCON INPUT **********

    Number of Meteorological Data Files  =  1
    Meteorological Data File Names
      C:\DOS\ANPP\TEST\FINAL.MET

    Height of lower wind instrument (m)  =      6.0
    Height of upper wind instrument (m)  =       .0
    Wind speeds entered as meters/second

    Ground-level release
    Release height (m)                   =       .0
    Building Area (m^2)                  =       .0
    Effluent vertical velocity (m/s)     =       .00
    Vent or stack flow  (m^3/s)          =       .00
    Vent or stack radius (m)             =       .00

    Direction .. intake to source (deg)  =      360
    Wind direction sector width (deg)    =       90
    Wind direction window (deg)          =   315 - 045
    Distance to intake (m)               =   3200.0
    Intake height  (m)                   =      2.0
    Terrain elevation difference (m)     =       .0

    Output file names
      final_LPZ_360.log
      final_LPZ_360.cfd

    Minimum Wind Speed (m/s)             =       .5
    Surface roughness length (m)         =       .10
    Sector averaging constant            =      4.0

    Initial value of sigma y             =       .00
    Initial value of sigma z             =       .00

    Expanded output for code testing not selected

    Total number of hours of data processed =   8760
    Hours of missing data                =      96
    Hours direction in window            =    2170
    Hours elevated plume w/ dir. in window =     0
    Hours of calm winds                  =     874
    Hours direction not in window or calm =    5620

    DISTRIBUTION SUMMARY DATA BY AVERAGING INTERVAL
   AVER. PER.          1          2          4          8         12         24         96        168        360        720
   UPPER LIM.    1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04   1.00E-04
     LOW LIM.    1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08   1.00E-08
 ABOVE RANGE           0.         0.         0.         0.         0.         0.         0.         0.         0.         0.
    IN RANGE        3044.      4288.      5345.      6665.      7572.      8482.      8501.      8378.      8054.      7442.
 BELOW RANGE           0.         0.       445.       640.       464.        93.         0.         0.         0.         0.
        ZERO        5620.      4374.      2868.      1345.       609.        49.         0.         0.         0.         0.
  TOTAL X/Qs        8664.      8662.      8658.      8650.      8645.      8624.      8501.      8378.      8054.      7442.
  % NON ZERO        35.13      49.50      66.87      84.45      92.96      99.43     100.00     100.00     100.00     100.00

    95th PERCENTILE X/Q VALUES
                  1.61E-05   9.18E-06   9.02E-06   8.00E-06   6.24E-06   4.26E-06   3.24E-06   3.07E-06   2.91E-06   2.79E-06

    95% X/Q for standard averaging intervals

    0 to 2 hours        1.61E-05
    2 to 8 hours        5.30E-06
    8 to 24 hours       2.39E-06
    1 to 4 days         2.90E-06
    4 to 30 days        2.72E-06

                              HOURLY VALUE RANGE
                            MAX X/Q              MIN X/Q
        CENTERLINE         1.73E-05             2.59E-08
        SECTOR-AVERAGE     1.08E-05             1.62E-08

NORMAL PROGRAM COMPLETION
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Table 7.2-1, Selected Design Basis Accidents

DCD Subsection	Description	Identified in NUREG-1555?	Comment
15.1.5	Steam System Piping Failure	Yes	
15.2.8	Feedwater System Pipe Break	Yes	Bounded by DCD 15.1.5.
15.3.3	Reactor Coolant Pump Shaft Seizure (Locked Rotor)	Yes	
15.3.4	Reactor Coolant Pump Shaft Break	Yes	Bounded by DCD 15.3.3.
15.4.8	Spectrum of Rod Cluster Control Assembly (Control Rod) Ejection Accidents	No	Evaluated for completeness.
15.6.2	Failure of Small Lines Carrying Primary Coolant Outside Containment	Yes	
15.6.3	Steam Generator Tube Rupture	Yes	
15.6.5	Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary	Yes	
15.7.4	Fuel Handling Accident	Yes	

Table 7.2-2, Summary of Design Basis Accident Doses

DCD Subsection	DCD Description Accident	Site Dose (mSv) TEDE OCA/EAB	LPZ	Limit-1[a]	Limit-2[b]	Reference Dose Table
15.1.5	Steam System Piping Failure					
	Pre-Existing Iodine Spike	3.74E-01	1.23E-01	2.50E+02	2.00E+02	7.2-3
	Accident-Initiated Iodine Spike	4.11E-01	3.06E-01	2.50E+01	2.00E+01	7.2-4
15.2.8	Feedwater System Pipe Break	[c]	[c]			
15.3.3	Reactor Coolant Pump Shaft Seizure					
	No Feedwater	2.99E-01	6.41E-02	2.50E+01	2.00E+01	7.2-5
	Feedwater Available	2.24E-01	1.31E-01	2.50E+01	2.00E+01	7.2-6
15.3.4	Reactor Coolant Pump Shaft Break	[d]	[d]			
15.4.8	Spectrum of Rod Cluster Control Assembly Ejection Accidents [d]	1.35E+00	8.40E-01	6.30E+01	5.04E+01	7.2-7
15.6.2	Failure of Small Lines Carrying Primary Coolant Outside Containment	7.85E-01	1.68E-01	2.50E+01	2.00E+01	7.2-8
15.6.3	Steam Generator Tube Rupture					
	Pre-Existing Iodine Spike	8.23E-01	1.97E-01	2.50E+02	2.00E+02	7.2-9
	Accident-Initiated Iodine Spike	4.11E-01	1.17E-01	2.50E+01	2.00E+01	7.2-10
15.6.5	Loss-of-Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks Within the Reactor Coolant Pressure Boundary	4.30E+00	2.39E+00	2.50E+02	2.00E+02	7.2-11
15.7.4	Fuel Handling Accident	1.94E+00	4.27E-01	6.30E+01	5.04E+01	7.2-12

[a] Limit-1, NUREG-1555 specifies a dose limit of 250 mSv TEDE for all design basis accidents. The more restrictive limits shown in the table apply to safety analysis doses, but they are shown here to demonstrate that even these more restrictive limits are met.

[b] Limit-2 is based on the value of 200 mSv from GoA Resolution 1219-N; this value is assumed as a guideline level for application of siting decisions in Armenia. Where more restrictive limits are applied for US guidance, the 200 mSv value is reduced accordingly.

[c] Feedwater System Pipe Break is bounded by Steam System Piping Failure

[d] Reactor Coolant Pump Shaft Break is bounded by Reactor Coolant Pump Shaft Seizure

Table 7.2-3, Doses for Steam System Piping Failure with Pre-Existing Iodine Spike

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[(a)]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	1.00E+01		3.74E-02	3.74E-01	
0 - 8		5.81E+00	1.65E-02		9.57E-02
8 - 24		7.18E-01	8.33E-03		5.98E-03
24 - 96		1.08E+00	1.98E-02		2.14E-02
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	1.00E+01	7.61E+00		3.74E-01	1.23E-01

[(a)] EAB Dose from DCD Subsection 15.1.5.4.6

Table 7.2-4, Doses for Steam System Piping Failure with Accident-Initiated Iodine Spike

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	1.10E+01		3.74E-02	4.11E-01	
0 - 8		1.02E+01	1.65E-02		1.68E-01
8 - 24		3.77E+00	8.33E-03		3.14E-02
24 - 96		5.36E+00	1.98E-02		1.06E-01
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	1.10E+01	1.93E+01		4.11E-01	3.06E-01

[(a)] EAB Dose from DCD Subsection 15.1.5.4.6

Table 7.2-5, Doses for Reactor Coolant Pump Shaft Seizure with No Feedwater

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[a]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	8.00E+00		3.74E-02	2.99E-01	
0 - 8		3.89E+00	1.65E-02		6.41E-02
8 - 24		0.00E+00	8.33E-03		0.00E+00
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	8.00E+00	3.89E+00		2.99E-01	6.41E-02

[a] EAB Dose from DCD Subsection 15.3.3.3.6

Table 7.2-6, Doses for Reactor Coolant Pump Shaft Seizure with Feedwater Available

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[a]	LPZ	ANPP/DCD	EAB	LPZ
6 - 8[b]	6.00E+00		3.74E-02	2.24E-01	
0 - 8		7.94E+00	1.65E-02		1.31E-01
8 - 24		0.00E+00	8.33E-03		0.00E+00
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	6.00E+00	7.94E+00		2.24E-01	1.31E-01

[a] EAB Dose from DCD Subsection 15.3.3.3.6

[b] Releases for 6 to 8 hours are given because this is the limiting time period for two-hour doses.

Table 7.2-7, Doses for Spectrum of Rod Cluster Control Assembly Ejection Accidents

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[(a)]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	3.60E+01		3.74E-02	1.35E+00	
0 - 8		4.58E+01	1.65E-02		7.55E-01
8 - 24		7.84E+00	8.33E-03		6.53E-02
24 - 96		6.32E-01	1.98E-02		1.25E-02
96 - 720		2.06E-01	3.48E-02		7.16E-03
Total	3.60E+01	5.45E+01		1.35E+00	8.40E-01

[(a)] EAB Dose from DCD Subsection 15.4.8.3.6

Table 7.2-8, Doses for Failure of Small Lines Carrying Primary Coolant Outside Containment

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[(a)]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	2.10E+01		3.74E-02	7.85E-01	
0 - 8		1.02E+01	1.65E-02		1.68E-01
8 - 24		0.00E+00	8.33E-03		0.00E+00
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	2.10E+01	1.02E+01		7.85E-01	1.68E-01

[(a)] EAB Dose from DCD Subsection 15.6.2.6

Table 7.2-9, Doses for Steam Generator Tube Rupture with Pre-Existing Iodine Spike

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[(a)]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	2.20E+01		3.74E-02	8.23E-01	
0 - 8		1.16E+01	1.65E-02		1.91E-01
8 - 24		7.24E-01	8.33E-03		6.03E-03
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	2.20E+01	1.23E+01		8.23E-01	1.97E-01

[(a)] EAB Dose from DCD Subsection 15.6.3.3.6

Table 7.2-10, Doses for Steam Generator Tube Rupture with Accident-Initiated Iodine Spike

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[(a)]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	1.10E+01		3.74E-02	4.11E-01	
0 - 8		6.27E+00	1.65E-02		1.03E-01
8 - 24		1.69E+00	8.33E-03		1.41E-02
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	1.10E+01	7.96E+00		4.11E-01	1.17E-01

[(a)] EAB Dose from DCD Subsection 15.6.3.3.6

Table 7.2-11, Doses for Loss of Coolant Accident Resulting from a Spectrum of Postulated Piping Breaks within the Reactor Coolant Pressure Boundary

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[a]	LPZ	ANPP/DCD	EAB	LPZ
1.2 - 3.2[b]	1.15E+02		3.74E-02	4.30E+00	
0 - 8		1.22E+02	1.65E-02		2.01E+00
8 - 24		9.31E+00	8.33E-03		7.76E-02
24 - 96		4.58E+00	1.98E-02		9.07E-02
96 - 720		6.09E+00	3.48E-02		2.12E-01
Total	1.15E+02	1.42E+02		4.30E+00	2.39E+00

[a] EAB Dose from DCD Subsection 15.6.5.3.8.1 and Table 15.6.5-3

[b] Releases for 1.2 to 3.2 hours are given because this is the limiting time period for two-hour doses.

Table 7.2-12, Doses for Fuel Handling Accident

Time	DCD Dose (mSv TEDE)		χ/Q Ratio	ANPP Dose (mSv TEDE)	
hr	EAB[a]	LPZ	ANPP/DCD	EAB	LPZ
0 - 2	5.20E+01		3.74E-02	1.94E+00	
0 - 8		2.59E+01	1.65E-02		4.27E-01
8 - 24		0.00E+00	8.33E-03		0.00E+00
24 - 96		0.00E+00	1.98E-02		0.00E+00
96 - 720		0.00E+00	3.48E-02		0.00E+00
Total	5.20E+01	2.59E+01		1.94E+00	4.27E-01

[a] EAB Dose from DCD Subsection 15.7.4.5

REFERENCES:

[7-1] GoA Resolution 1219-N dated August 18, 2006, *On Approval of Radiation Safety Norms*.

[7-2] International Atomic Energy Agency (IAEA), 2003, Safety Requirements NS-R-3, *Site Evaluation for Nuclear Installations*, paragraph 2.24.

[7-3] IAEA, 1996, Safety Series № 115, *International Basic Safety Standards for Protection against Ionizing Radiations and for the Safety of Radiation Sources*, Paragraph 2.37.

[7-4] IAEA NS-R-3, paragraphs 4.13 and 4.2-4.3.

[7-5] IAEA, 1997, Method for the Development of Emergency Response Preparedness for Nuclear or Radiological Accidents, IAEA-TECDOC-953.

[7-6] U.S. Nuclear Regulatory Commission (US NRC), 1999, *Environmental Standard Review Plan*, NUREG-1555, Section 7.1.

[7-7] US NRC, 1968/2007, Title 10 Code of Federal Regulations, Part 50, Section 50.34, *Contents of construction permit and operating license applications; technical information*, (10 CFR 50.34), Paragraph (a)(1)(ii)(D).

[7-8] US NRC, 1962/1966/1973/1975/1988/1999/2002, 10 CFR 100.11, *Determination of exclusion area, low population zone, and population center distance*, paragraph (a)(2) footnote 2.

[7-9] US NRC, 1976, Regulatory Guide 4.2, Revision 2, *Preparation of Environmental Reports for Nuclear Power Stations*, Section 7.1.

[7-10] Westinghouse, 2007, *Westinghouse AP1000 Design Control Document Rev. 16 (Public Version)*, available at URL: http://adamswebsearch2.nrc.gov/idmws/ViewDocByAccession.asp?AccessionNumber=ML071580939

[7-11] US NRC, 2007, Regulatory Guide 1.23, Revision 1, *Meteorological Monitoring Programs for Nuclear Power Plants.*

[7-12] Oak Ridge National Laboratory, Radiation Safety Information Computational Center (RSICC), 2002, *RSICC Computer Code Collection ARCON96 Code System to Calculate Atmospheric Relative Concentrations in Building Wakes*, CCC-664.

[7-13] J. V. Ramsdell, Jr., and C. A. Simonen, Pacific Northwest National Laboratory (PNNL), 1997, *Atmospheric Relative Concentrations in Building Wakes*, NUREG/CR-6331, Rev.1; PNNL-10521.

[7-14] US NRC, 2003, Regulatory Guide 1.194, *Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants*.

[7-15] US NRC, 2000, Regulatory Guide 1.183, *Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors*.

[7-16] US NRC, 1996, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants (GEIS)*, NUREG-1437, Volume 1, Section 5.3.3.

[7-17] PA Consulting, 2008, *Initial Planning Studies for a New Nuclear Unit at the ANPP Site*, Chapter 5.

[7-18] U.S. NRC, 1984/1988/2007, Title 10 Code of Federal Regulations, Part 51, Section 51.52, *Environmental Effects of Transportation of Fuel and Waste – Table S-4*.

Environmental Background Information Document

Chapter 8: Evaluation of the Nuclear Power Plant Site

October 2008

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8. EVALUATION OF THE NUCLEAR POWER PLANT SITE

The objective of this chapter is to present the evaluation of major site characteristics related to public health, safety, and environmental issues. These characteristics and the acceptance criteria are provided in international guidelines for determining the suitability of sites for light-water-cooled nuclear power stations.

The U.S. Nuclear Regulatory Commission identifies factors for consideration of the sites for stationary power reactors in the Code of Federal Regulations (Ref. [8-1]):

(a) Population density and use characteristics of the site environs, including the exclusion area, the population distribution, and site-related characteristics must be evaluated to determine whether individual as well as societal risk of potential plant accidents is low, and that physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans are identified.

(b) The nature and proximity of man-related hazards (e.g., airports, dams, transportation routes, military and chemical facilities) must be evaluated to establish site parameters for use in determining whether a plant design can accommodate commonly occurring hazards, and whether the risk of other hazards is very low.

(c) Physical characteristics of the site, including seismology, meteorology, geology, and hydrology.

The International Atomic Energy Agency (IAEA) also identifies factors for consideration in evaluation of sites for nuclear facilities (Ref. [8-2]):

(a) The effects of external events occurring in the region of the particular site (these events could be of natural origin or human induced);

(b) The characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released;

(c) The population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.

The external zone for a proposed site shall be established with account taken of the potential for radiological consequences for people and the feasibility of implementing emergency plans, and of any external events or phenomena that may hinder their implementation. Ref. [8-3]

Many of the important site characteristics are evaluated in other sections of the EBID, for example:

- water availability and quality and the potential for flooding at the ANPP site due to precipitation or dam failures are discussed in EBID Section 2.3;
- site geology and seismicity are addressed in EBID Section 2.6; and
- tornadoes are discussed in EBID Section 2.7.

This chapter evaluates important site characteristics that are not specifically evaluated in other EBID sections.

This chapter evaluates the following site characteristics:

- Population density with respect to the exclusion area and low population zone
- Emergency Planning Zones (EPZs).
- Security Plans
- Rare meteorological events (e.g., Lightning)
- Potential hazards associated with nearby transportation routes and industrial facilities.

8.1 POPULATION DENSITY

The US NRC has a guideline that a reactor should be located such that the population density averaged over any radial distance out to 20 miles (cumulative population at a distance divided by the area at that distance), does not exceed 500 persons per square mile. A reactor should not be located at a site whose population density is well in excess of the above value. Ref. [8-4]

The metric equivalent of the NRC guidance would be 200 persons/km^2 at radial distances out to 32 km. Table 8-1 provides calculated 2020 population densities out to 30 km. The densities exceed the guideline for radial distances 7 to 10 km and 10 to 15 km because these distance ranges encompass the towns of Armavir and Vaharshapat, respectively. As discussed in subsection 8.2, below, Armavir is within the 10 km radius Urgent Protective Measures Planning zone and emergency planning has provided for protective measures, including sheltering and evacuation from there if necessary. Vaharshapat is outside the urgent protective measures planning zone, but is included in emergency planning as an evacuation center and provider of resources in the event of an accident.

For the purpose of site evaluation, specifically with respect to radiological impacts on the general population, a number of criteria are employed internationally to define areas of interest, such as exclusion area, sanitary protective zone, low population zone, and zones of mandatory evacuation, etc. Since the Republic of Armenia does not currently define such specific zones (except emergency planning zones that are strictly distance-based, as discussed below), the following discussion uses the U.S. Nuclear Regulatory Commission's system of zoning based on radiological criteria, as defined and discussed below.

8.1.1 Exclusion Area

Exclusion area is defined in the U.S. Code of Federal Regulations (Ref. [8-5]) thus:

> *"Exclusion area* means that area surrounding the reactor, in which the reactor licensee has the authority to determine all activities including exclusion or removal of personnel and property from the area. This area may be traversed by a highway, railroad, or waterway, provided these are not so close to the facility as to interfere with normal operations of the facility and provided appropriate and effective arrangements are made to control traffic on the highway, railroad, or waterway, in case of emergency, to protect the public health and safety. Residence within the exclusion area shall normally be prohibited. In any event, residents shall be subject to ready removal in case of necessity. Activities unrelated to operation of the reactor may be permitted in

> an exclusion area under appropriate limitations, provided that no significant hazards to the public health and safety will result."

Numerical criteria for definition of the *Exclusion Area* are given in Ref. [8-6] as:

> An Exclusion Area is within a boundary of such size that an individual located at any point on its boundary for two hours immediately following onset of the postulated fission product release would not receive a total radiation dose to the whole body in excess of 25 Rem (0.25 Sv) or a total radiation dose in excess of 300 Rem (3.0 Sv) to the thyroid from iodine exposure.

The ANPP site, as illustrated in Figure 2.2-6, Area designated with (circle) 1, is the area in which the ANPP Unit 3 operator will have control over activities, including exclusion or removal of personnel and property, and thus is the "owner controlled area." No residences are allowed within these site boundaries.

The preliminary analyses described in EBID Chapter 7 assume that the exclusion area boundary that meets the dose criteria is approximately 800 m from the reactor. Reviewing images on Google Earth™, there do not appear to be any residences within this distance.

8.1.2 Low Population Zone

Low Population Zone is defined in the U.S. Code of Federal Regulations (Ref. [8-5]) thus:

> *"Low population zone* means the area immediately surrounding the exclusion area which contains residents, the total number and density of which are such that there is a reasonable probability that appropriate protective measures could be taken in their behalf in the event of a serious accident. These guides do not specify a permissible population density or total population within this zone because the situation may vary from case to case. Whether a specific number of people can, for example, be evacuated from a specific area, or instructed to take shelter, on a timely basis will depend on many factors such as location, number and size of highways, scope and extent of advance planning, and actual distribution of residents within the area."

Numerical criteria for definition of the *Low Population Zone*, are given in Ref. [8-6] as:

> A *Low Population Zone* (LPZ) is an area of such size that an individual located at any point on its outer boundary who is exposed to the radioactive cloud resulting from the postulated fission product release (during the entire period of its passage) would not receive a total radiation dose to the whole body in excess of 25 Rem (0.25 Sv) or a total radiation dose in excess of 300 Rem (3.0 Sv) to the thyroid from iodine exposure.

The preliminary analyses described in EBID Chapter 7 assume that the boundary of a low population zone that meets the above criteria is approximately 3.2 km from the reactor and 2.4 km beyond the EAB.

Using community distances given in Table 2.5-1 and projected 2055 populations from Table 2.5-2, the estimated population within the LPZ is zero. The densest population in the immediate site vicinity is the Town of Metsamor, which the 2001 census reported as just under 9,000 persons/km^2 (see Table 2.5-5).

8.1.3 Population Center Distance

Population Center Distance is defined in the U.S. Code of Federal Regulations (Ref. [8-5]) thus: "*Population center distance* means the distance from the reactor to the nearest boundary of a densely populated center containing more than about 25,000 residents."

Numerical criteria for *population center distance* are given in Ref. [8-6] and Ref. [8-7] as:

> A population center distance of at least one and one-third times the distance from the reactor to the outer boundary of the low population zone. In applying this guide, the boundary of the population center shall be determined upon consideration of population distribution. Political boundaries are not controlling in the application of this guide.

The nearest community of this size, based on the 2001 census, is Armavir Town, centered approximately 9.2 km from the reactor location with an estimated 2006 population of 32,300 (See Table 2.5-1). The administrative (political) boundary of Armavir Town is 5.44 km from the reactor location, based on Land Cadastre coordinates, but as can be seen from Figure 8-1, this boundary does not coincide with the location of the population of the town. Based on images from Google Earth™, the nearest boundary of Armavir Town population residence is approximately 8 km from the reactor location. Applying the criterion of one and one-third times the distance to the outer boundary of the LPZ, gives a maximum distance from Unit 3 reactor to the LPZ boundary of 6 km. As indicated in Chapter 7, the distance to the LPZ boundary is assumed to be 3.2 km.

8.2 EMERGENCY PLANNING ZONES

Physical characteristics unique to the proposed site that could pose a significant impediment to the development of emergency plans must be identified (Ref. [8-6] and [8-8]).

Extensive emergency planning has been done and an emergency plan developed for the operating ANPP Unit 2 that will serve as the basis for the Emergency Plan applicable when Unit 3 becomes operational. The emergency plan is defined by Government of Armenia Resolution № 2328-N as amended by Resolution № 194 (Ref. [8-9] - hereafter the External Emergency Plan).

The External Emergency Plan defines the three emergency planning zones (Ref. [8-10]) as:

> *Preventive protective measures zone* (PPM) – an area within a radius of 5 km around the ANPP where, based on a warning received immediately from the facility, actions are planned (based on the category of the accident), before or at the beginning of radioactive discharge, for urgent implementation.
>
> *Urgent protective measures planning zone* (UPMP) – an area within a radius of from 5 km to 10 km around the ANPP where, as proposed by the state regulatory body for nuclear and radiation safety, actions are planned to be implemented by instruction of the national emergency response coordinator.
>
> *Long-term protective actions planning zone* (LTPMAP) – an area adjacent to the ANPP where measures are planned, based on the restrictions on the consumption of locally produced food and drinking water, and prevention of chronic exposure of the population to radiation, that will be implemented [following an accident] by instruction of the national emergency response coordinator, as proposed by the regulatory body.

8.2.1 Emergency Plan Protective Actions

The External Emergency Plan identifies protective actions to be taken within the PPM zone (within 5 km of the site) as follows (Ref. [8-11]):

> For the efficient implementation of the population protection measures the population of the communities in the PPM zone is notified from the ANPP by ”Radiation Danger” alarm. This alarm is a command for the population to be ready to use their Individual Protective Measures, administer iodine preparations and take shelter.
>
> The information about the exit from the shelters and behavior rules in the contaminated zone is delivered by TV, radio and mobile loudspeakers.

Protective actions within the UPMP zone (from 5 to 10 km from the site) are as follows (Ref. [8-12]):

> The protection of the population in the communities located in the UPMP zone is implemented selectively, based on the radiation monitoring data. The alarm signal “Radiation Danger” is the command for the population of these communities to implement the protective measures.

The External Emergency Plan includes guidance for longer term protective actions and has provisions for evacuation of population from any of the 25 communities in the PPM and UPMP zones that may be contaminated to 27 towns in other areas of Armenia.

As seen in Figure 2.1-3, the PPM/UPMP zone of radius 10 km is transected by the main highway between Yerevan and Armavir, which will be a primary evacuation route, with secondary roads serving each of the villages in the area to support evacuation also. To the north of the site, there are only the Aragatsotn marz villages of Nor Amanos, Nor Yedesia, and Aragatsotn. These villages are served by roads going to the north, leading away from the site.

The substantial amount of organization and governmental coordination demonstrated by the External Emergency Plan for ANPP Unit 2 indicates that there are no significant impediments within the organizations of the Government of Armenia, the ANPP site or site vicinity to taking protective actions to protect the public in the event of an emergency at ANPP Unit 3.

8.2.2 Special Populations

Metsamor Town is within the PPM zone and Armavir Town is within the UPMP zone.

Table 2.5-18 indicates a total of 3 schools in Metsamor Town and 14 schools in Armavir Town with a total capacity of approximately 15,000 students. (There are likely other schools in smaller communities of the PPM and UPMP zones, but there are no specific data on the number or capacities of those schools.) The External Emergency Plan has provisions for sheltering and evacuation of school students and for replacement tuition for students relocated from contaminated areas.

Although the External Emergency Plan has provisions for evacuation of medical personnel from within the PPM and UPMP zones, there are no specific provisions for dealing with hospital patients. Table 2.5-18 indicates a total of 290 hospital beds in Metsamor and Armavir towns. The State Regulatory Committee for Nuclear and Radiation Safety should incorporate provisions for evacuation of hospitals and clinics in the PPM/UPMP zones in their next update of the External Emergency Plan.

8.3 SECURITY PLANS

Site characteristics must be such that adequate security plans and measures can be developed (Ref. [8-6] and [8-13]).

> Generally, a distance of about 110 meters to any vital structure or vital equipment would provide sufficient space to satisfy security measures (e.g., protected area barriers, detection equipment, isolation zones, vehicle barriers, etc.). If the distance to a vital structure or vital equipment is less than about 110 meters, special measures or analyses may be needed to show that adequate security plans can be developed. Ref. [8-13]

Based on the plant layouts illustrated in Figures 3.1-2 through 3.1-4, more than 110 m distance is available for implementation of security measures and adequate security plans can be developed for ANPP Unit 3.

8.4 RARE METEOROLOGICAL EVENTS

Meteorological characteristics of the site that are necessary for safety analysis or that may have an impact upon plant design (such as maximum probable wind speed and precipitation) must be identified and characterized. Ref. [8-14]

The meteorological conditions of the ANPP site, including wind and precipitation are discussed in EBID Section 2.7, including meteorological extremes suitable for setting plant design parameters.

8.4.1 Tornadoes

EBID Section 2.7.3 provides information on design characteristics of tornadoes for the ANPP site, indicating that the design basis tornado would be in the range of Fujita Category F2.

8.4.2 Lightning

No specific data were located related to lightning strikes in the ANPP vicinity. Lightning is most often associated with thunderstorms. The following information was found regarding thunderstorms and the ANPP site.

The beginning of summer is characterized by thunderstorm activity. In May when cold fronts pass through, the air mass processes become stronger, due to which precipitation is often followed by thunderstorms occurring in the second half of the day. Mostly, thunderstorms happen in the evening time (18:00 -20:00) and often in the second half of the day (at 12:00 – 18:00). The average duration of a thunderstorm is 1.6 hours. Ref. [8-15]

The Safety Analysis Report for ANPP Unit 2 reports the number of thunderstorms per month, over a period of many years, as given in Table 8-2 (Ref. [8-16]).

There is no reason to expect that lightning strikes in the ANPP vicinity present a site suitability concern.

8.4.3 Atmospheric Dispersion

The atmospheric stability characteristics of the site are discussed in EBID Section 2.7. Specific meteorological conditions affecting dispersion of radioactive materials are further

discussed in Section 5.4 (normal operation) and Chapter 7 (accidents involving radioactive materials).

8.5 FLOODING POTENTIAL

The maximum probable flood along with the potential for seismically induced floods … must be estimated using historical data. Ref. [8-17]

EBID Section 2.3 considers the potential for flooding of the facility, concluding that flooding is not a credible event due to the topography in the site vicinity and lack of significant amounts of precipitation in the area. By nature of the elevation above the Araks River, even in the event of upstream dam failures, the site is not at risk of flooding.

8.6 HAZARDS ASSOCIATED WITH NEARBY TRANSPORTATION ROUTES AND INDUSTRIAL FACILITIES

Potential hazards associated with nearby transportation routes, industrial and military facilities must be evaluated and site parameters established such that potential hazards from such routes and facilities will pose no undue risk to the facility. Ref. [8-6]

Potentially hazardous facilities and activities within 8 km of a proposed site, and major airports within 16 km of a proposed site, should be identified. If a preliminary evaluation of potential accidents at these facilities indicates that the potential hazards from shock waves and missiles approach or exceed those of the design basis tornado for the region or there are potential hazards such as flammable vapor clouds, toxic chemicals, or incendiary fragments, the suitability of the site should be determined by detailed evaluation of the degree of risk imposed by the potential hazard. Ref. [8-18]

The region shall be investigated for installations (including installations within the site boundary) in which flammable, explosive, asphyxiant, toxic, corrosive or radioactive materials are stored, processed, transported and otherwise dealt with that, if released under normal or accident conditions, could jeopardize the safety of the installation (Ref. [8-19]).

To support preparation of this chapter, information was requested regarding storage and shipment of toxic or hazardous chemicals as listed in Table 8-3, which is based on US NRC Regulatory Guide 1.78 (Ref. [8-20]).

The nearest hazards to ANPP Unit 3 are those due to existing Units 1 and 2 and radwaste storage facilities that occupy the ANPP site. It is assumed that Unit 2 will be in operation for some period of time during the initial startup and operation of Unit 3. During this time, the chemicals, fuels and equipment used to support Unit 2 operation will continue to be present. Table 8-4 lists the potentially hazardous chemicals and fuels on the ANPP site (Refs. [8-21]). In addition, a natural gas pipeline of 150 mm diameter supplies fuel to the auxiliary boiler for Units 1 and 2 (Ref. [8-22]).

Specific hazards to ANPP Unit 3 that may arise as a result of decommissioning activities for Units 1 and 2 cannot be listed at this time since decommissioning technologies have not been selected. The hazards due to decommissioning activities must be evaluated in connection with the Unit 1 and 2 decommissioning plan.

Initial Planning Studies for ANPP Unit 3 (Ref. [8-23]) outline existing radwaste storage facilities onsite and suggest that some of the existing waste storage facilities could be adapted to serve as permanent disposal facilities and recommends establishing a new disposal facility in the northern quadrant of the ANPP site. The potential impacts of such

facilities on ANPP Unit 3 must be considered in connection with the environmental and safety assessments for those facilities.

No industrial facilities, other than those on the ANPP site discussed above, are in operation in the site vicinity. Table 8-5 lists fuel storage facilities identified in response to requests to identify such facilities within 8 km[1] of the site (Ref. [8-24] and [8-25]).

EBID Subsection 2.5.2.5 describes transportation routes in the ANPP region, including those in the site vicinity:

- National Highway M-5, which goes between Yerevan to the east of ANPP to Armavir Town to the west, passes within 4 km south of the site;
- The Yerevan-Tbilisi railway runs within 7 km of the site, with a rail spur that goes to the ANPP site; and
- The Zvartnots International Airport, which is 21.8 km from ANPP. Although the airport is outside of the 16 km distance specified in RG 4.7 (Ref. [8-18]), flight patterns pass within 5 km of ANPP (see details, below).

The Ministry of Transportation and Communications does not record shipment of chemicals by highway, but provided statistics on material shipped by railway through Armavir Marz during 2007, as given in Table 8-6. The Ministry also reported that they had no records of railway accidents involving hazardous chemicals in 2007. Ref. [8-26]

The Developer should conduct or sponsor a survey of traffic on Highway M-5, to include notations of potentially hazardous cargoes shipped past the ANPP site. This survey could be conducted in conjunction with the traffic survey recommended in EBID Section 4.4. Should hazardous cargo shipments exceed appropriate guidelines, such as those in RG 1.78, the results of that survey should be factored into the design of protection systems for the plant (see discussion below regarding potential hazards from sulfuric acid).

8.6.1 Aircraft Crashes

Figures 8-2 and 8-3 provide approach and departure charts for Zvartnots Airport (Ref. [8-27]). As shown on these charts, the path for planes approaching from the west (runway 09) and taking off to the west (runway 27) pass a no-fly zone (UD (p) 1) of radius 3.5 km around ANPP at 20 km from the airport datum.

IAEA Safety Guide NS-G-3.1 defines crashes as a result of takeoff or landing operation as Type 2 events with a probability in the range 10^{-5}–10^{-6} that tend to occur within approximately a semicircular area of 7.5 km in radius centered at the ends of the runways (Ref. [8-28]). Measurement on Google Earth™ indicates the Unit 3 reactor location to be approximately 19.9 km from the western end of the Zvartnots runway, well outside the screening distance value of 7.5 km indicated in Ref. [8-28].

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[1] A distance of 8 km (5 mi) is the distance specified in US NRC Regulatory Guide 1.78 for screening of chemicals that are potentially hazardous to a nuclear plant, specifically for control room habitability.

Air traffic data for Zvartnots airport was provided by the Department of Civil Aviation (Ref. [8-29]), as follows:

- In the first quarter of 2008 there were total of 3,424 arrivals/departures:
    - 35-40% was carried out by Airbus aircrafts (type not specified, probably A320/321);
    - 30-40% by Tu-154/134;
    - 5-10% Yak-42; and
    - 5-10% Boeing (type not specified, but probably 737)
- 70% of planes taking off (1197) passed near ANPP (takeoff on Runway 27)
- 98% of planes landing (1678) passed near ANPP (approach to Runway 09)
- There is a no-fly zone within 3.5 km radius of ANPP for planes flying under 6000 meters.

IAEA Safety Guide NS-G-3.1 also provides an example method for estimating a screening distance value if airways or airport approaches pass within 4 km of the site (Ref. [8-30]). Where the distance *d* is greater than 16 km, the hazard should be considered if the number of projected yearly flight operations is greater than $1000d^2$. Application of that criterion results in a limiting number of flights of 400,000 per year, substantially more than the traffic at Zvartnots. Using an estimated frequency of 14,000 flight operations (4 times all operations for first quarter 2008 from Ref. [8-29]), application of the criterion results in a screening distance value of 3.7 km, indicating that hazards from Zvartnots need not be considered.

Nevertheless, NS-G-3.1 recommends a separate check for areas in the vicinity of airports (Ref. [8-31]).

Worldwide aircraft accident rates for 1997 to 2006 from Ref. [8-32] are tabulated in Table 8-7. Only aircraft on approach to or during the climb phase of takeoffs to the west are a hazard to ANPP; thus only the statistics for accidents on initial approach and climb (flaps up) phases are used. The worldwide hull loss accident rate for this same time period is 1.2 per million aircraft departures (Ref. [8-33]). Using the Zvartnots-specific data for first quarter of 2008, Table 8-7 calculates an accident rate of 2.1×10^{-7} / flight for takeoffs and approaches to/from the west of Zvartnots Airport. It is assumed that no more than one in one hundred flights would violate the no-fly zone. Further assuming that the accident rate to the west of the airport applies to a semicircular area from the end of the runway, and that the critical area of the site corresponds to the power block and service water spray ponds (Table 3.2A-1, items 17.2.4 and 3.5.1), the calculated accident rate, as shown in Table 8-7, that could impact ANPP Unit 3 is 1.2×10^{-8} per year.

This preliminary assessment indicates that the affects of an airplane crash need not be considered during plant design. Nevertheless, a more in-depth probabilistic analysis of aircraft crashes should be conducted to determine if the plant design must accommodate aircraft impacts.

8.6.2 Release of Hazardous Fluids

Tables 8-4 and 8-6 indicate significant quantities of sulfuric acid and ammonia are stored onsite and shipped on the railway that passes within 7 km of the site.

Table 8-8 provides the limiting amounts of these chemicals at distances of 500-800 m, 3.2 to 4.8 km, and 6.4 to 8.0 km, based on RG 1.78 (Ref. [8-34]). These distances are

chosen because they represent, respectively, the distances to ANPP Unit 2, Highway M-5, and the Yerevan-Tblisi railway.

The amount of ammonia listed in Table 8-4 (100 kg) is less than that indicated in Table 8-8 (4,300 kg). The largest amount of ammonia shipped at one time (6,800 kg, assuming both cars in September 2007 were in the same train) is less than the limiting amount in Table 8-8 (4,200,000 kg). Based on these values, anhydrous ammonia need not be considered a hazard to the Unit 3 control room.

The amount of sulfuric acid kept onsite for ANPP Unit 2 exceeds the limiting amount for a distance of 500 to 800 m. In addition, data in Table 8-6 show that railway shipments of sulfuric acid are classed as “frequent” using the criteria of RG 1.78 (Ref. [8-35]) and must be taken into account in evaluating control room habitability for ANPP Unit 3. The presence of this hazard can be addressed by implementation of measures to protect the control room operators from accidental releases, if features are included in the plant design to (Ref. [8-36]):

(1) provide capability to detect such releases;
(2) isolate the control room if there is a release;
(3) make the control room sufficiently leak tight; and
(4) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators.

Clearly, technical solutions are available to protect the Unit 3 control room from potential releases of sulfuric acid, either from ANPP Unit 2 or accidental releases from railroad shipments, and this need not represent a site suitability issue. The same should be true for any hazardous cargoes shipped on Highway M-5.

8.6.3 Explosions

US NRC Regulatory Guide 1.91 (Ref. [8-37]) provides guidance for evaluation of explosive hazards. Formula (1) of the Regulatory Guide provides a means to calculate a conservative safe distance to explosive hazards based on equivalent amounts of the explosive trinitrotoluene (TNT). Safe distances calculated using Formula (1) for selected amounts of TNT are given in Table 8-9. The values of 23,000 kg and 50,000 kg are given by the Regulatory Guide as representative of highway trucks and railroad box cars, respectively. Distances to Highway M-5 (4 km) and the Yerevan-Tblisi railway (7 km) exceed by a large margin the distances in Table 8-9; thus the ANPP site is not at risk from explosions on these transportation routes.

The onsite diesel fuel storage is in underground tanks and therefore does not represent explosion hazards for the site. For the same reason, the gasoline and diesel fuel associated with filling stations indicated in Table 8-5, by the nature of storage and distance from the site do not present an explosive hazard to Unit 3.

8.6.4 Other Human-Induced Events

In addition to the three main types of external human induced events discussed above, there may be other types of interacting events which can result from external human induced events. Fires are one such type which may be common to a number of external human-induced events. Ref. [8-38]

There are no nearby forests or vegetation that could support a major wildfire in the site vicinity. Potential sources of fuel are identified in Tables 8-4 through Table 8-6. In

addition, as mentioned above, a natural gas pipeline supplies the auxiliary boiler on the ANPP site. IAEA guidance NS-G-3.1 suggests a screening distance value of 1 – 2 km for hazards of fires that may affect items important to safety. The only sources meeting this criterion are those on the ANPP site, specifically the diesel fuel storage tanks and the natural gas pipeline that serve Unit 2.

Detail on the routing of the natural gas pipeline or the location of the diesel storage tanks was not available, but the reserve boiler and the diesel generator buildings are on the far side of the Unit 1 and Unit 2 main building from where Unit 3 will be situated (see Figure 2.1-4 and building legend in Table 2.1-1).

Since design features of fuel supplies include protection against ignition of stored fuels, or uncontrolled releases of gas from pipelines, large exposure fires from these sources are highly unlikely. ANPP Unit 2 procedures control ignition hazards, such as hot work, to minimize the potential for starting of fires. In any case, the site fire protection plan provides for rapid response to any on-site fire to extinguish and limit its effects.

Based on typical design features and administrative controls established at nuclear plant sites to prevent and minimize the effects of fires, there is no reason to consider the presence of fuels on the ANPP site as hazards presenting a site suitability concern.

Table 8-1, Calculation of Population Densities

Distance from ANPP (km)	4 - 5	5.1 - 7	7.1 - 10	10.1 - 15	15.1 - 20	20.1 - 30
Estimated 2020 Population [(a)]	15,000	10,000	71,000	120,000	90,000	210,000
Population to radial distance	15,000	25,000	96,000	216,000	306,000	516,000
Radial Area (km^2)	79	154	314	707	1,257	2,827
Population Density (person/km^2)	191	162	306	306	244	182

[(a)] 2055 high population values from Table 2.5-9, corrected to 2020 with average forecast values used for Figure 2.5-3, rounded to two significant digits.

Table 8-2, Thunderstorms at ANPP Site [(a)]

Month	Average	Maximum
1	0	
2	0.03	1
3	0.5	4
4	2.4	8
5	6.5	16
6	6	19
7	3.1	9
8	1.7	8
9	1.7	10
10	1	6
11	0.3	2
12	0	
Annual	23	61

[(a)] ANPP SAR, Ref. [8-16]

Table 8-3, Toxic or Dangerous Chemicals [(a)]

Acetaldehyde	Fluorine
Acetone	Formaldehyde
Acrylonitrile	Halon 1211
Anhydrous ammonia	Halon 1301
Aniline	Helium
Benzene	Hydrogen cyanide
Butadiene	Hydrogen sulfide
Butene	Methyl alcohol
Carbon dioxide	Nitrogen (compressed or liquified)
Carbon monoxide	Sodium oxide
Chlorine	Sulfur dioxide
Ethyl chloride	Sulfuric acid
Ethyl ether	Vinyl chloride
Ethylene dichloride	Xylene
Ethylene oxide	

[(a)] Ref. [8-20]

Table 8-4, Existing Chemicals on the ANPP Site in Excess of 9 kg [(a)]

	Name	At any given time	Storage conditions
1	H_2SO_4	1,000 tonne	Steel, cylindrical, insulated containers
2	NH_3	100 kg	Steel containers in isolated room
3	H_2	39 kg	Steel containers
4	N_2	1,860 m^3 (gas)	Recipients, receivers
5	Diesel	16,500 kg	Steel tanks, underground

[(a)] Ref. [8-21]

Table 8-5, Chemical and Fuel Storage Facilities within 8 km of ANPP

Community name	Requested chemicals existing	Diesel oil and gasoline filling stations	Diesel oil and gasoline depository
Armavir Marz (Ref. [8-24])			
v. Aknalich	no	no	no
t. Metsamor	no	3	no
v. Haytagh	no	no	no
v. Ferik	no	no	no
v. Arshaluys	no	2	no
v. Taronik	no	no	no
v. Mayisyan (Jdanov)	no	1	no
v. Tsaghkalanj	no	no	no
v. Zartonk	no	1	no
Aragatsotn Marz (Ref. [8-25])			
v. Nor Yedesia	No	No	no

Table 8-6, Chemicals Transported by Railway through Armavir Marz in 2007 Ref. [8-26]

Load		Sulfur-ic acid	Anhydrous ammonia	Gasoline	Diesel oil	Fuel SU-1	Total
January	Shipments	0	0	156	159	79	394
	tonne	0.00	0.00	10079.00	10976.60	5458.31	26513.91
February	Shipments	11	2	217	103	103	436
	tonne	734.00	68.00	13753.40	7113.00	6594.50	28262.9
March	Shipments	1	0	264	59	67	391
	tonne	60.00	0.00	17215.20	4328.50	4446.60	26050.3
April	Shipments	14	1	254	144	73	486
	tonne	937.50	40.00	17209.90	10320.80	4418.10	32926.3
May	Shipments	0	2	182	114	124	422
	tonne	0.00	62.00	12334.60	8240.70	8067.70	28705
June	Shipments	7	0	232	138	61	438
	tonne	469.00	0.00	13882.70	9241.90	4084.50	27678.1
July	Shipments	0	2	158	159	69	388
	tonne	0.00	54.00	9974.40	10763.00	4185.70	24977.1
August	Shipments	0	2	334	169	69	574
	tonne	0.00	55.00	20594.10	11482.90	4178.10	36310.1
September	Shipments	6	2	255	178	70	511
	tonne	400.00	68.00	15050.40	10945.70	4412.40	30876.5
October	Shipments	0	1	287	111	70	469
	tonne	0.00	29.00	17618.60	7402.49	4191.10	29241.19
November	Shipments	0	0	208	164	7	379
	tonne	0.00	0.00	12442.10	11553.60	441.90	24437.6
December	Shipments	0	2	294	164	101	561
	tonne	0.00	64.00	17294.00	10974.00	6807.00	35139
Total	Shipments	39	14	2841	1662	893	5449
	tonne	2600.5	440.00	177448.40	113343.19	57285.91	351118.00

Table 8-7, Aircraft Accident Rate Calculation

	Number	Percent
Climb accidents 1997-2006 [(a)]	10	11%
Initial Approach 1997-2006 [(a)]	9	10%
Total Climb & Initial Approach	19	21%
10-Year Accident Rate per departure [(b)]	1.2E-06	
Zvartnots flights from/to West, 2008 Q1 [(c)]	2875	84%
Takeoff toward West	1197	70%
Approach from West	1678	98%
Calculated Zvartnots rate, climbing to West	9.2E-08	
Calculated Zvartnots rate, initial approach from West	1.2E-07	
Calculated total accident rate per departure	2.1E-07	
Estimated annual accident rate to West of Zvartnots	2.4E-03	
Assumed rate of incursion into no-fly zone, per year	1.0E-02	
Area of semicircle from runway (r = 19.9 km) km^2	622	
Critical Area of Site, km^2 [(d)]	0.3	
Estimated accident rate at site, per year	1.2E-08	

[(a)] Ref. [8-32]
[(b)] Ref. [8-33]
[(c)] Ref. [8-29]
[(d)] Table 3.2A-1, Item 17.2.4 plus item 3.5.1

Table 8-8, Limiting Amounts of Chemicals in ANPP Unit 3 Vicinity (kg) [(a)]

Chemical	Limiting Concentration mg/m^3 [(b)]	Distance from Control Room (km)		
		0.5 to 0.8	3.2 to 4.8	6.4 to 8.0
Anhydrous ammonia	210	4,300	620,000	4,200,000
Sulfuric acid	15	310	44,000	300,000

[(a)] assuming CR exchange rate = 0.06 per hour, using method of RG 1.78, Appendix A
[(b)] RG 1.78, Table 1

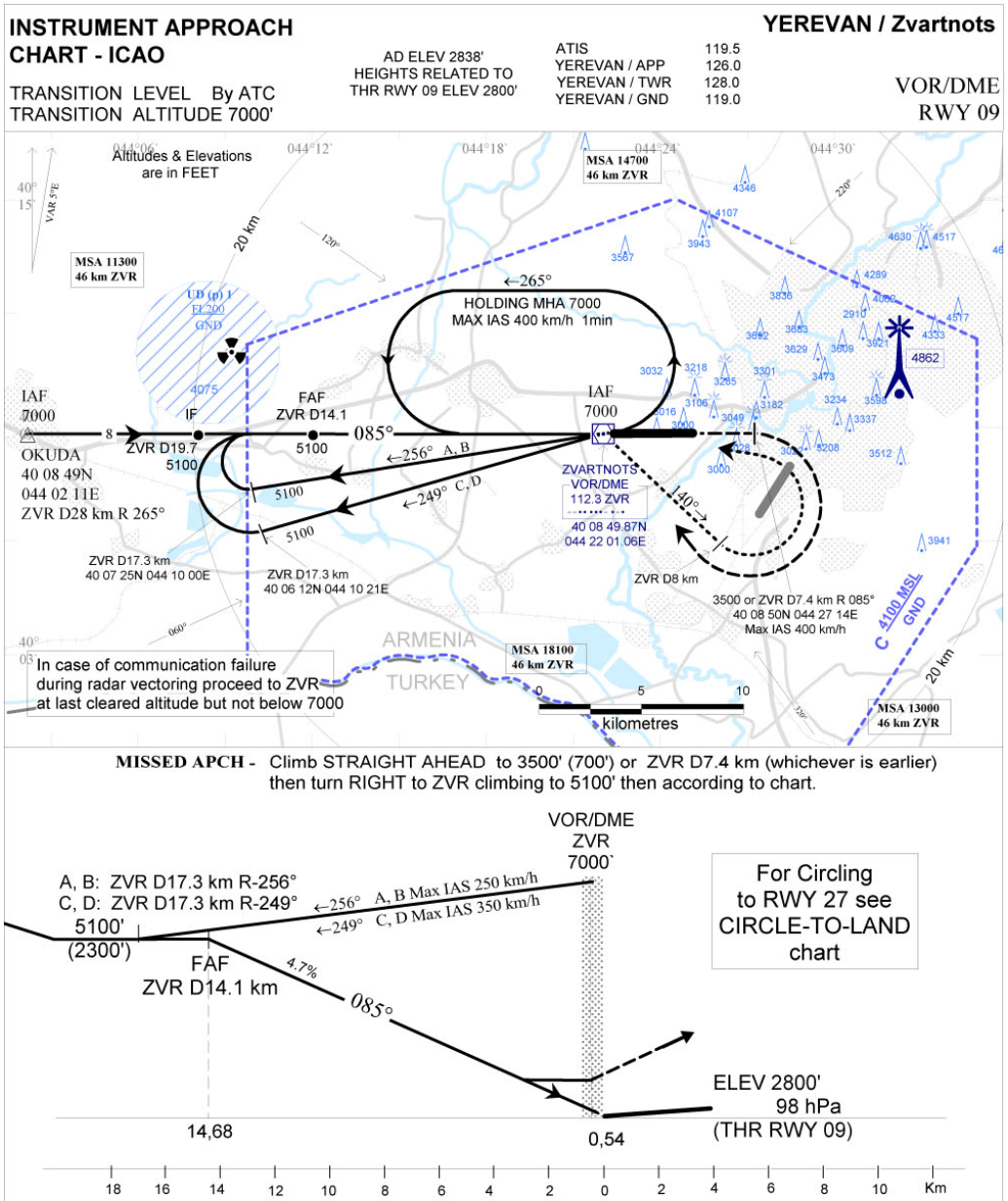
Table 8-9, Limiting Safe Distance from Explosive Hazards

W (kg) of TNT Equivalent	Distance, R (m)[(a)]
100	84
1,000	180
23,000	510
50,000	660

[(a)] $R > 18*W^{1/3}$

Figure 8-1, Administrative Boundary of Armavir Town closest to ANPP

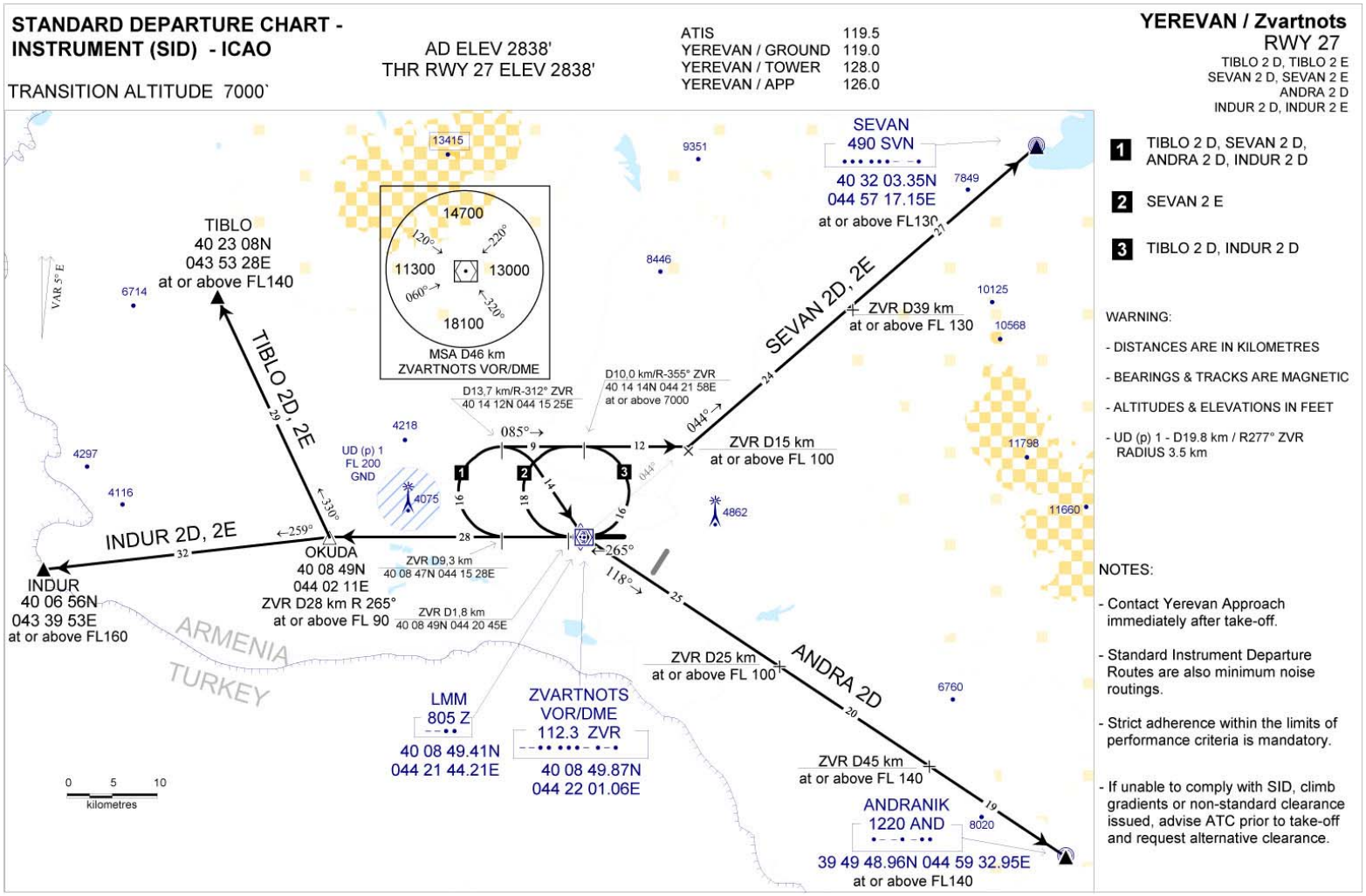
Figure 8-2, Aircraft Approach Chart, Zvartnots Runway 09



Cat of ACFT		OCA/H A	B	C	D	Final Approach Distance km-s	DME 13	DME 11	DME 9	DME 7	DME 5	DME 3	DME 1
Straight-in Approach	VOR/DME	3210' (410')				ALT (HGT)	4925' (2125')	4620' (1820')	4315' (1515')	4005' (1205')	3700' (900')	3395' (595')	3090' (290')
Circle-to-land		3500' (660')		3630' (790')									
Ground Speed	km/h	150	180	210	240	270	300	330	360	390			
Rate of Descent grad. 4.7 %	m/sec	1.9	2.3	2.7	3.1	3.5	3.9	4.3	4.7	5.1			
	ft/MIN	380	460	530	610	690	770	840	930	1010			

MAPt - VOR ZVR

Figure 8-3, Aircraft Departure Chart, Zvartnots Runway 27



REFERENCES:

[8-1] United States Nuclear Regulatory Commission (US NRC), 1996, Title 10 Code of Federal Regulations, Part 100 *Reactor Site Criteria*, Subpart B *Evaluation factors for Stationary Power Reactor Site Applications on or after January 10, 1997,* § 100.20, *Factors to be considered when evaluating sites* (10 CFR 100.20).

[8-2] International Atomic Energy Agency (IAEA), 2003, NS-R-3, *Safety Requirements, Site Evaluation for Nuclear Facilities*, Section 2.1.

[8-3] IAEA, 2003, NS-R-3, Paragraph 2.29.

[8-4] US NRC, 1998, Regulatory Guide 4.7, Revision 2, *General Site Suitability Criteria for Nuclear Power Stations*, Appendix A, *Site Safety Considerations for Assessing Site Suitability for Nuclear Power Stations*, Regulatory Position A.4.

[8-5] US NRC, 1996, 10 CFR 100.3, *Definitions*.

[8-6] US NRC, 2002, 10 CFR 100.11, *Determination of exclusion area, low population zone, and population center distance*.

[8-7] US NRC, 2008, 10 CFR 100.21, *Non-seismic siting criteria*.

[8-8] US NRC, 1998, RG 4.7, Regulatory Position 5.

[8-9] Government of Armenia (GoA) Resolution № 2328-N dated December 22, 2005, *On the Approval of the National Plan for the Protection of the Population in the Event of a Nuclear and (or) Radiation Accident at the Armenian Nuclear Power Plant (External Emergency Plan for the Armenian Nuclear Power Plant)*, as amended by GoA Resolution № 194, dated January 17, 2008, *On Making Amendments in the RoA Government Decree No. 2328-N, dated December 22, 2005*.

[8-10] GoA Resolution № 2328-N as amended by GoA Resolution № 194, dated January 17, 2008, Appendix 1, paragraph 2.

[8-11] GoA Resolution № 2328-N as amended by GoA Resolution № 194, dated January 17, 2008, Appendix 1, paragraphs 12 and 13.

[8-12] GoA Resolution № 2328-N as amended by GoA Resolution № 194, dated January 17, 2008, Appendix 1, paragraph 16.

[8-13] US NRC, 1998, RG 4.7, Regulatory Position 6.

[8-14] US NRC, 1996, 10 CFR 100.20, *Factors to be considered when evaluating sites,* paragraph (c)(2).

[8-15] ATOMENERGOPROYEKT, 2000, *Armenian NPP, Unit 2, Essential Service Water Cooling System, Substantiation of Safety*, Section 8.2.2.1.

[8-16] CJSC "ANPP", 2007, *Safety Analysis Report on Power Operation Unit No. 2 at the ANPP*, Table 1.4-4, item 6.5.

[8-17] US NRC, 1996, 10 CFR 100.20, *Factors to be considered when evaluating sites,* paragraph (c)(3).

[8-18] US NRC, 1998, RG 4.7, Regulatory Position 8.

[8-19] IAEA, 2003, NS-R-3, Paragraph 3.51.

[8-20] US NRC, 2001, Regulatory Guide 1.78, Revision 1, *Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release*, Table 1.

[8-21] CJSC "ANPP" Letter dated May 06, 2008, Code 07-190, G. Markosyan, Director to A. Galstyan, Deputy Minister of Energy and Natural Resources.

[8-22] CJSC "ANPP" Letter dated 06.06.2008, G. Markosyan, Director to A. Galstyan, Deputy Minister of Energy and Natural Resources.

[8-23] PA Consulting, 2008, *Initial Planning Studies for a New Nuclear Unit at the ANPP Site*, Chapter 5.

[8-24] Marzpet of Armavir Marz, Letter dated 13.05.2008, N 1109, A. Ghahramanyan, Marzpet to A. Movsisyan, Minister of Energy and Natural Resources.

[8-25] Marzpet of Aragatsotn Marz, Letter dated 05.08.2008, N 1260, G. Gyozalyan, Marzpet to A. Movsisyan, Minister of Energy and Natural Resources.

[8-26] Ministry of Transportation and Communications, Letter dated 16.05.2008, N 01-07/1792, G. Sargsyan to A. Movsisyan, Minister of Energy and Natural Resources.

[8-27] eAIP 1st Edition, URL: http://www.armats.com/rus/sai/products/eaip/html/UD-AD-2.UDYZ-en-GB.html,

Specific files at:

http://www.armats.com/rus/sai/products/eaip/graphics/UDYZ_AD_2-2-21-53.pdf

and

http://www.armats.com/rus/sai/products/eaip/graphics/UDYZ_AD_2-2-29-53.pdf.

[8-28] IAEA, 2002, Safety Guide No. NS-G-3.1, *External Human Induced Events in Site Evaluation for Nuclear Power Plants*, Paragraphs 5.1 to 5.3.

[8-29] Department of Civil Aviation of the Government of Armenia, Letter dated April 30, 2008, Coded 05-394, A. Movsesyan to A. Movsisyan, Minister of Energy and Natural Resources.

[8-30] IAEA, 2002, NS-G-3.1, Para 5.4, footnote 11.

[8-31] IAEA, 2002, NS-G-3.1, Para 5.6.

[8-32] Boeing, 2006, *Statistical Summary of Commercial Jet Airplane Accidents Worldwide Operations 1959-2006,* p 21, *Fatal Accidents and Onboard Fatalities by*

Phase of Flight Worldwide, Commercial Jet Fleet – 1997 Through 2006. Full report available at URL: http://www.boeing.com/news/techissues/pdf/statsum.pdf.

[8-33] Boeing, 2006, p 19, *10-Year Accident Rates by Type of Operation, Fatal and Hull Loss Accidents –Worldwide Commercial Jet Fleet – 1997 Through 2006*.

[8-34] US NRC, 2001, RG 1.78, Appendix A.

[8-35] US NRC, 2001, RG 1.78, Regulatory Position 1.2.

[8-36] US NRC, 2001, RG 1.78, Regulatory Position 4.

[8-37] US NRC, 1978, Regulatory Guide 1.91, Revision 1, *Evaluations of Explosions Postulated to Occur on Transportation Routes near Nuclear Power Plants.*

[8-38] IAEA, 2002, NS-G-3.1, Paragraphs 8.1 through 8.9.

Environmental Background Information Document

Chapter 9: Alternatives to the Proposed Action

October 2008

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9. ALTERNATIVES TO THE PROPOSED ACTION

This chapter presents the evaluation of alternatives to a new unit at the ANPP site. Alternatives considered include:

- No-Action Alternative;
- Alternatives Not Requiring New Generating Capacity;
- Alternatives Requiring New Generating Capacity;
- Alternative Sites.

Various aspects of alternatives are discussed including economic and technical feasibility as well as implications of alternatives with respect to the Energy Sector Development Strategy adopted by the Government of Armenia on June 23, 2005.

The no-action alternative is the case when a new nuclear power plant is not constructed in Armenia. This alternative is analyzed in Section 9.1 from the point of view of economic consequences that will occur if the no-action alternative is preferred.

Alternatives not requiring new generating capacity include combinations of increased import export electricity exchanges, measures to smooth out annual demand curves to make better use of existing generating capacities, energy efficiency and conservation. These measures should be considered as a complement to other alternatives to reduce the need for additional generating capacity, rather than a standalone solution to the forthcoming shortage in supplies. This alternative is discussed in Section 9.2.

Alternatives requiring new generating capacity include the development of natural gas-fired power plants or combined cycle power plants capable of satisfying base load, together with development of hydro projects. This alternative is discussed in Section 9.3.

The option of alternative sites for the new nuclear plant is addressed in Section 9.4.

9.1 NO-ACTION ALTERNATIVE

The no-action alternative refers to a case where according to the intentions of the Armenian Ministry of Energy, Unit 2 of the existing Armenian Nuclear Power Plant (ANPP) discontinues its operation in the fourth quarter of 2016 and its decommissioning activities begin after shutdown (Ref. [9-1]), while at the same time, no replacement NPP is planned to be in operation by that time.

In the Armenia Power Sector Least Cost Generation Plan“ prepared in 2006, the forecast of energy and required generating capability has been done. Ref. [9-2]. Table 9-1 displays the matrix of demand growth and system development scenarios and necessary capacity additions to the system from that Plan.

Table 9-1, Power system development and associated capacity requirements (Ref. [9-1])

Scenario Assumptions	Necessary capacity additions
ANPP retirement in 2015[1] Peak demand low growth scenario – 1,9% 30% system capacity margin	additional 70 MW capacity needed by 2025
ANPP retirement in 2015 Peak demand reference growth scenario – 2,7% 30% system capacity margin	additional 100 MW needed by 2015 and 450 MW by 2025
ANPP retirement in 2015 Peak demand high growth scenario – 3,4% 30% system capacity margin	additional 360 - 940 MW of capacity will be needed between 2015 - 2025
ANPP retirement in 2015, TPPs retired by 2020 Peak demand low growth scenario – 1,9% 30% system capacity margin	additional 960 – 1430 MW of capacity needed between 2015 - 2025

The scenario under which 1430 MW capacity addition is required assumes low peak demand growth and decommissioning of ANPP by 2015 and Yerevan and Hrazdan TPPs by 2020. This is a realistic assumption given the fact that all currently operating units of Hrazdan and Yerevan TPPs will be at the end of their design lifetime by then. Part of the 1430 MW capacity shortage is expected to be compensated by planned construction of Hrazdan TPP Unit 5 (400 MW) and re-equipment of Yerevan TPP (225 MW) with combined cycle gas turbine technology.

According to Public Services Regulatory Commission (PSRC), ANPP in 2007 produced around 40% of total electricity generated in Armenia or 2265 million kWh. Ref. [9-3]. The shutdown of ANPP Unit 2 will take a significant amount of baseload electricity production capacity out of the power system.

Armenian TPPs fueled by natural gas supplies from Russia and Iran are capable of generating baseload electricity year round subject to reliability of gas supplies.

Hydro power plants generate a significant share within the electricity production mix. Their capability to provide baseload electricity is weak, however, due to the seasonal nature of their operation with high generation in spring high-water season and low generation in winter time. This fact is important because the Armenian power sector is dominated by residential consumers and the system peak is during the winter heating season.

This fact is important because the Armenian power sector is dominated by residential consumers and the system peak is during the winter heating season.

[1] Although the official position is that the unit 2 shut down is due end of 2016, in a number of early studies a different due date is used, e.g. in LCGP 2006 end of 2015 is specified.

It is possible to expand to a greater scale the existing practice of electricity swap with Iran. Namely, exporting excess electricity in spring/summer and importing from Iran in winter time. In this case, the hydro power resource together with proper import/export scheduling can somewhat mitigate the consequences of ANPP Unit 2 shutdown. This option requires increasing the transmission capacity between countries and the availability of new generating capacities in Iran. This option is not feasible because of the growing domestic demand for electricity in Iran and the fact that 90 percent of Iran's electrical generation is gas fueled and therefore subject to the same fuel price escalation as would be expected in Armenia. Also, one of the basic principles of the energy sector development strategies is: "Avoiding methods of energy import that might expose the security and economy of Armenia to events, political impacts beyond the control of the Republic of Armenia". Ref. [9-4]

The energy shortage created by ANPP Unit 2 shutdown in 2016, in the short-run, will have to be compensated by existing Hrazdan and Yerevan TPP's reserve capacities. However, electricity generated by the TPPs is very expensive due to the obsolete and by current standards inefficient equipment coupled with rising prices for natural gas. The problem of low thermal efficiencies of the TPPs can be mitigated with future introduction of combined cycle technology at Hrazdan 5 and Yerevan TPPs.

In the long-run, after 2020 when the existing TPPs are expected to be retired, the no-action alternative will likely result in the power system being deficient in generating capacity. With current demand growth rates, which so far have been within the LCGP-forecasted band, a major concern is the possibility of electricity shortages and possible blackouts of residential and other consumers due to the system's inability to meet demand. Demand reductions may be necessary for continued 24 hour operation of the power system. Reducing demand is possible by introducing a higher tariff for electricity or a progressive tariff. Progressive tariff schemes charge customers a greater tariff for the consumption in excess of certain specified limit, thus creating extra stimulus for conservation. Increased electricity tariffs will become an added cost to domestic economy.

Another issue of concern is the forgone electricity export opportunity to neighboring countries. This may become a future cost in the form of an increased trade deficit. The trade deficit may be greater if future shortages in domestic supply will be compensated by imports from neighboring countries.

Main baseload generation capacities of the Armenian power sector are going to be decommissioned (ANPP) or at the end of their lifetime (Yerevan TPP, Hrazdan TPP) in the coming years. The no-action alternative to a new NPP may be an economically expensive option in the long run. The no-action alternative will likely result in a need for increased electricity imports from Iran and measures to reduce the domestic power demand. This option should be considered with respect to GoA energy policy goals of achieving sustainable economic development and enhancing energy independence postulated in the Energy Sector Development Strategy adopted by the Government of Armenia on June 23, 2005 (Ref. [9-5]).

9.2 ALTERNATIVE NOT REQUIRING NEW GENERATING CAPACITY

This alternative would satisfy the projected demand for electrical energy without constructing new generating capacity.

As advised in US NRC NUREG 1555, "Standard Review Plans for Environmental Reviews for Nuclear Power Plants", among possible considerations to accomplish this task the following options must be discussed: power purchases from other utilities (countries) or

power generators, reactivation or extended service life of plants within the power system in combinations that should provide a supply alternative to the proposed project, the potential for energy conservation or demand management measures that would be equivalent to the output of the proposed project. Ref. [9-6].

Georgia is a net importer of electricity. Nowadays, Georgia imports electricity from Russia, Armenia, and Turkey and exports a small portion to Azerbaijan. Ref. [9-7]. Domestic production in Georgia is seasonal because their main generators are hydro power plants. Disruptions in electricity supply to consumers in Georgia happen on a frequent basis. There is no evidence to believe that by 2020 Georgia will have the domestic capacity to export electricity to Armenia on the required scale. The possibility of exporting electricity supplies from Russia or Turkey to Armenia via Georgia must be studied in context of development plans of regional power transmission systems and Armenian energy security requirements.

The power sector of Iran is well developed with many existing and new generating units under construction. The LCGP identifies plans to construct a new 400 kV two-circuit line from Armenia to Iran (Hrazdan TPP - Shinuair-Ahar). Armenian electricity demand is only a small portion of Iranian demand. However, even when the new transmission line is in service, it is not reasonable to assume that Iran will have the capacity to export the required amount of electricity to Armenia. The electrical demand in Iran has been growing at a rate of almost 9% per year over the period 2001 through 2006 and during the same period, electricity generation in Iran has grown at about 7.5% per year (Ref. [9-8]). It is unlikely that Iran will be in position to export significant amounts of electricity.

The opportunity may exist to partially mitigate the future electricity shortage in Armenia with the use of Iran-Armenia interconnection in spite of high domestic power demand in Iran due to different demand peaking seasons in Armenia and Iran. Armenia experiences its peak demand in the winter heating season, while Iran's peak demand is in summer. Summer peak load in Iran is approximately 50% higher than the winter peak. Ref. [9-9]. The difference in peak demand periods creates the opportunity for Armenia to export in summer and import in winter. This practice is currently implemented with the electricity swap contract that exists between Armenia and Iran. Ref. [9-10].

In summer, the Armenian power system experiences low demand for electricity. According to the LCGP forecast presented in Table 9-2, this pattern of summer low demands will follow into the future with a 888 MW summer low in 2030. Iran has significant reserve generating capacity in the wintertime. New transmission lines are under construction between Armenia and Iran with transmission capacity totaling 1000 MW. It is feasible to partially compensate for the 2016 ANPP Unit 2 shutdown with increased imports from Iran in wintertime and satisfying summer demand by domestic hydro plants and gas-fired combined cycle plants that are expected to be commissioned at Hrazdan and Yerevan TPPs. Economic costs of this option are hard to estimate due to absence of established tariffs for electricity trade between the two countries. However, a rough calculation suggests that if the annual generation of ANPP had to be fully substituted by imports of electricity from Iran, the annual value of the imports would be approximately equivalent to 760-830 million m^3 of natural gas. This alternative has the same economic and environmental problems as producing the electricity from TPPs in Armenia. This alternative will also create strong economic and energy dependence on Iran. Iran is experiencing diplomatic difficulties with western countries and the prospect of Armenia's heavy dependence on Iran could link Armenia with Iran's political stances. The implementation of this option would expose the security and economy of Armenia to events and political impacts beyond the control of the Republic of Armenia. Therefore, this

option will run counter to the basic principles of the energy sector development strategies of GoA (Ref. [9-5]).

Table 9-2, LCGP Reference Scenario Electric Demand Forecast (2017-2030) (Ref. [9-1])

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Total Domestic Consumption (GWh)	5876	6112	6357	6612	6877	7153	7439	7738	8048	8371	8706	9056	9419	9796
Peak Load (MW)	1733	1785	1839	1895	1952	2011	2071	2134	2198	2264	2333	2403	2475	2550
Minimum Load (MW)	533	554	576	599	623	649	675	702	730	759	789	821	854	888

The project to reactivate the abandoned Hrazdan Unit 5 is underway. The project is owned and implemented by ArmRusGaprom and the plan is to convert the 5th unit into natural gas-fired combined cycle power plant with installed capacity of 400 MW. This project will contribute to the Armenian power system by adding to its generating fleet a high fuel-efficient unit. This project is intended to substitute for the aging units of Hrazdan TPP and thus in the long-run will not offset the impacts of ANPP Unit 2 shutdown.

A similar replacement project to build a new combined cycle plant at the aging Yerevan TPP location is also planned, but as with Hrazdan 5, will replace other existing capacity rather than offset the ANPP Unit 2 shutdown.

The option of extending the service life of ANPP unit 2 was discussed in LCGP 2006:

“An alternative to the construction of new generation capacity is the life extension of the ANPP beyond 2015. Russian experts believe that the service life of similar units may be extended for about 15 years, i.e. until 2031 for ANPP. The ANPP experts/staff are exploring the feasibility of extending the life of the plant by 20 years to 2035. Life extension projects are being pursued at similar design plants at Novovoronezh and Kola NPPs in Russia.”

“It is estimated that ANPP life extension costs will be between $100 and $300 million and most of this money would need to be spent in 2013-2018 timeframe, for a life extension beyond 2015. For the 2005 LCGP analysis, a life extension cost of $50 million per year from 2013 to 2018 is assumed.” Ref. [9-11].

This alternative would solve the problem of power capacity shortage for domestic consumption. The opportunity to export electricity to neighboring countries will be lower than with a new 1000 MW unit. It can be expected that this scenario will be opposed by the EU. The EU has repeatedly expressed its position that decommissioning of old Soviet-design rectors should not be postponed. Ref. [9-12].

In the Feasibility Study Report to the RoA Government published in 1998, issues on development of the power sector of the Republic of Armenia for the period of 1999-2020 were discussed. One of the suggested options of nuclear energy development was the reactivation of ANPP unit 1. The cost of rehabilitation was estimated to be 200 million USD, the duration of rehabilitation - 3 years and the remaining life 15-18 years. It was also

mentioned that the experience of rehabilitation of Unit 2 demonstrated that in reality the necessary safety upgrades to the old Soviet-design facility may actually boost the costs of such a project drastically. In summary of conclusions to that report it is stated: ”From the position of the long-term plan for development of the RoA power sector, the rehabilitation and re-commissioning of the first unit of ANPP is impossible.” Ref [9-13].

The idea that RoA has limited domestic energy resources and hence, should adopt a rigorous nationwide energy efficiency and conservation policy has been repeatedly stressed by government officials. There are a number of sectors where inefficiencies exist. An example is residential consumers, which represent a major consumer group and still employ practices of inefficient resistance heating and hot water preparation. The gasification process that is underway is offsetting this practice with residents switching to natural gas-fired boilers and heaters. However, many families still cannot afford the fuel substitution. Centralized heating and hot water projects are in the planning stage for some districts, but their impact on electricity demands has not been studied.

It is known that the Armenian power system is experiencing its highest demand in wintertime due to high heating and lighting loads. It is expected that countrywide substitution of electric resistance heating with gas-fired heating will significantly reduce the wintertime power system load. It is advisable to conduct a study to determine the effect on the power system of resistance heating substitution. However, it is unlikely that such a substitution could come close to offsetting the loss of generation from ANPP Unit 2.

9.3 ALTERNATIVES REQUIRING NEW GENERATING CAPACITY

This section describes the alternative to a new NPP in the form of new non-nuclear generating capacity. Because fossil fuel imports to RoA are predominantly limited to natural gas, it is assumed that as an alternative to a new NPP, a gas-fired thermal plant would be considered. The other locally available energy resource in Armenia is the hydro. Potentially, a large hydropower plant with high capacity factor could also substitute for a new NPP.

In the ”Armenia Power Sector Least Cost Generation Plan 2006“ a discussion of future capacity additions summarizes the following perspectives:

“Since coal, wind and solar were not found to be viable generation options to meet base load requirements for Armenia, only gas fired, hydro, and nuclear generation options were analyzed in the LCGP process. The natural gas-fired options include completing Hrazdan as a combined cycle unit, creating a new combined cycle unit, or developing new small gas turbines. The new hydro generation options included Shnokh (70 MW), Megri (140 MW), and Lori-Berd (68 MW).“ Ref. [9-14].

Converting Hrazdan Unit 5 into a combined cycle gas fired power plant is a necessary development for Armenian power system. Unit 5 was designed to be a simple cycle power plant running on mazut (fuel oil). Due to the collapse of the Soviet Union, the project was abandoned. After the transfer of Hrazdan TPP to ArmRusGasprom in the assets against natural gas debt deal, the company decided to modify Unit 5 into a combined cycle natural gas-fired plant. As was mentioned earlier, the existing generating units of Hrazdan TPP are approaching the end of their design life and aging equipment reduces efficiency and they need to be replaced. Currently Hrazdan TPP Units 1, 2, 3, and 4 have gross dependable capacity of 1030 MW. Ref [9-15]. The new Unit 5 is planned to be 400 MW. Unit 5 will only be able to substitute for a part of current total generating capacity of 1030 MW when the retirement dates of the four aging units approach. Hence, it is possible to assume that attempts to extend the life of one or two old units will be made. It is likely that

retirement of the two units with least depreciation will be postponed and life extended, but not for long. These units utilize deteriorated equipment so the cost of generation will be high, coupled with high natural gas prices. In Section 9.2, it is mentioned that Hrazdan Unit 5 is not a substitute for ANPP as it will replace the aging units.

The possibility of a major hydropower project to partly substitute for the capacity of ANPP after its shutdown is considered for 3 major hydro projects currently being developed: Megri HPP, Shnokh HPP and Lori-Berd HPP. On the basis of recent information provided by Hydroproject CJSC on three projects, the plant capacity factors were calculated:

- Megri (128 MW), annual generation 774 mln kWh, plant capacity factor 70%;
- Shnokh (75 MW), annual generation 300 mln kWh, plant capacity factor 45%;
- Lori-Berd (65 MW), annual generation 200 mln kWh, plant capacity factor 35%.

Megri HPP has comparatively high capacity factor, which means that the plant will be able to generate electricity steadily throughout the year, similar to ANPP. However, a 70% capacity factor is still not close to the capacity factors of modern NPPs which exceed 90%, meaning that the generation will likely drop during the winter time. Installed capacity for all 3 plants is small in comparison to the expected shortage in generating capacity. This means that the winter peak capacity demand problem is not solved by the large HPP projects under development. Still, the benefit of large hydro projects for Armenian power system is not to be underestimated.

A main non-nuclear alternative to a new nuclear unit in Armenia is the construction of new natural gas-fired simple steam cycle or combined cycle turbine (CCT) power plants. The construction of a combined cycle thermal power plant in Armenia will be technically and economically more feasible than the nuclear scenario due to number of factors. With two combined cycle projects underway, Hrazdan TPP Unit 5 and Yerevan TPP, there will be enough experience in Armenia to organize and implement a similar project. The transportation of equipment to Armenia will be easier than for the nuclear option, as equally sized CCT power plants do not have components of such weight as a reactor pressure vessel. The initial capital costs are much lower compared to an NPP. The construction time is shorter, so less interest during construction should be paid to creditors.

However, the option of constructing a new combined cycle thermal power plant raises the question of energy security. Relying solely on natural gas supplies makes the Armenian economy and government more susceptible to political turbulence in the region. The current agreement with Iran for electricity exports in exchange for gas imports allows for profit margin if a high efficiency CCT technology is used. It is of high importance to decision makers and investors to know for how long this agreement will be in force.

The environmental aspects of operating a large TPP include the emissions of CO_2, NOX and SO_2 in significant amounts. NPPs do not have similar emissions, except for comparatively insignificant emissions due to operation of diesel generators and auxiliary boilers. Modern technologies like selective catalytic reducers allow partial reduction of certain emissions. However, the emissions of CO_2, that are not controlled, remain a major concern from the climate change point of view. According to US Environmental Protection Administration, the average emissions from gas-fired generation in the US is 0.6 kg CO_2/kwh. A new gas-fired CCT would have better efficiency than the average, so emissions would be about 0.4 kg CO_2/kwh. On this basis, operating a 1000 MW NPP at 90% capacity avoids 3.16 billion kg of CO_2 emissions per year.

It is believed among part of scientific community that increasing anthropogenic emissions of CO_2 and other greenhouse gases during the last century and into 21st century is causing increases in temperature of the atmosphere. The change in average temperature of the atmosphere is believed to be precursor to catastrophic manifestations of nature.

In 1997 the Kyoto protocol was adopted to set binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions. Agreed reductions amount to an average of five per cent against 1990 levels over the five-year period 2008-2012. Ref. [9-16].

Currently RoA has no obligations within the framework of Kyoto protocol to reduce CO_2 emissions. However, in the context of global environment and climate change, measures to reduce CO_2 emissions are advocated on permanent basis around the world. From this standpoint, nuclear energy is viewed by many experts as one of the remedies for reducing global CO_2 emissions and mitigating climate change. The production of electricity with the use of nuclear fission does not generate CO_2.

A combined cycle gas-fired power plant is a lower capital cost alternative to an NPP. However, it is less favorable from point of view of energy independence and regional and global pollution. Consideration of this alternative needs to be considered in the context of Armenia's energy policy goals of energy independence that include recommendations for diversification of imported energy resources. Ref. [9-17].

9.4 ALTERNATIVE SITES

During the preparation of the EBID no detailed comparison of different plant sites was done. However, this section discusses earlier studies of potential sites for locating nuclear facility.

The site selection for the existing ANPP was conducted during the preliminary design stage for Units 1 and 2 on the basis of surveys and studies. Out of a number of candidate sites, the current ANPP site was given preference. There are no other locations in Armenia that have been studied as thoroughly as the current site for building a nuclear facility. The research of seismic fitness of the current site is the most extensive and includesd seismic risk micro-zoning.

One study of two other locations from seismic fitness point of view has been identified. In the Feasibility Study Report to the RoA Government published in 1998, a detailed review of Seismic Characteristics of the Installation Site of Nuclear Capacities was conducted. Ref [9-18].

The review discusses three possible areas for locating a nuclear facility: North-eastern, Vayots Dzor-Sevan and the current ANPP site. All three locations are presented on the map in figure 9-1. The study analyzes only the seismic aspects of locating nuclear facility at the other locations.

One of the shortcomings of the study is that the seismic risk micro-zoning of the two other sites has not been conducted, while the current ANPP site has been investigated in depth and seismic risk micro-zoning has been done. This means that the seismic characteristics of the other sites are not known with necessary precision and further study would be necessary to confirm their acceptabililty.

Map 9-1, Alternative sites for locating nuclear facility

Competitive sites:

1 – North-eastern;
2 – Vayots Dzor-Sevan;
¤ - the current ANPP site

The following summarizes the conclusions of the Feasibility Study Report, 1998 chapter on seismic characteristics of alternative locations for a nuclear facility:

> "Thus, as a result of collection, summarizing and analysis of the available geologic and tectonic, geophysical and seismic data (taking into consideration the recommendations of International Atomic Energy Agency) in order to characterize seismic and tectonic conditions of sub-regions (competitive points/sites) for the location of construction sites of nuclear capacities, the following conclusions can be made:
>
> 1. All 3 considered competitive sites are located in the high active tectonic zone (the zone of collision of lithospheric plates of Arabia and Eurasia) which is characterized by high seismic activity.
>
> 2. The manifestation of seismicity in different sites is not similar: earthquakes are unequally distributed, distinctly different seismic activation of beds.
> 3. According to the schematic seismic risk mapping of the RoA, the operating ANPP is located in the zone of high seismicity, with the magnitude of anticipated maximum intensity of 9 (MSK). In compliance with the design standards for earthquake-proof nuclear power plants, the construction of NPP on the sites with the intensity of Maximum Basis Earthquake (MBE) over 8 is not acceptable. However, after consideration of the results of seismic risk micro-zoning of area, the assessment of seismic hazard of the operating ANPP site for the specific soil conditions are: I_{MBE}= 8, I_{DBE}= 7[2]. The same assessments of seismic hazard were from studies of the ANPP site extension carried out previously. The peak ground acceleration (PGA) on the site is 0.21g for 50% exceedance and 0.34g. for 84% of exceedance.
>
> 4. The north-eastern site considered as an alternative site for locating a NPP, is situated in the zone of moderate seismicity with the anticipated maximum intensity of 8. The territory of the considered region is divided into separate blocks with many faults. Availability of active faults is not excluded, so, there is a possibility of surface faults. It is worth mentioning that because of highly divided terrain, the choices of sites for construction are limited. The engineering-geological conditions are also very unfavorable and there is a high possibility that the seismicity could be redefined to a greater value after performance of seismic micro-zoning. The issue of suitability of this site for siting of NPP will be finalized after additional investigations.
>
> 5. The third competitive site is situated in the Hayotsdzor-Sevan region, between the Garni (maximum magnitude of possible earthquake source (PES) is 7.0 MSK) and Pambak-Sevan (Mmax =7.2 MSK) active faults. Because of absence of the results of micro-zoning this option also cannot be excluded at this stage.

---

[2] MBE – maximum basis earthquake, DBE – design basis earthquake

6. The specific location for siting of the nuclear capacities can be defined after carrying out additional investigations and studies. However, it should be considered that the region, vicinity and site of the operating ANPP are the most thoroughly investigated and is suitable for locating of nuclear facilities. Taking into account the fact of availability of necessary infrastructures, the existing site of the ANPP and its extension area are the most favorable and appropriate for construction of a new NPP."

The Feasibility Study Report to the RoA Government 1998 addresses only the seismic aspects of locating a NPP at discussed locations. It should be considered that the existing site of ANPP is superior to other two locations in many respects.

The existing site has highway (M-5) and railroad accesses, which simplify the construction effort. There are transmission lines in place to route electricity to major transmission hubs. Housing for operating personnel and their families and other necessary social infrastructure are in place, such as police, hospital, schools, etc. Other infrastructure necessary for operation of an NPP is available at the current site, such as water intake structures. Use of the Sevjur River for cooling water makeup may require some limitations to be placed on agricultural water users; however, for most of the year, adequate water appears to be available in the Sevjur to support operation of Unit 3 at the current ANPP site.

Locating a NPP at other sites will involve disturbance of new territory for plant and other infrastructure, while the current site for new units have already been disturbed.

The northern site (marked 1 on the map) may have one advantage over others. Although it does not currently have railroad access and a railroad spur would be necessary from Ayrum station to the site, there are no tunnels from the Georgian border to Ayrum station. This increases the technical feasibility of transportation of major large-sized equipment compared to the current site as there are three tunnels on the railway to the ANPP site. The spur to site 1 would have to pass by or through the Gugarats mountain range. If the bypass of the range is not possible, it will be necessary to build a tunnel wide enough to allow for transportation of large-sized equipment. A study is required to better understand the advantages and disadvantages of the Northern site from a transportation point of view.

To be able to make judgments on fitness of other locations for placing a NPP from the point of view of water availability, water impacts, cooling tower impacts, ecological impacts, etc it is necessary to have comprehensive study of each location.

REFERENCES:

[9-1] "TACIS PROJECT", 2007, *Armenian Nuclear Power Plant Decommissioning Strategy*, *Support to the Energy Policy of Armenia* EUROPAID/120653/C/SV/Am

[9-2] PA Consulting Group, 2006, *Armenia Power Sector Least Cost Generation Plan*, p. 5-11.

[9-3] "PSRC", *Supplied Electricity*, http://www.psrc.am/en/?nid=297

[9-4] Government of Armenia, 2005, *Energy Sector Development Strategy in the Context of Economic Development in Armenia, Adopted by the Government of Armenia at June 23, 2005 session N 1 resolution of N 24 protocol,* p. 8.

[9-5] Government of Armenia, 2005, *Energy Sector Development Strategy in the Context of Economic Development in Armenia, Adopted by the Government of Armenia at June 23, 2005 session N 1 resolution of N 24 protocol.*

[9-6] US Nuclear Regulatory Commission (NRC), 1999, *Standard Review Plans For Environmental Reviews For Nuclear Power Plants*, p. 9.2.1-1

[9-7] "Trend capital news agency", *Georgia Began Electricity Import from Turkey, http://capital.trendaz.com/index.shtml?show=news&newsid=1150190&catid=500&subcatid=384&lang=EN, last accessed on 30 June 2008.*

[9-8] Statistical Pocketbook of the Islamic Republic Of Iran, 2006 - 2007. http://eamar.sci.org.ir/

[9-9] PA Consulting Group, 2008, *Initial Planning Studies to Assess Feasibility of a Replacement Nuclear Power Unit in Armenia,* Chapter 3, "Review of the Regional Export Possibilities and Grid Requirements" Section 3.2, "Description of Regional Power Systems".

[9-10] PA Consulting Group, 2006, *Armenia Power Sector Least Cost Generation Plan*, p. 47.

[9-11] PA Consulting Group, 2006, *Armenia Power Sector Least Cost Generation Plan*, p. 3-10.

[9-12] European Neighbourhood and Partnership Instrument, Country Strategy Paper 2007-2013, http://ec.europa.eu/world/enp/pdf/country/enpi_csp_armenia_en.pdf p. 13.

[9-13] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report,* Conclusions

[9-14] PA Consulting Group, 2006, *Armenia Power Sector Least Cost Generation Plan*, Executive Summary

[9-15] PA Consulting Group, 2006, *Armenia Power Sector Least Cost Generation Plan*, p. 3-3.

[9-16] "UNFCCC", http://unfccc.int/kyoto_protocol/items/2830.php

[9-17] Government of Armenia, 2005, *Energy Sector Development Strategy …, p. 13.*

[9-18] CJSC "Research Institute of Energy", 1998, *Feasibility Study Report, 13. Seismic Characteristics of the Installation Site of Nuclear Capacities.*

Environmental Background Information Document

Chapter 10: Environmental Assumptions, Commitments, Assessment Open Items, and Conclusions

October 2008

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10. ENVIRONMENTAL ASSUMPTIONS, COMMITMENTS, ASSESSMENT OPEN ITEMS, AND CONCLUSIONS

This Environmental Background Information Document (EBID) has been developed in a relatively short time (one year) with a small staff dependent on what information could be obtained from various entities with the assistance of the Ministry of Energy and Natural Resources (MoENR).

Where key decisions have not yet been made by the Government of Armenia (e.g. reactor vendor) or required information was not available in the timeframe that this document was drafted (e.g. the results of the MoENR and IAEA joint study of manpower resource and training needs), assumptions were made in order to move forward with this study. Section 10.1 summarizes key assumptions that were made during development of the EBID. Assumptions were considered *key assumptions* if changes in the assessment of environmental impacts could result if actual conditions vary from those assumed.

In a number of areas, actions were assumed in order to avoid or mitigate potential environmental impacts. These actions are listed as *commitments*, actions that if not taken, could result in greater adverse impacts. Section 10.2 identifies such commitments that are necessary to assure that environmental impacts are within those predicted by the EBID.

Within the time and resources available, a number of studies necessary to address RoA and international requirements and guidelines for environmental assessment were not addressed. These are identified in Section 10.3 as *open items* that should be completed in order to have a complete environmental assessment meeting the guidelines applied during this review.

Section 10.4 summarizes the conclusions of the assessment completed to date based on the *key assumption*s, including implementation of *commitments,* and satisfactory closure of *open items*.

NOTE: The information in Sections 10.1 through 10.4 is summary in nature and must be considered within the context of the other sections of the EBID where more complete discussion is provided; therefore, extraction of information from this chapter and related tables must be done carefully to ensure that it is placed in proper context.

10.1 SUMMARY OF KEY ASSUMPTIONS

This Section lists key assumptions made that could result in significant changes to the environmental assessment if actual conditions vary. In addition, where systems or site features discussed in the EBID will be shared with ANPP Unit 1 and Unit 2 facilities, this is highlighted.

10.1.1 Project Schedule

It is assumed that Unit 3 construction will begin in 2010 and Unit 3 will start operations in 2016. This represents an ambitious schedule for plant construction and commissioning but is based on the need to replace the power generated by ANPP Unit 2, which is currently scheduled for shutdown by December 2016. The date primarily impacts population estimates and assessment of population-related socioeconomic and radiation impacts and a change by one to five years is not likely to result in significantly different conclusions regarding impacts; however, longer delays in plant startup may change the results of impact analyses.

Concurrent operation of both Units 2 and 3 is assumed to occur for some period of time before permanent shutdown of Unit 2. Concurrent operation will be necessary, if allowed based on the existing (or extended) Unit 2 lifetime, to allow for startup and testing of Unit 3 prior to removal of Unit 2 as a generation resource.

10.1.2 Station Location

EBID Section 2.1 identifies the station location as the existing ANPP site in Armavir Marz where ANPP Units 1 and 2 are located. EBID Chapter 9 summarizes evaluations of alternative sites; otherwise, all EBID assessments of environmental impacts assume that Unit 3 will be located to the west of Units 1 and 2, in the area previously planned for two additional VVER 440 plants. It is assumed that all construction activities will be within the area previously disturbed for construction of the earlier units or preparation for the planned units 3 and 4. All impact analyses are based on this location; if a different location is considered, much of the environmental assessment contained in the EBID is invalid.

Unit 3 will share the ANPP site with existing Units 1 and 2 and associated facilities.

10.1.3 Station Vicinity

EBID Section 2.1 defines the station vicinity as an area with radius of 10 km of the reactor location. This coincides with the area most likely to be impacted physically by construction and operation of Unit 3 and is consistent with the Urgent Protective Measures Planning zone defined in the Republic of Armenia emergency plan for accidents at ANPP (see discussion in Section 8.2).

EBID Section 2.5 provides summary data for an area that extends to 16 km from the site, roughly equivalent to the distance to the nearest border with Turkey. Adjusting the definition of Station Vicinity from 10 km to 16 km is not likely to result in changes to assessment results.

10.1.4 Station Region

EBID Section 2.1 defines the station region as the area within 50 km of the site. Although U.S. Nuclear Regulatory Commission (U.S. NRC) guidance recommends consideration of impacts out to a distance of 80 km (50 miles) and the Republic of Armenia extends emergency planning within Armenia to a distance of 100 km, a distance of 50 km was chosen for the EBID assessments because that is the area most likely to be impacted by construction and operation of Unit 3, including anticipated accidents. Should detailed accident analyses show the potential for accident consequences extending beyond the 50 km distance (other than acceptance of evacuated population), additional data collection will be necessary for population distribution and collective dose analyses beyond 50 km.

10.1.5 Population Estimates

Population statistics are presented in EBID Section 2.5 and used in evaluation of impacts on the population in Sections of Chapters 4, 5, and 7. Population also figures in the site evaluation documented in Chapter 8.

10.1.5.1 POPULATION IN ARMENIA

EBID Section 2.5 presents the results of the 2001 census of population within the Republic of Armenia, along with National Statistical Service estimates of population in 2006. Projections of population changes in the future are made using the results of population projections for the entire Republic of Armenia by the National Statistical

Service for the period 2001-2035. Because guidelines suggest evaluation of the population forty years after plant startup, or until approximately 2055, the population curves developed by the Statistical Service were extrapolated to 2045 and 2055 using a straight-line between the projections for 2025 and 2035 (see Figure 2.5-3).

Application of factors resulting from the population projections to predict future populations assumes that the Republic-wide population changes predicted in the Statistical Service analyses apply down to a community level. Should new census data or updated population projections become available, the population figures presented in Section 2.5 and used in other sections, such as 4.4, 5.4 and Chapter 7, should be revised. Small percentage changes in actual or projected populations are unlikely to change the overall assessment conclusions.

10.1.5.2 POPULATION IN TURKEY

Detailed census data for communities in the neighboring provinces of Turkey were not available. Census data for the city of Igdir and population density statistics for Igdir and Kars provinces of Turkey obtained from the Internet were combined with calculated areas within the 50 km zone to estimate Turkish population within the zone. Projection of Turkish population to 2055 assumed the same percentage increases predicted for Armenia. Should more recent or more accurate population data for the Turkish communities in the 50 km zone become available, the related data presented in Section 2.5 and used in other chapters of this EBID will need to be revised accordingly. As with any changes in Armenian population, small percentage changes in assumed or projected populations in Turkey are unlikely to change assessment conclusions.

10.1.5.3 POPULATION AT THE ANPP SITE

Statistics on current staffing of ANPP, including residences of the ANPP staff, were provided by CJSC “ANPP”. Projections of plant population and residences for ANPP Unit 3 staff in Section 2.5 are based on the projected staff for a VVER-1000, Model AES-91, which is less than half of that for Unit 2. It is assumed that relative distribution of staff member residences among the communities of Armenia would remain the same as for the current ANPP staff.

10.1.5.3.1 Construction Population

Estimates of construction population based on a US Department of Energy study (NP2010) are given in Table 2.5-4 and were used to evaluate socio-economic impacts of construction in EBID Section 4.4. The estimates use a modest increase over the construction work force predicted for construction in the US, which may be non-conservative relative to the situation in Armenia which likely has a lack of necessary skilled workers for plant construction.

The Ministry of Energy and Natural Resources (MoENR) is conducting, jointly with IAEA, a study of available resources and training needed to support construction and operation of a new nuclear unit in Armenia. The results of this study will not be available until late 2008. Should the MoENR/IAEA study or construction planning predict the need for a substantially larger construction workforce, then the analyses of Section 4.4 will need to be revised.

EBID Section 4.4 lists detailed assumptions regarding the number of construction workers relocating to the plant vicinity, where they will reside, and numbers of accompanying family members. Should the expected numbers of relocating workers increase or should the Government of Armenia or Project Developer provide residences or incentives for

location of temporary workers that result in a different distribution of personnel among the cities of the region, the conclusions of Section 4.4 must be reconsidered.

It is expected that construction workers will arrive at the site by train, van, or bus. The assessment in EBID Section 4.4 assumes that all construction workers arrive by van or bus, with an average of six (6) persons per vehicle. If a significant percentage (greater than 20%) of the construction workforce will arrive by personal vehicles, the assessment of traffic impacts in section 4.4 must be revised and appropriate mitigation actions implemented, as suggested in Subsection 4.4.1.3.

10.1.5.3.2 Operational Phase Population

EBID Section 5.8 evaluates the socioeconomic impacts of operation based on specific assumptions about the Unit 3 staffing. Should the MoENR/IAEA study indicate that a significantly different number of employees will be needed to support Unit 3 operation, or a quite different percentage of Unit 3 staff will be relocating to the vicinity, then the results of Section 5.8 must be reconsidered.

10.1.6 Reactor Selection

The reactor plant for ANPP Unit 3 has not been selected. For the purposes of the EBID assessments, it was assumed that the parameters in the Plant Parameter Envelope (PPE) of Appendix A to Section 3.2 bound the eventual reactor selection. The candidate reactors enveloped by the PPE are the Westinghouse AP1000, the CANDU EC-6 (represented in part by parameters from the ACR-700 design), and a recent version of the Russian VVER-1000 (model AES-92, although some supplied parameters are for the AES-91). It must be recognized that values for all relevant parameters in the PPE were not provided for the VVER-1000, and thus the PPE may not bound the VVER-1000 in all respects.

At design conditions, the plant will generate up to 1,117 MWe net electrical power (maximum for the AP1000) and will reject as much as 2,300 MWth waste heat to the environment. Operating parameters for the candidate reactors are given in Table 10-1 (based on Table 3.2-1).

Table 10-1 - Operating Parameters for Candidate Reactor Plants [(a)]

Parameter	AP1000	CANDU EC-6	VVER-1000
Core Thermal Power, MWth	3,430	2,158	3012
Net Electrical Output, MWe	1117	666	1,060
Waste Heat Rejected, MWth	2,313	1,492	1,952
Efficiency, %	32.6%	30.9%	35.2%

[(a)] See Table 3.2-1 for assumptions.

Once the reactor vendor and model are selected, design parameters should be compared with those in the PPE to assess if environmental impacts may be greater than those indicated in this EBID.

The area of greatest uncertainty in the PPE relates to radioactive releases, especially if the selected reactor is a VVER-1000. The area of greatest environmental impact relates to the consumption of water, primarily by the circulating water system (condenser cooling), as discussed below.

10.1.7 Heat Removal (Cooling Water) Technology

Water cooled nuclear power plants reject to the environment approximately two-thirds of the heat produced in the reactor. Most of this heat is rejected through the circulating water system that cools the condenser where turbine exhaust steam is condensed. The balance of rejected heat is removed through various heat exchangers cooled by the circulating water and service water systems.

The base configurations assumed for heat removal systems, as described in Sections 3.3 and 3.4, are a natural-draft, wet cooling tower for heat removal from the circulating water system and spray ponds for service water cooling, with makeup water for both systems withdrawn from the Sevjur River. Section 3.4 describes alternative technologies for circulating water, such as: wet mechanical draft cooling towers; dry mechanical draft cooling towers; dry natural draft cooling towers; and hybrid wet/dry cooling tower systems. The alternative to spray ponds for service water cooling is a system of wet mechanical draft cooling towers.

EBID Section 5.2 assesses the impacts of water use, based on the assumed configurations described in Sections 3.3 and 3.4. This section concludes, based on a statement in the ANPP Unit 2 Safety Analysis Report, that the water consumed by wet cooling towers may result in reduction of withdrawals from the Sevjur River for irrigation during some parts of the year.

As discussed in Section 1.1.3.3, the GoA must take actions to establish the amount of water that may be allocated to ANPP Unit 3 and to decide if alternative cooling technologies are necessary to reduce water consumption. It is assumed that these actions are taken in order to assure availability of water to Unit 3 without significant adverse impacts on other water users and the ecology of the Sevjur River.

Changes to alternative cooling technologies are likely to reduce the impacts of water use by ANPP Unit 3; however, although alternative technologies can reduce water consumption by Unit 3, they will result in energy penalties, or reductions in net electrical output from the plant.

10.1.8 Cooling Water Treatment

EBID Section 3.3 describes water treatment approaches for ANPP Unit 3 that differ significantly both in employed technologies and in operating costs from those currently used at ANPP Unit 2. These approaches are based on current treatment technologies used in US power plants and planned for application at AP1000 plants to provide for energy efficiency and long component lifetimes. Should the selected reactor use significantly different water treatment technologies, then the impacts of those technologies on plant effluents should be reevaluated.

As discussed in Section 1.1.3.3, the GoA must take action to establish appropriate water quality standards for the Sevjur River. It is assumed that this action is taken in order to assure that Unit 3 can discharge cooling system blowdown without significant adverse impacts on the ecology of the Sevjur River.

10.1.9 Radioactive Waste Management

The description of radioactive waste management systems in EBID Section 3.5 are based on the detailed information available as part of the AP1000 design control documents filed with the US NRC. For most radioactive waste streams, the assumption is that latest treatment technologies would be used for waste treatment by using mobile processing

systems. Use of mobile systems is intended to avoid permanent installation of technologies that may become obsolete.

Should the selected reactor produce significantly different types or amounts of radioactive waste or use significantly different waste management technologies, the impacts of radioactive waste management should be reevaluated.

10.1.9.1 TRANSPORTATION OF RADIOACTIVE WASTE

Sections 3.5, 3.8, 5.4 and Chapters 7 and 8 assume that radioactive waste will be stored temporarily within Unit 3 and/or the existing onsite storage facilities, and then placed in a disposal facility established at the ANPP site, as recommended in Initial Planning Studies Chapter 5, thereby eliminating the need for transportation of radioactive materials off-site. If radioactive materials will be transported off-site, the assessments of impacts must be revised.

10.1.9.2 SPENT FUEL STORAGE AND TRANSPORTATION

Sections 3.5 and 5.4 and Chapters 7 and 8 assume that spent reactor fuel will be stored temporarily within the Unit 3 spent fuel storage pool and then placed in dry storage at the ANPP site for the lifetime of the facility. It is assumed that a new spent fuel dry storage facility would be built for Unit 3, but use of the existing facility on the ANPP site cannot be ruled out. Should spent fuel be shipped off-site for reprocessing as suggested in Initial Planning Studies Chapter 2, then environmental impacts of such shipments and potential transportation accidents need to be considered in conjunction with the licensing of that activity.

10.1.10 Auxiliary Boiler Fuel Source

Section 3.2 assumes that the Unit 3 auxiliary boiler will be fueled by natural gas. If fuel oil is used to fire the auxiliary boiler, the boiler effluents will be different, although the overall environmental conclusions are unlikely to change, due to the limited time the boiler is needed.

10.1.11 Features Shared with Existing Units

Most systems and facilities for ANPP Unit 3 will be built specifically for Unit 3; however with the possibility of concurrent operation of Units 2 and 3, some infrastructure may be shared between the two units, as discussed below:

10.1.11.1 INTAKE AND DISCHARGE SYSTEMS

Although pumps and piping are likely to be renovated or duplicated to provide reliable and sufficient water supplies for Unit 3, it is expected that the existing intake structure will be used. If new pumps and piping are installed for Unit 3, they may be sized to serve both Units 2 and 3. In any case, the existing piping corridor will be used for routing the piping between the intake structure and the units.

It is expected that the discharge pipe for cooling system blowdown and other discharges from the ANPP site will be renovated or replaced and the discharge pipe extended to the Sevjur River. On completion, this discharge pipe could serve both Units 2 and 3. In any case, the existing piping corridor will be used to route the discharge pipe to the vicinity of the Sevjur River.

10.1.11.2 HOUSEHOLD AND FIRE PROTECTION WATER SUPPLIES

It is expected that the existing water supply to the Unit 2 household water system from the Upper Zeiva Springs will be replaced by a deep well system drilled to the north east of the existing cooling towers. The new deep well system should have sufficient capacity to serve both Units 2 and 3.

The capacity of the existing fire protection water storage tanks, which are fed from the household water system, may be relied upon, along with one or more new tanks to provide adequate water storage to serve the entire ANPP site fire fighting needs.

10.1.11.3 SWITCHYARD AND TRANSMISSION SYSTEMS

The existing 110 kV and 220 kV overhead high voltage transmission system currently serving Unit 2 will be relied upon to serve Unit 3, with the addition of a new 400 kV transmission system. Although some equipment upgrades may be necessary to accommodate interconnections between Units 2 and 3, portions of the switchyard buswork and switches may serve both units.

10.1.11.4 SLUDGE ACCUMULATION SYSTEM

It is expected that the Phase I sludge accumulation system will be relied upon as a means to treat accumulated water that is unable to be discharged to the Sevjur River due to constituents exceeding discharge limits.

10.1.11.5 CONTAMINATED SEWAGE NETWORK

It is expected that the existing contaminated sewage network and process using expanded perlite to remove oil from selected drains will also be employed for drains from Unit 3 areas that have a potential for contamination with oil and petroleum products.

10.1.11.6 SANITARY WASTE TREATMENT SYSTEM

It is expected that a new sanitary waste treatment system will be completed and placed into operation with sufficient capacity to serve the staffs of Units 1, 2 and 3.

10.2 COMMITMENTS TO AVOID OR MITIGATE ENVIRONMENTAL IMPACTS

The actions discussed in Table 10-2 should be considered as commitments that are necessary to avoid, minimize, or mitigate adverse environmental impacts of ANPP Unit 3.

10.2.1 Introduction

No commitments are identified in Chapter 1 of the EBID, however the GoA must take actions to assure that impacts of water use by and water discharges from Unit 3 are acceptable. These actions are identified in Table 10-2.

10.2.2 Chapter 2, Environmental Description

See Table 10-2 for commitments in EBID 2.6, Geology, for completion of seismic hazard assessment to address IAEA requirements and comments by IAEA on previous seismic studies and to allow definition of seismic design inputs for Unit 3.

10.2.3 Chapter 3, Project Description

Commitments are identified in Chapter 3, as indicated below:

10.2.3.1 PLANT LAYOUT - NO COMMITMENTS ARE IDENTIFIED IN SECTION 3.1.

10.2.3.2 POWER CONVERSION - NO COMMITMENTS ARE IDENTIFIED IN SECTION 3.2.

10.2.3.3 PLANT WATER USE – SEE TABLE 10-2.

10.2.3.4 COOLING SYSTEMS - SEE TABLE 10-2.

10.2.3.5 RADIOACTIVE WASTE SYSTEMS - SEE TABLE 10-2.

10.2.3.6 NON-RADIOACTIVE WASTE SYSTEMS - SEE TABLE 10-2.

10.2.3.7 POWER TRANSMISSION SYSTEM - NO COMMITMENTS ARE IDENTIFIED IN SECTION 3.7.

10.2.3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS - SEE TABLE 10-2.

10.2.4 Chapter 4, Environmental Impacts of Construction

Commitments are identified in Chapter 4, as indicated below:

10.2.4.1 LAND-USE IMPACTS - SEE TABLE 10-2.

10.2.4.2 WATER-RELATED IMPACTS - SEE TABLE 10-2.

10.2.4.3 ECOLOGICAL IMPACTS - SEE TABLE 10-2.

10.2.4.4 SOCIOECONOMIC IMPACTS OF CONSTRUCTION - SEE TABLE 10-2.

10.2.4.5 RADIATION EXPOSURE TO CONSTRUCTION WORKERS - SEE TABLE 10-2.

10.2.4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION - SEE TABLE 10-2.

10.2.5 Chapter 5, Environmental Impacts of Station Operation

Commitments are identified in Chapter 5, as follows:

10.2.5.1 LAND-USE IMPACTS - SEE TABLE 10-2.

10.2.5.2 WATER-RELATED IMPACTS - SEE TABLE 10-2.

10.2.5.3 COOLING SYSTEM IMPACTS - SEE TABLE 10-2.

10.2.5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION - SEE TABLE 10-2.

10.2.5.5 ENVIRONMENTAL IMPACTS OF WASTE - SEE TABLE 10-2.

10.2.5.6 TRANSMISSION SYSTEM IMPACTS - SEE TABLE 10-2.

10.2.5.7 URANIUM FUEL CYCLE IMPACTS - NONE.

10.2.5.8 SOCIOECONOMIC IMPACTS OF STATION OPERATION - SEE TABLE 10-2.

10.2.5.9 DECOMMISSIONING – SEE TABLE 10-2.

10.2.5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION - NONE.

10.2.6 Chapter 6, Environmental Measurements and Monitoring Programs - See Table 10-2.

10.2.7 Chapter 7, Impacts of Postulated Accidents Involving Radioactive Materials – see Table 10-2.

10.2.8 Chapter 8, Evaluation of the NPP Site - See Table 10-2.

10.2.9 Chapter 9, Alternatives to the Proposed Action - No commitments in Chapter 9.

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
		Government of Armenia Actions	
G-WA-1.0[1]	Water Availability for Unit 3	The Ministry of Nature Protection must determine the minimum flow in the Sevjur River to sustain aquatic ecosystems near the ANPP.	1.1.3.3, 1.2, 2.3.3.3, 3.3.1.1, 5.2.4
G-WA-1.1		The WRMA must determine how the water of the Sevjur will be allocated among competing demands. The Agency must further determine whether a water use permit can be issued for ANPP Unit 3. This will require a review of existing water permits and a survey of Sevjur River water users to: a. Quantify the Sevjur River water consumption by the permittees annually, month-by-month, and equivalent maximum instantaneous withdrawals. b. Assess whether irrigation system efficiencies can be improved to reduce water needs. c. Determine the feasibility of issuing permits setting monthly withdrawal limits. d. Determine whether alternate sources of water can supply some of the irrigation needs. e. Conclude what volume of water can be allocated for a future water permit for ANPP Unit 3.	1.1.3.3, 1.2, 2.3, 3.3.1.1, 5.2.3, 5.2.4

[1] Item numbers are assigned to facilitate future tracking of Government Actions (G-) and commitments (C-) in the various categories (e.g. Site Suitability – SS – and System Designs – SD).

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
G-WA-1.2		The Ministry of Energy and Natural Resources must evaluate the feasibility of alternative actions to ensure adequate water availability for the new unit such as: a. Employment of alternative cooling system technologies (dry or hybrid wet-dry cooling towers); and/or b Compensation of agricultural water users for improving the efficiency of their irrigation systems and obtaining water from other sources.	1.1.3.3, 3.3.1.1
G-WQ-1.0	Water Quality Standards for the Sevjur River	The Water Resources Management Agency must determine the water quality norms that will be applied to the Sevjur River in the vicinity of Unit 3 and what conditions, if any, must be included in a discharge permit for the new Unit.	1.1.3.3, 1.2, 2.3
G-RW-1.0	National Radioactive Waste Management Strategy	A national radioactive waste management strategy should be defined for Armenia, based on IAEA waste management requirements and guidelines to define expected technologies and locations for storage and disposal of radioactive waste from ANPP Units 1, 2, and 3.	3.0, 3.5, 3.8, 5.5.2.1, 7
G-HR-1.0	Human Resources Study	The Ministry of Energy and Natural Resources should complete the Human Resources study for a new nuclear unit (being conducted in connection with IAEA). When the study is complete, the Government of Armenia should identify preferred approaches to housing of temporary construction workers.	4.4.2, 4.4.2.1, 4.6.4

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
G-SC-1.0	Reactor Siting Criteria	The Government of Armenia should establish criteria for acceptable levels of risk and accident dose criteria for siting of new nuclear facilities in Armenia.	7.1.1, 8
G-EP-1.0	Emergency Planning	The State Regulatory Committee for Nuclear and Radiation Safety should incorporate provisions for evacuation of hospitals and clinics in the PPM/UPMP zones in their next update of the External Emergency Plan.	8.2.2
Site Suitability			
C-SS-1.0[2]	Seismic Hazard Assessment	Conduct the planned seismic hazard assessment for the new ANPP unit site	2.6.2
C-SS-1.1		Establish a quality assurance plan for the data collection and analyses to be performed, following the IAEA guidelines.	2.6.2
C-SS-1.2		Develop an integrated database of geological, geophysical, and geotechnical information to be used in developing seismotectonic models and in calculating seismic hazard curves.	2.6.2
C-SS-1.3		Compile a catalogue of all relevant historical and instrumentally recorded earthquakes with their associated parameters (the Seismological Database).	2.6.2
C-SS-1.4		Develop a set of seismotectonic models that will be used to estimate the location, magnitude, and recurrence frequency of future earthquakes that could affect the plant site.	2.6.2
C-SS-1.5		Select of a set of ground motion attenuation relations to be used to estimate the expected ground motions, and their uncertainties, at the plant site from the seismic sources	2.6.2

[2] Item numbers are assigned to facilitate future tracking of commitments (C-) in the various categories (e.g. Site Suitability – SS – and System Designs – SD).

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
		defined in the seismotectonic models.	
C-SS-1.6		Perform Probabilistic Seismic Hazard Analysis (PSHA) to determine the levels and characteristics of ground motion hazard at the site of the new ANPP unit. The PSHA will develop the seismic hazard curves and corresponding uniform hazard response spectra (UHRS). From the hazard curves, the acceleration and UHRS corresponding to specific levels of probability of exceedance will be used in establishing the design basis severity level 1 and 2 (SL1 and SL2) earthquakes for the new ANPP unit, based on probabilities for SL1 and SL2 established by the State Committee for Regulation of Nuclear Safety.	2.6.2
C-SS-1.7		Evaluate the potential for surface faulting in the near region of the ANPP site.	2.6.2
C-SS-1.8		Respond to recommendations of previous IAEA Seismic Safety Review Missions for ANPP.	2.6.2
System Designs			
C-SD-1.1	Technical Water (Raw Water) source	For the river intake channel, the maximum water velocity of the cross-section will be less than 0.15 m/s. Impingement of smaller fish will be further reduced by use of intake screens. The design of the screens will include a method for returning impinged fish to the river. Fine mesh screens will filter fish eggs and larvae if studies show them to be necessary.	3.4.2.1, 5.3.1, 5.10.3, 6.1
C-SD-2.0	Plant discharges	Liquid effluents will be diluted by circulating water and/or service water blowdown and discharged to the Sevjur River via the discharge pipe which will be extended to the Sevjur River downstream of the plant intake.	3.4.2, 3.4.2.2.1, 3.6.1.1, 4.2.1, 5.3.2, 5.4.2.1, 5.5.1.1.1

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
C-SD-2.1		During design of Unit 3, the need for replacement of the current discharge piping will be considered.	3.4.2.2.1
C-SD-4.0	Sanitary Sewage Treatment	Site preparation for Unit 3 will include construction and commissioning of a new sewage waste water treatment facility to serve the ANPP site prior to plant operation. The design should accommodate sanitary discharges from ANPP Phase 1 (Units 1 & 2). The design should also take into account expected peak onsite labor for Unit 1 & 2 decommissioning.	3.6.2, 5.5.1.1.3, 5.10.5
C-SD-5.0	Demineralized Water System (DWS)	The DWS will use reverse osmosis and electro-deionization to purify water without the use of chemicals necessary for regeneration of traditional ion exchange resins.	3.6.1.1.3, 5.5
C-SD-6.0	Household Water supply	The current household water supply from Upper Zeiva Springs will be replaced by a set of wells drilled to the northeast of the current ANPP cooling towers.	3.3.1, 3.3.2.3, 4.6.2, 5.2, 5.2.5
C-SD-6.1		Upper Zieva Springs will be used as the source for batch plant and construction personnel needs.	4.2.2, 4.6.2
C-SD-7.0	Fire Protection water tanks	Additional water tanks of 4,000 m^3 capacity will be installed, resulting in a total storage capacity (6,000 m^3) for fire protection system stored water volume.	3.3.1.6
C-SD-8.0	Contaminated (industrial) sewage network	Waste streams will be monitored for oil contamination. Drains that could have oil contamination will be routed to the Phase 1 contaminated treatment system for cleaning with expanded perlite.	3.6.1.2.1, 5.5.1.1.2, 5.10.5, 6.5.4
C-SD-8.1		The turbine building sump pumps will route the wastewater to the contaminated sewage network for removal of oily waste.	3.6.1.2.1, 5.5.1.1.2, 5.10.5, 6.5.4
C-SD-8.2		The diesel fuel oil area sump pump also will discharge wastewater to the contaminated sewage network.	3.6.1.2.1
C-SD-9.0	Cooling water systems with potential for radioactive	Systems and structures for containment of radioactive fluids will prevent leakage of radioactive water into the groundwater.	5.4.2.1.1

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
	contamination		
C-SD-10.0	Control Room Ventilation	Measures will be implemented to protect the control room operators from accidental releases of sulfuric acid, including features in the plant design to: (1) provide capability to detect such releases; (2) isolate the control room if there is a release; (3) make the control room sufficiently leak tight; and (4) provide equipment and procedures for ensuring the use of breathing apparatus by the control room operators.	8.6.2
C-SD-11.0	Mixed Waste	Initial engineering plans should ensure consideration is given to minimizing generation of mixed (radioactive and hazardous) wastes. Unit 3 should provide for containment and processing of small amounts of mixed wastes.	5.5.1.2.2, 5.5.2.3, 5.10.5
C-SD-11.1		Collect and package mixed waste for disposal in accordance with national waste management program.	5.5.2.3, 5.10.5
C-SD-12.0	Radioactive Waste	Liquid radwaste exceeding concentrations suitable for release will be concentrated and solidified in accordance with available technologies within Unit 3 buildings.	3.8.3
C-SD-12.1		Solid radioactive waste from Unit 3 will be packaged for transport and disposal inside Unit 3 buildings. Onsite transportation of packaged radioactive waste will be performed in special vehicles on engineered roads over very short distances.	3.8.3, 7.4.1
C-SD-13.0	Spent Reactor Fuel	Spent reactor fuel will be stored in the ANPP Unit 3 spent fuel pool for a minimum of five years before being placed in canisters designed for dry storage. Transportation between Unit 3 and the ANPP dry fuel storage pads will occur totally on special roads with specialized transport vehicles within the ANPP site boundaries.	3.8.2, 7.4.1
System Operation			

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
C-SO-1.0	Service Water System (SWS)	During emergency conditions, SWS blowdown and makeup will be isolated; the SWS will draw water only from the water basin and there will be no demand for makeup water from the Raw Water System.	3.3.1.3
C-SO-2.0	Steam Generator Blowdown	Steam generator blowdown will be monitored for radiation. If steam generator tube leakage results in significant levels of radioactivity in the steam generator blowdown stream, this stream is redirected to the liquid radwaste system for treatment before release.	3.5.1.1.5, 6.5.3
C-SO-3.0	Blowdown Pond	Cooling system blowdown water quality will be monitored. If blowdown water quality does not meet RoA discharge limits, blowdown from the SWS and/or the CWS will be directed to the blowdown pond.	3.4.2, 3.6.1.3, 6.5.3
C-SO-3.1		Unit 3 will have a system for the collection of wastewater whose chemical composition does not comply with the RoA discharge limits. Should the water in any of the plant systems exceed discharge limits, the system discharges will be directed to the blowdown pond for isolation,	5.5.1.1.1, 5.10.5
C-SO-3.2		If water in the blowdown pond exceeds discharge limits, it will be directed to the Phase 1 neutralizer pool and evaporator pool for treatment.	3.6.1.3, 5.5.1.1.1, 5.10.5, 6.5.3
C-SO-4.0	Solid Waste	Licensed municipal solid-waste haulers will continue to collect non-radioactive solid waste and dispose it in the Metsamor city landfill.	5.5.1.2.1
Conduct of Construction			
C-CC-1.0	Best (Construction) Management Practices	Impacts due to construction are best controlled by using construction practices that do not produce impacts or at least minimize impacts. Construction activities should be planned and conducted using “Best Management Practices”.	4.6, 4.2.3, 4.3.1, 4.3.2, 4.3.4, 4.6.2, 4.6.3
C-CC-		Phase construction to minimize daily emissions and keep	4.1.3.1, 4.4.1, 4.6.1, 4.6.4

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
1.1		impacts within manageable levels.	
C-CC-1.2		Identify the areas of the site to be used for construction activities and: - Prohibit activities on the site outside of the identified construction areas. - Prohibit the movement of heavy construction equipment outside of the construction area. - Control movement of people beyond these areas.	4.1, 4.3.1, 4.3.3, 4.6.1, 4.6.3
C-CC-1.3		Develop and implement dust management plans.	4.4.1, 4.6.4
C-CC-1.4		Institute specific best operating practices to control dust and noise from the batch concrete plant.	4.1, 3.1, 4.2.3, 4.6.1, 4.6.2
C-CC-1.5		Implement procedures to prevent wastewater from the batch plant and from washing of concrete trucks from being discharged directly into drains or canals without treatment.	4.2.3, 4.6.2
C-CC-1.6		Maintain equipment and vehicles to minimize engine emissions and implement an engine emissions inspection program.	4.1.3.1, 4.4.1, 4.6.1, 4.6.4
C-CC-1.7		Collect oil from vehicle maintenance areas and ensure proper disposal of this oil.	4.2.3, 4.3.4
C-CC-1.8		Limit idling of construction equipment.	4.1.3.1, 4.6.1
C-CC-1.9		Limit the speed of construction equipment on unpaved roads.	4.1.3.1, 4.6.1
C-CC-1.10		Confine vehicle movements to established roads and authorized construction areas.	4.3.3, 4.6.3
C-CC-1.11		Remove dirt spilled onto paved roads on the construction site.	4.1.3.1, 4.6.1

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
C-CC-1.12		Cover haul trucks during unloading and loading activities.	4.1.3.1, 4.6.1
C-CC-1.13		Cease grading and excavation during periods of high winds or extreme air pollution episodes.	4.1.3.1, 4.6.1
C-CC-1.14		Phase grading to minimize the area of disturbed soils.	4.1.3.1, 4.6.1
C-CC-1.15		Re-vegetate road medians and slopes.	4.1.3.1, 4.6.1
C-CC-1.16		Limit burning of construction wastes.	4.1.3.1, 4.6.1
C-CC-1.17		Control construction area storm water runoff (e.g., by direction of runoff to a settling pond or filtration of runoff through hay-bales), discharge from worker support facilities, and from accidental spills to ensure minimal impact on surface water and groundwater quality.	4.2.3, 4.3.4, 4.6.2
C-CC-1.18		Separately collect and implement measures to prevent the discharge of oils, lubricants, and other construction chemicals to surface or ground waters.	4.2.3, 4.6.2
C-CC-1.19		Develop procedures to monitor waste from system and component flushing and to determine the proper means of treatment and disposal.	4.2.3, 4.6.2
C-CC-1.20		Excavated earth will be placed on site adjacent to the previously filled area.	4.1.1
C-CC-1.21		Limit the period unvegetated soil is exposed.	4.2.3, 4.6.2
C-CC-1.22		Restore disturbed portions of the site after the completion of construction. The area not occupied by permanent buildings should be allowed to re-vegetate following construction.	4.3.1, 4.6.3
C-CC-1.23		Comply with RoA regulations and permits on equipment emissions.	4.4.1, 4.6.4

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
C-CC-1.24		Provide first aid and first responder emergency medical treatment onsite during construction.	4.4.2.3.3
C-CC-2.0	Traffic Controls	Route truck and worker transport traffic on the eastern access road.	4.1.1, 4.4.1, 4.6.4
C-CC-2.1		Install traffic signals and signage at the intersections of Highway M-5 with the eastern and western access roads to improve traffic control and reduce highway speeds.	4.4.1, 4.4.2.3.1, 4.6.4, 4.6.4
C-CC-2.2		Establish centralized parking and shuttle service for construction workers.	4.4.1, 4.6.4
C-CC-2.3		Encourage use of railroad transport by construction workers.	4.4.1, 4.6.4
C-CC-2.4		Stagger work start times during the day.	4.4.1, 4.6.4
C-CC-3.0	Noise	Implement good construction practices to minimize noise.	4.1.3.2, 4.3.3.2, 4.6.1, 4.6.3
C-CC-3.1		Compare noise levels from stationary equipment, such as concrete batch plants, water pumps, etc. against the MoH limits and take mitigating actions if sound levels could exceed MoH Order 138 limits.	4.4.1.5, 4.6.4
C-CC-3.2		Monitor noise levels from mobile and fixed equipment.	4.4.1, 4.6.4
C-CC-3.2		Alter terrain during early site preparation to provide noise barriers.	4.4.1, 4.6.4
C-CC-3.3		Limit vehicle speeds onsite.	4.4.1, 4.6.4
C-CC-3.4		Require mufflers on equipment and restrict use of engine braking.	4.4.1, 4.6.4
C-CC-4.0	Sanitary	Sanitary needs during construction will be met primarily by use of portable toilets serviced by an off-site contractor (without discharge into the ANPP sanitary sewer system).	3.6.2, 4.2.3, 4.6.2

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
C-CC-5.0	Construction Workers	Establish temporary worker accommodations (hostel) near site (Metsamor or Armavir towns) or provide incentives to locate in Yerevan.	4.4.2, 4.6.4
C-CC-5.1		Establish skilled worker training programs to develop internal Armenian workforce.	4.4.2, 4.6.4
C-CC-5.2		Establish cooperation between police and constructor to develop site induction training and feedback systems on worker behaviors.	4.4.2, 4.6.4
Keeping Construction Radiation Exposures As Low as Reasonably Achievable (ALARA)			
C-A-1.0	Radiation Exposure of Construction Workers	Personnel working in the switchyard construction area will be badged for site access, will be subject to the ANPP dosimetry program, and will be issued standard dosimeters.	4.5.2, 4.5.5, 6.4.2
C-A-1.1		ANPP will establish a continuous monitoring program to measure exposures at the Unit 1 and 2 protected area fence and at nearest points of approach to the sources listed in Subsection 4.5.2, and at selected locations throughout the construction and construction support building areas.	4.5.5, 4.6.5, 6.4.2
C-A-1.2		If the measured dose rate at any measured location in the construction zones would result in a calculated annual exposure exceeding 0.75 mSv, corrective measures, will be implemented.	4.5.5, 4.6.5
C-A-1.3		If construction workers must access areas where they could receive in excess of 0.75 mSv per year, they will be subject to radiation worker training and dosimetry.	4.5.5, 4.6.5
C-A-1.4		Prior to any construction activities on the plant discharge pipe or the project to extend the discharge pipe to the Sevjur River, surveys of dose rates and contamination by radioisotopes of concern will be conducted.	4.5.5, 4.6.5, 6.2.2, 6.3.2
C-A-1.5		Contamination will be measured in the Kosh-Ujan storm water drainage canal downstream of the current plant discharge	4.5.5, 4.6.5, 6.2.2, 6.3.2

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
		point.	
C-A-1.6		If contamination levels or radiation dose rates exceed limits for the general population, the construction workers on the plant discharge pipe project will be subject to training as radiation workers and issued dosimetry and personnel protective measures, as appropriate.	4.5.5, 4.6.5
Conduct of Operations			
C-CO-1	Water withdrawals	A rigorous allocation of water will be necessary under low river flow conditions to maintain environmental river flows and prevent curtailment of water to agricultural uses. Use of dry or hybrid wet/dry cooling systems will mitigate impacts.	5.2.3, 5.10.3
C-CO-2	Waste	Implement a recycling program for petroleum wastes.	5.5.1.2.3. 5.10.5
C-CO-3	Worker exposures to noise, heat, industrial hazards, and radiation	Implement training programs, provide protective gear, and institute onsite first aid treatment.	5.8.1.1, 5.10.8
C-CO-4	Socioeconomic pressures on services and housing	Use of dormitory or hostel for housing of temporary workers. Increased investment in services of Metsamor Town using tax revenues.	5.8.2.1, 5.8.2.2, 5.10.8
Transmission system			
C-TS-1.0	Transmission system construction, operation and maintenance	Adopt best management practices, such as those developed by the Tennessee Valley Authority, to mitigate and minimize the impacts of transmission line construction, high-voltage line operation, and corridor maintenance.	5.6
Government and Community Actions			
C-GC-1.0	Community Sanitary Treatment	The sanitary treatment plant serving Armavir, Metsamor, and Norapat will rehabilitated (as discussed in the Metsamor Master Plan). The plant will be sized to serve the predicted populations of these communities and renovation will be completed prior to or early in the construction of Unit 3.	4.2.3, 4.4.2.3.2, 4.6.4, 5.8.2.3.2
C-GC-2.0	Community Planning	The law authorizing construction of ANPP Unit 3 should include requirements for planning organization notification of	5.1.1

Table 10-2, Commitments to Avoid or Mitigate Environmental Impacts

Item	Topic	Description	Reference Chapter / Section / Subsection
		the ANPP operating organization when changes to land use or new activities in the site vicinity are authorized that could present a hazard to the site or affect emergency plans.	
C-GC-3.0	Taxes	The GoA should develop revenue sharing programs to distribute tax benefits to impacted communities.	4.4.2, 4.6.4, 5.8.2.2, 5.10.8
C-GC-4.0	Emergency Planning	The External Emergency Plan ANPP Unit 2 (defined by Government of Armenia Resolution № 2328-N as amended by Resolution № 194) will serve as the basis for the Emergency Plan applicable when Unit 3 becomes operational.	8.2
C-GC-5.0	Hazards	The hazards due to Unit 1 and Unit 2 decommissioning activities must be evaluated in connection with the Unit 1 and 2 decommissioning plan.	8.6
C-GC-5.1		If new radwaste storage or disposal facilities are planned on the ANPP site, the impacts on Unit 3 must be considered in connection with the environmental and safety assessments for those facilities.	8.6
C-GC-6.0	Decommissioning Funds	Decommissioning funds for ANPP Unit 3 should be collected in a manner similar to that provided for in GoA Resolution № 1637 of October 12, 2006.	5.9

10.3 OPEN ITEMS FOR A COMPLETE ENVIRONMENTAL ASSESSMENT

The preparation of the EBID did not include the conduct of a full set of new environmental studies. The EBID is based primarily on publicly available data and information gathered from the ANPP and from various Government of Armenia entities with the assistance of the MoENR. In some cases, the available information fell short of what would be required to complete an in-depth environmental assessment.

No attempt was made to independently validate the data relied upon in the EBID. Additional studies to support the final environmental assessment should be done by qualified experts following current standards and guidelines. The results of such studies should be subjected to a program of independent review to assure that the data are applicable and of high quality. These studies should be performed under a management system that conforms to IAEA requirements (see Chapter 1 References [1.0-8], [1.0-9] and [1.0-10]) to ensure quality.

The open items listed in Table 10-3 should be taken into account when completing a comprehensive environmental assessment to meet international guidelines and the Laws of Armenia.

10.3.1 Chapter 1, Introduction

10.3.1.1 STATUS OF REVIEWS, APPROVALS AND CONSULTATIONS - SEE TABLE 10-3.

10.3.1.2 APPLICABLE LAWS, REGULATIONS, STANDARDS, AND GUIDELINES - SEE TABLE 10-3.

10.3.2 Chapter 2, Environmental Description

10.3.2.1 STATION LOCATION - SEE TABLE 10-3.

10.3.2.2 LAND – SEE TABLE 10-3.

10.3.2.3 WATER – SEE TABLE 10-3.

10.3.2.4 ECOLOGY – SEE TABLE 10-3.

10.3.2.5 SOCIOECONOMICS – SEE TABLE 10-3.

10.3.2.6 GEOLOGY - SEE TABLE 10-3.

10.3.2.7 METEOROLOGY AND AIR QUALITY – SEE TABLE 10-3.

10.3.3 Chapter 3, Project Description

10.3.3.1 PLANT LAYOUT – SEE TABLE 10-3.

10.3.3.2 POWER CONVERSION – SEE TABLE 10-3.

10.3.3.3 PLANT WATER USE – NO OPEN ITEMS IDENTIFIED IN SECTION 3.3.

10.3.3.4 COOLING SYSTEMS – NO OPEN ITEMS IDENTIFIED IN SECTION 3.4.

10.3.3.5 RADIOACTIVE WASTE SYSTEMS - SEE TABLE 10-3.

10.3.3.6 NON-RADIOACTIVE WASTE SYSTEMS - NO OPEN ITEMS IDENTIFIED IN SECTION 3.6.

10.3.3.7 POWER TRANSMISSION SYSTEM - SEE TABLE 10-3.

10.3.3.8 TRANSPORTATION OF RADIOACTIVE MATERIALS - SEE TABLE 10-3.

10.3.4 Chapter 4, Environmental Impacts of Construction

10.3.4.1 LAND-USE IMPACTS - NO OPEN ITEMS IDENTIFIED IN SECTION 4.1.

10.3.4.2 WATER-RELATED IMPACTS - NO OPEN ITEMS IDENTIFIED IN SECTION 4.2.

10.3.4.3 ECOLOGICAL IMPACTS - SEE TABLE 10-3.

10.3.4.4 SOCIOECONOMIC IMPACTS OF CONSTRUCTION - SEE TABLE 10-3.

10.3.4.5 RADIATION EXPOSURE TO CONSTRUCTION WORKERS - SEE TABLE 10-3.

10.3.4.6 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING CONSTRUCTION - SEE TABLE 10-3 FOR ITEMS THAT ARE DUPLICATED FROM OTHER SECTIONS OF THIS CHAPTER.

10.3.5 Chapter 5, Environmental Impacts of Station Operation

10.3.5.1 LAND-USE IMPACTS – NO OPEN ITEMS IDENTIFIED IN SECTION 5.1.

10.3.5.2 WATER-RELATED IMPACTS - SEE TABLE 10-3.

10.3.5.3 COOLING SYSTEM IMPACTS - SEE TABLE 10-3.

10.3.5.4 RADIOLOGICAL IMPACTS OF NORMAL OPERATION - SEE TABLE 10-3.

10.3.5.5 ENVIRONMENTAL IMPACTS OF WASTE - SEE TABLE 10-3.

10.3.5.6 TRANSMISSION SYSTEM IMPACTS - SEE TABLE 10-3.

10.3.5.7 URANIUM FUEL CYCLE IMPACTS - NO OPEN ITEMS IDENTIFIED IN SECTION 5.7.

10.3.5.8 SOCIOECONOMIC IMPACTS OF STATION OPERATION - SEE TABLE 10-3.

10.3.5.9 DECOMMISSIONING - NO OPEN ITEMS IDENTIFIED IN SECTION 5.9.

10.3.5.10 MEASURES AND CONTROLS TO LIMIT ADVERSE IMPACTS DURING OPERATION - SEE TABLE 10-3 FOR ITEMS THAT ARE DUPLICATED FROM OTHER SECTIONS OF THIS CHAPTER.

10.3.6 Chapter 6, Environmental Measurements and Monitoring Programs - See table 10-3 for open items that duplicate those in other sections.

10.3.7 Chapter 7, Impacts of Postulated Accidents Involving Radioactive Materials - See Table 10-3.

10.3.8 Chapter 8, Evaluation of the NPP Site - See Table 10-3.

10.3.9 Chapter 9, Alternatives to the Proposed Action - No open items identified in Chapter 9.

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
Permits, Approvals and Consultations			
EA-0.0[3]	EA Requirements and Guidelines	The final environmental assessment should consider any changes to the documents listed in Appendix 1.3A-1 and any new laws or conventions related to environmental assessment in order to assure that the assessment complies with the latest requirements and guidelines. It is particularly important to consider any revisions to RoA laws and decrees.	1.3
EA-1.0[4]	Status	The final EA should reflect the latest status of reviews, approvals and consultations related to the environmental assessment (update Table 1.2-1).	1.2
EA-1.1		The final EA should provide a list of organizations consulted during the EA process.	1.2.7.1

[3] Environmental Assessment (EA-) item numbers are assigned to facilitate future tracking of open items. Those with **bold** numbers are considered the most significant open items needing action.
[4] Environmental Assessment (EA-) item numbers are assigned to facilitate future tracking of open items.

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
EA-1.2		When the design for the various plant water systems is complete, proposed additions of chemicals should be evaluated against applicable water discharge criteria. The need to control sulfates in plant discharges must be evaluated when applying for the water use (and discharge) permit.	5.5.1.1.1, 5.10.5
EA-1.3	Seismic Hazard Studies	Complete seismic hazard studies, as outlined in Table 10-2, items C-SS-1.0 through C-SS-1.8.	2.6.2
Site Layout and Appearance			
EA-1.4	Drawings/Figures of site and Unit 3	The final EA should include Figure 2.1-5 showing a high oblique aerial view of the site or a perspective drawing.	2.1.4
EA-1.5		Figure 3.1-5 should be provided to show an architectural rendering of the site with the addition of Unit 3.	3.1
EA-1.6		Figure 3.1-10 (a modification of Figure 2.1-5) should be provided to illustrate the appearance of the ANPP site with the addition of Unit 3.	3.1
EA-1.7		Confirm that the ANPP site, as illustrated in Figure 2.2-6, area designated with (circle) 1, is the area in which the ANPP Unit 3 operator will have control over activities, including exclusion or removal of personnel and property, and thus is the “owner controlled area.”	2.2, 8.1.1
Accident Analyses			

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
EA-2.0		The final EA should include the results of appropriate dose analyses based on site-specific meteorological factors, expected source terms for the selected reactor, and the evaluation of exposure pathways.	2.7.3, 5.4, 6.4.1, 7.1.4.1
Miscellaneous			
EA-3.0	Radioactive Waste Management and Transportation	The final EA should reflect in Section 3.8 the strategy for radioactive waste management in Armenia, when it is promulgated.	3.0, 3.5, 3.8
EA-3.1		The final EA should reflect the expected method of transport of new reactor fuel for Unit 3 (e.g., air cargo or by rail), along with an assessment of the risks of that mode of transport.	3.8.1, 7.4.3
EA-3.2		The final EA should confirm that solid radioactive wastes will not be transported off of the ANPP site for storage or disposal.	3.8.3, 7.4.1
EA-3.3		The final EA should confirm that irradiated (spent) reactor fuel will be placed in dry storage (after a suitable decay time in a spent fuel pool) on the ANPP site and will not be transported off site for storage until it is shipped for reprocessing and/or disposal.	3.8.2, 7.4.1, 7.4.2
EA-3.4		If possible disposition options for spent reactor fuel are known, they should be reflected in the final EA and the risks of potential transportation modes evaluated.	3.8.2, 7.4.2
EA-3.5	Power transmission systems	The Developer must assess the environmental impacts of the	3.7.2.5, 4.4.1.1, 5.6

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
		new transmission line construction and operation, once the corridor routing is defined.	
EA-3.5	Land transfer to ANPP	The RoA has indicated their intent to give the ANPP control over an additional 289 ha of adjoining property. Figures and tables should be revised to reflect these changes.	1.1, 2.1, 2.2.3.2, 4.1
Flora and Fauna			
EA-4.0	Flora and Fauna Inventory	An inventory of species present at or near the ANPP site should be taken, to: show whether any endemic species occur and establish whether other species of potential medicinal value are present.	2.4.1, 4.3.2, 4.3.3
EA-4.1		An inventory of floral and faunal species present at or near the ANPP site and intake and discharge areas on the Sevjur River should be conducted and measures developed to protect any identified species of special importance.	2.4.1, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.6.3, 6.1
EA-4.2		A study of the reproduction of the fish of the Sevjur should be undertaken. When the final design of the intake for Unit 3 is evaluated, the losses of eggs and larvae at all water intakes along the stretch of the Sevjur River above the ANPP intake should be assessed to determine the cumulative impact of water withdrawals in the Sevjur River system.	2.4.1.6, 5.3.1, 6.1

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
EA-4.3	Flora and Fauna Protective Measures	If shoreline work is determined necessary for intake systems, an environmental review of construction plans should be performed to ensure that the wetland habitat is protected from construction impacts.	4.3.1
Designer Issues			
EA-5.0	Bounding parameters	When the selected reactor design is known, design-specific parameters should be compared against those in Appendix 3.2A to confirm that the parameters critical to the environmental assessment are bounded by those used in this EBID. For any parameters outside those in Appendix 3.2A, the impacts of those parameters should be assessed.	3.2.1
EA-5.1	Storm water	Design studies needed to determine if provisions must be made for storm water on/from/across the construction site.	4.2.1, 4.6.2, 6.1
EA-5.2	Water intake	Design studies needed for water supplies to determine if Sevjur River channel will be altered and resulting impacts must be assessed.	4.2.1, 4.3.1, 4.6.2, 4.6.3, 6.1
EA-5.3	Discharge pipe	Design studies are needed for extension of the discharge pipe to the Sevjur River to determine impacts on river channel.	4.2.1, 4.3.1, 4.6.2, 4.6.3, 6.1
Surveys, Censuses, and Studies			
EA-6.0	Traffic	A traffic flow study and measurement of resulting noise levels	4.4.1.3, 4.4.1.5.1, 6.2.1

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
		should be performed to allow assessment of the impacts and to support decision making regarding mitigation measures for increased traffic in the area during construction.	
EA-6.1	Noise	Surveys of ambient noise levels and census of noise receptors should be conducted to support the analysis of noise impacts of construction.	4.4.1.5, 6.2.1
EA-6.2		The Constructor should survey noise levels from construction equipment to be used at the site (including simultaneous operation of multiple pieces of equipment), compare with the levels in Table 4.4-1, and prepare mitigation plans where noise levels could exceed the guidelines of MoH Order 138.	4.4.1.5, 6.2.1, 6.3.1
EA-6.3		A survey and assessment of noise abatement features of the local terrain should be completed to determine if additional measures, such as earthen berms, should be employed near the construction site.	4.4.1.5, 6.2.1
EA-6.4	Labor	The results of the MoE/IAEA resource study and plans for accommodating relocating workers should be compared with the assumptions in EBID Section 4.4 to determine if predictions must be revised for the final EA.	4.4.2, 4.4.2.1, 4.6.4
EA-6.5		The degree of stresses on the labor market should be assessed following completion of the MoE/IAEA study.	4.4.2.1, 4.6.4
EA-6.6	Housing	A survey of vacant housing stock in Armavir and Metsamor towns should be conducted to support the final EA.	4.4.2.1

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
EA-6.7	Radiation	A detailed radiation survey of the construction zones and construction support area shown on Figure 2.1-4 should be conducted (including along the fences surrounding the buildings near item 78 in that figure) to confirm that the predicted doses in EBID 4.5 are bounding.	4.5.2, 6.2.2
EA-6.8	Farming, hunting and fishing	In order to define the limiting individuals for radiation exposure due to releases from ANPP Unit 3, a current survey is needed to identify: - Individuals (or families with infant children) who receive their drinking water from sources within 10 km of the site; - Individuals who consume fruits and vegetables primarily grown within 10 km of the site; - Individuals (or families with infant children) who consume milk and dairy products primarily from cows or goats raised within 10 km of the site; - Individuals who consume fish or other aquatic life caught primarily within 10 km of the site; - Individuals who consume meat from animals raised within 10 km of the site; and - The location of milk-producing animals and farms raising poultry or animals for meat production within 10 km of the site.	2.5.1.1.1, 5.4.3, 5.4.6, 5.8.3, 5.8.3.1
EA-6.9	Income Levels	In order to assess the impacts on low income population within the 16 km zone, statistics are needed from the Family	2.5.1.1.1

Table 10-3, Environmental Assessment Open Items

Item	Topic	Description	Reference Chapter / Section / Subsection
		Poverty Database System on numbers of individuals and families qualifying as poor within the 16 km zone.	

10.4 CONCLUSIONS

This Section summarizes the conclusions regarding the impacts of construction and operation, postulated accidents, and site suitability.

As noted in the introduction to this chapter, the following are only summaries of conclusions which must be considered within the context of the other sections of the EBID where more complete discussion is provided; extraction of information from this subsection must be done carefully to ensure that it is placed in proper context.

10.4.1 Impacts of ANPP Unit 3 Construction

Impacts due to construction are best controlled by using construction practices that do not produce impacts or at least minimize impacts. Construction activities should be planned and conducted in a manner that results in minimal environmental impact. A set of construction practices that minimize impacts are recommended throughout Chapter 4 and summarized in Section 4.6.

Land use impacts are anticipated to be SMALL; however, land in the vicinity of the site may be impacted by degraded air quality due to dust during construction and vehicle emissions. Noise of construction equipment is also a potential impact on use of neighboring land. Measures to prevent or mitigate these impacts are recommended in Section 4.1.3.1 and Table 4.6-1.

Water-related impacts of construction are expected to be SMALL. Design studies are needed for assessment of potential impacts at water intake and discharge locations. Measures to prevent or mitigate the potential for contamination of surface and ground waters during construction are identified in Section 4.2.3 and in Table 4.6-2.

Ecological impacts of construction are expected to be SMALL. Inventories of flora and fauna near the plant intake and discharge sites are necessary to assess potential impacts there. Measures to prevent or mitigate impacts are identified in Sections 4.3.1 and 4.3.3 and in Table 4.6-3.

The socioeconomic impacts of construction are anticipated to be SMALL, except:

1. Traffic impacts due to transportation of workers and equipment;
2. Noise impacts on nearby residents due to operation of construction equipment;
3. Noise impacts due to peak traffic volume if it is routed through Metsamor Town; and
4. Impacts of in-migrating workers on Metsamor and Armavir Towns (based on the assumption that the majority of workers will locate there).

Measures to prevent or mitigate socioeconomic impacts are identified in Sections 4.4.1 and 4.4.2 and in Table 4.6-4.

The potential adverse impacts due to radiation exposure of construction workers during construction are anticipated to be SMALL. Measures to ensure that radiation doses remain as low as reasonably achievable are identified in Section 4.5.5 and in Table 4.6-5.

10.4.2 Impacts of ANPP Unit 3 Operation

Land use impacts of unit operation are anticipated to be SMALL for all categories. No measures to prevent or mitigate impacts are identified in Section 5.1.

Water-related impacts of operation are expected to be SMALL, assuming that the GoA actions given in Section 1.1.3.3 and listed in Table 10-2 are taken.

The impacts of cooling system operation are expected to be SMALL for all categories. Measures to prevent or mitigate the potential for impacts on fish in the pool from which water is drawn and operation of the switchyard under cooling tower drift conditions during plant operation are identified in Sections 5.3.1 and 5.3.3.4 and in Table 5.10-3.

The radiological impacts of normal plant operation are expected to be SMALL. A census of farm animals and subsistence practices in the site vicinity is necessary to identify limiting individuals for ingestion doses.

The environmental impacts of waste are anticipated to be SMALL for all categories, assuming that the GoA actions are taken to establish appropriate water quality standards for the Sevjur River as discussed in Section 1.1.3.3 and as listed in Table 10-2. It is recommended that a radwaste disposal plan be developed consistent with Initial Planning Studies, Chapter 5. Measures to prevent or mitigate impacts are recommended in Sections 5.5.1 and 5.5.2, and in Table 5.10-5.

The impacts of the new 400 kV line between ANPP and Hrazdan must be considered once the routing of the line is determined. Otherwise, the impacts of transmission system operation are anticipated to be SMALL, if any.

Based on existing fuel cycle technologies, the impacts are anticipated to be SMALL and no mitigation measures are necessary.

Potential adverse socioeconomic impacts of Unit 3 operation are anticipated to be SMALL, if any, for all categories evaluated except:

- Population increases in Metsamor Town due to new operating staff for Unit 3 (population increases due to new staff may be offset by departure of staff retiring from Units 1 and 2).

- Increases in costs of housing in Metsamor Town due to new residents (impacts may have already occurred due to pressures during construction phase).

Measures to prevent or mitigate impacts are recommended in Sections 5.8.1.1, and 5.8.2, and in Table 5.10-8.

Environmental impacts of Unit 3 decommissioning are expected to be SMALL and no measures to prevent or mitigate impacts of decommissioning are necessary.

10.4.3 Impacts of Postulated Accidents Involving Radioactive Materials

The anticipated impacts of design basis accidents were assessed based on the results of accident analyses for the AP1000, accounting for atmospheric dispersion factors based on Zvartnots International Airport meteorological data. The results of this assessment show that the impact of design basis accidents at ANPP Unit 3 would be SMALL. (Design basis accident results for other reactors may have different offsite consequences.)

Based on assumptions that solid radioactive waste will be stored and disposed of on the ANPP site and that spent nuclear fuel will be placed in a dry storage facility on the site, no transportation accidents involving these materials are expected. In any case, onsite accidents involving spent nuclear fuel or radioactive wastes should be bound by the design basis accident results for a fuel handling accident, which are shown as acceptable.

Actual expected transportation means and conditions for new (un-irradiated) and spent (irradiated) nuclear fuel must be evaluated when necessary details are known. Likewise, the potential impacts and risks of severe accidents must be evaluated when a specific reactor design is selected and site-specific parameters affecting transport of radioactivity are known.

10.4.4 Suitability of ANPP Site for New Unit

The suitability of the ANPP site relative to seismicity and geology has been studied in the past, most recently in: *Additional Studies on Armenia Nuclear Power Plant Seismic Conditions* by ARMENERGYSEISMICPROJECTS Institute (1995); *Probabilistic Seismic Hazard Assessment of the Armenian NPP Site* by National Survey for Seismic Protection (2004); and, *Seismic Hazard Assessment for the Armenia Nuclear Power Plant Site*, prepared under DTI Project NSP-04 / A18 by Aspinall and Associates (2006). These studies were reviewed by the International Atomic Energy Agency in: *Review of the Probabilistic Seismic Hazard Assessment of the Armenian NPP Site*, IAEA-TCR-02362 (2004) and *Follow Up Review of the Probabilistic Seismic Hazard Assessment (PSHA) for the Armenian NPP Site*, IAEA-TCR-03094 (2006). As discussed in EBID Section 2.6, an additional seismic assessment study is planned to take place in 2008 and 2009 to respond to recommendations of the IAEA seismic safety review missions and to conduct a probabilistic seismic hazard analysis following the guidelines of IAEA Safety Standards Series No. NS-G-3.3, *Evaluation of Seismic Hazards for Nuclear Power Plants*.

Based on the accident dose analyses described in Chapter 7, population densities generally meet international guidelines for siting of a nuclear facility. Population density for radial distances 7 to 10 km and 10 to 15 km exceed US NRC guidelines by approximately 50% because these distance ranges encompass the towns of Armavir and Vagharshapat, respectively; however, the population density out to a radial distance of 30 km is within the guideline value.

Extensive emergency planning has been done and the emergency plan developed for the operating ANPP Unit 2 will serve as a suitable basis for the emergency plan applicable when Unit 3 becomes operational. There are no physical characteristics of the site that pose a significant impediment to development of emergency plans for Unit 3.

The ANPP site has sufficient room to allow for implementation of security plans and measures for Unit 3.

The probability of extreme meteorological events impacting the ANPP site is sufficiently low and expected conditions, such as tornado characteristics, are within design limits typical for modern reactor plant designs. There are no conditions that prevent normal atmospheric dispersion of plant effluents in the site vicinity.

The potential for flooding at the site is low because of the low rainfall in the area draining toward the site and because the site sits at a high elevation above the Sevjur and Araks Rivers.

Design features are needed to protect control room operators from accidental releases of sulfuric acid stored on the ANPP site and or due to damage of railway cars on the nearby Yerevan-Tblisi railway. A survey of hazardous chemicals transported on Highway M-5 is needed to determine if any additional protective measures are needed.

Preliminary screening indicates that the affects of an airplane crash need not be considered during plant design. Nevertheless, an in-depth probabilistic analysis of aircraft crashes is recommended to determine if the plant design must accommodate aircraft impacts.

The ANPP site is not at risk due to explosions on nearby transportation routes.

Design features of onsite fuel supplies, in combination with site fire protection measures, minimize the hazard of large fires impacting Unit 3.