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European Bank for Reconstruction and Development

Armenian Small Municipalities Water Project
Engineering, Design and Contracts Supervision

Proj. No. 610-1182

Detailed Design
Environmental Impact Assessment

DILIJAN – WATER SUPPLY SYSTEM AND SEWER NETWORK

04/2013

FICHTNER
WATER & TRANSPORTATION

"JRTUC" LLC

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Issue and Revision Record

No.	Date	Originator	Checked	Description
A	11/04/2013	K. Hovhannisyan “Jrtuc” LLC	M. Uhlich	-

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Structure of Detailed Design

Volume I	**Detailed Design Report (excluding cost calculation)**
Volume II	**Detailed Design Drawings**
	Book 1: Water Supply
	Book 2: Sewerage
Volume III	**Environmental Management Plan**
Volume IV	**Detailed Design Cost Calculation (confidential)**

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Abbreviations

ASMWP	Armenian Small Municipalities Water Project
AWSC	Armenian Water Sewerage Company
Bank	European Bank for Reconstruction and Development
Client	Armenian Water Sewerage Company
CNR	Construction norm
Consultant	Fichtner Water & Transportation GmbH in association with Jrtuc LLC
DRR	Daily Regulation Reservoir
EBRD	European Bank for Research and Development
EN	European norm
FWT	Fichtner Water & Transportation GmbH
mg/l	milligram per litre
mg*eq/l	milligram equivalent per litre
WWTP	Waste Water Treatment Plant
LCGA	Local self-governance agency

Literature

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1. INTRODUCTION

Anthropogenic environmental impact of the human activities: The correct and complete environmental impact assessment has a significant role for the sustainable use of the ecosystems and for maintaining the harmony between the nature and human life activities. The environmental assessment shall include the forecast of the direct and indirect impacts, their description and shall be a base for the development of the necessary measures aimed at their prevention or possible mitigation.

In accordance with the RA Law "About the Environmental Impact Assessment Expertise", all types of the foreseen activities, which have an environmental impact, are subject to an obligatory environmental expertise.

The design for "The Reconstruction of the Water Supply and Wastewater Network of Dilijan Town" has been implemented in the administrative area of Dilijan town of RA Tavush Marz. The administrative area covers 43km^2 and is located at 1250-1500m a.s.l.

The presented paper is developed in accordance with the requirements of the RA Law "About the Environmental Impact Assessment Expertise" and includes justifications for the data and calculations, which are necessary for implementing the environmental impact assessment of the foreseen activities.

2. THE MAIN CONCEPT AND OBJECTIVES OF THE DESIGN

The main objective of the works foreseen in the project is the improvement of the water supply and wastewater systems of Dilijan town.

The objectives of the future water supply improvement of Dilijan town water supply system are as follows:

- Detailed studies of the existing system (water resources, distribution network, reservoirs, etc.),
- Reduction of water losses,
- Ensuring the continuity of the water supply,
- Compliance with the water quality standards.

Generally the preference is given to a gravity-operated reservoir-fed distribution system. The objectives for the reconstruction of the water supply system components (mains, distribution network, reservoirs, etc.) are the following:

- Maintaining a sustainable pressure in the water supply network
- Satisfaction of the water demand during the implementation of the maintenance works

The main objectives for the reconstruction of the wastewater system are the following:

- Organizing a safe wastewater disposal to the treatment plant
- Organized disposal and treatment of sewerage

In order to reach these objectives, several parts of the existing wastewater network shall be rehabilitated and additional works shall be carried out.

3. DESCRIPTION OF BASELINE ENVIRONMENTAL CONDITIONS

Dilijan town is located in the western part of the valley of Aghstev River, 96km far from Yerevan. The town is located at the elevation of 1250-1500m a.s.l. The main industrial sector is the processing industry with major role of food and mineral water production.

The city area is covered with deep woody canyons, steep rocks and forests. The city area with its surroundings makes up Dilijan National Park.

3.1 Climate

The climate is specified by mild summer and mild winter. In winter the relative air humidity is maintained constantly. The average annual precipitation is up to 661mm and the average annual air temperature is +8.2oC. The absolute minimal temperature is -23°C, and absolute maximum is +38°C. The average thickness of snow cover in 10 days is 66cm, soil frost depth – 80cm.

The precipitation is observed mostly in spring months. The long-term average monthly and annual precipitation in millimeters is presented in Table 3-1.

Table 3-1. Average monthly and annual precipitation

Months												
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Annual**
32	32	52	67	108	104	68	51	50	44	37	24	661

3.2 Water Resources

The main water resource of Dilijan town is Aghstev river. Aghstev river is one of the big tributaries of Kur river and flows into the latter from the right bank. The total river basin area is 1270km^2, the length is 106km. The average incline of the river is 16%, the avearge elevation of the basin is 950m, and the river network density coefficient is 0.78km/km^2.

Aghstev river is a typical mountain river with a seasonal nature of eth water regime. The river has a mixed feeding though snow, rain and ground waters. The annual flow distribution of Aghstev river is characterized by strongly expressed, long lasting spring floods and constant low flows. The rise in water level during the spring floods starts in March and the low flow season starts in mid-July. The average natural outflows of Aghstev river (m^3/s) - based on Ijevan water metering station data, are presented below.

Table 3-2. Average natural outflow of Aghstev river

Months											
I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
3.41	3.95	12.20	5.7	41.7	5.57	7.62	4.21	3.96	4.70	3.91	0.795

The surface waters are characterized by light mineralization – 100-200 mg/l, moderate hardness (content of Ca^{2+}+Mg^{2+} ions makes up 1.5-3.0 mg*eq/l) and high aggressiveness - the content of HCO_3^- makes up 2.0 mg*eq/l.

The ground water basin is rich with high-quality fresh waters, which are a source of water supply.

The surface runoff water has weak mudflow formation potential and moderate mudflow activity (once per 3-10 years).

3.3 Lands

The foundation for the geological structure of Aghstev river basin area are volcanic-sedimentary rocks.

The geological structure is as follows: upper pliocene, river, flood and slope sediments. New volcanisms are absent.

The surface formation is characterized as lower mountain zone with mild-inclined, partly rocky slopes, cut with V-shaped and sometimes box-shaped valleys.

The classification by relief types are IV accumulative "sedimentative, inwash" relief, plains, alluvial-pluvial mild-inclined foothills, as well as water-erosive and water-accumulative relief type, wide valleys.

The land is used mainly for agricultural purposes - orchards, vineyards, vegetable crops, arable land, pastures. From the agricultural production grouping perspective, the soil belongs to forest brown and washed out forest-steppe rocky loam group.

The soil cover of the area belongs to forest brown and washed out forest-steppe rocky loam type.

3.4 Flora

The flora of the area is mainly forest type. Forests are located on the steep slopes with risk of erosion. The general erosion level of the area reaches up to 45-70%. The flora is represented by Fagus orientalis Lipsky, Quergus iberica Stev., Carpinus betulus L., C. orientalis Mill type formations.

Cereal multi-grass and meadow-steppe groups are found in the field parts. Rose-hip bushes are spread next to the forest flora in the rocky-bush parts.

The main medical herbs are Hypericum perforatum L., Leonurus cardiaca L., Thymus kotschyanus Boiss. Et Hohen., Equisetum arvense L., etc.

3.5 Fauna

The vertebrates include forest cat, highbred deer, squirrel, european roe deer. Mammal fauna includes brown bear, wild boar, wolf, fox and marten. Reptiles are wide spread.

The forest is reach with birds – tomtits, chaffinches, bullfinches. The feathery predators include owls, eagle owls, common buzzards.

Invertebrates include rainworms, ants, bees, locusts, crickets, grasshopers, woodlice, large blue butterflies, mosquitos, flies and shrimps.

3.6 Special Nature Protection Zones

Due to the geographical position of the region, the irregularity of the relief, different locations of slopes, interaction of floristic regions it is known for its rich landscape- and bio-diversity. In order to preserve this diversity, Dilijan State Park was established as a special nature protection zone.

3.7 Social-Economic Conditions

All objects foreseen within the project will be installed in Dilijan and Haghartsin administrative areas.

Dilijan

The town occupies the surface of 43km, the number of the population is 22100 inhabitants (as of 1 January 2012): The distance from Yerevan is 99km, from Marz central town – 34km, and from the state border – 52km. It is located at 1250-1500m a.s.l. There are old tumble-down churches, chapels.

The conditions in the Dilijan town are as follows:

1. Climatic conditions – mild zone, the average annual air temperature is 8.2°C
2. Provision with drinking and irrigation water - deficient
3. Town is gasificated
4. Condition of the roads - sufficient
5. Main occupation of the population – plant cultivation, cattle breeding

The town has:

1. 5 schools with 1350 students
2. Medical center
3. Cultural center
4. Community center
5. 6 operating kindergartens
6. Musical schools
7. Arts school
8. Art gallery
9. Museum

The XVIII century church in Shamakhyan district is among the historical-cultural monuments.

Haghartsin

Haghartsin administrative area occupies a surface of 36.7km^2. The number of population is 3784 (as of 1 January 2012). The distance from Yerevan is 110km, from Marz central town – 23km, and from the state border – 41km. It is located at average of 1050m a.s.l.

The conditions in the community are as follows:

1. Climatic conditions - moderate zone, the average temperature in summer is +19°C and in winter - -2 °C
2. Historical-cultural monuments - Haghartsin monastery complex
3. Area occupied by the community - 2775.88ha, out of which 1055.3ha of pastures and 157.65ha of arable lands
4. Occupation of the population - plant cultivation, cattle breeding
5. Provision with drinking water - sufficient, with irrigation water - insufficient
6. Community is gasificated
7. Condition of the roads - sufficient

The community has:

1. a school with 1000 students capacity; actual number of students - 550
2. Medical center
3. Cultural center
4. Community center
5. Kindergarten

4. DESCRIPTION OF THE FORESEEN ACTIVITY

4.1 General Information

The following objects are included in the structures of Dilijan town water supply system and wastewater network:

- Pumping station
- Transmission mains
- Distribution networks
- Daily Regulation Reservoirs
- Sewerage system

The main indicators for the structures are presented in Table 4-1.

Table 4-1. Main indicators for W&W systems

N/N	INDICATORS	MEASUREMENT UNIT	QUANTITY
1	Pumping station	UNIT	2
2	Transmission mains	KM	3.555
3	Distribution network	KM	18.2
4	DRR	UNIT	2
5	Sewerage system	KM	10.182

4.2 Pumping station

It is proposed to construct a pumping station within the project – with installation of 2 groups of pumps.

The general characteristics of the foreseen pumping station are presented in Table 4-2:

Table 4-2. General characteristics of the pumping station

Pumping station name	Pump groups to be installed/ level - m	Supplied DRR / level –m	Type of pumps	$Q_{d.max}$ l/s	H m	Number of daily operation hours (average daily) Hours	Pressure pipeline
Shamakhyan pumping station	I group	Right bank DRR	Vertical	16	152	20	DN 150, L= 1,25km
	1361	1500					
	II group	Left bank DRR	Vertical	4	213	20	DN 100, L= 2,43km
	1361	1560					

4.3 Transmission mains

The design proposes to construct transmission mains in two directions: I – for the supply of the right bank DRR, II – for the supply of the left bank DRR. The parameters for the foreseen transmission mains are presented in Table 4-3.

Table 4-3. Main parameters of the transmission mains

Name	Description of works
TM-1 Transmission main of the Right bank	Depending upon head, the transmission main will comprise 3 sectors: • Steel - D 159x4,5; L=200m • PE, OD160; L=350m, PN16 • PE, OD160; L=575m, PN10 Air vents and wash outs will be foreseen at all required locations. Transmission main total length is 1,125km
TM -2 Transmission main of the Left bank	For the same reasons, this transmission main will comprise 3 sectors as well: • Steel - D 108x4; L=200մ • PE, OD110; L=814m, PN16 • PE, OD110; L=1416m, PN10 Air vents and wash outs will be foreseen at all required locations. Transmission main total length is 2,43km

4.4 Distribution Network

Taking into account the complicated mountain terrain of the serviced district, a sectorization of the distribution network is foreseen in the design. Based on the hydraulic calculation, the following rehabilitation and extension works are proposed for the distribution network.

Table 4-4. Rehabilitation works in the water supply system

Construction of distribution network km	Construction of water main km	Reconstruction of water main km	House connections pcs
13.7	3.55	0.96	324
Total - 18.2 km			

4.5 Daily Regulation Reservoirs

The design proposes to implement the construction of one new reservoir with the capacity of 300m^3 in Shamakhyan district and the rehabilitation of the existing 500 m^3 DRR which is in an emergency condition.

Table 4-5. Rehabilitation works on the reservoirs

Name	Description of works
DRR of the Right bank	- Major repair of the cover slab - Cast concrete of the floor - Shotcreting of the walls and floor over a metallic mesh - Construction of inlet and outlet valve units - Rehabilitation of the sanitary zone

4.6 Sewerage System

Based on the studies and calculation in the design it is proposed to foresee the following works in Dilijan town sewerage system (Table 4-6).

Table 4-6. Rehabilitation works in the sewerage system

Construction of collection network km	Construction of sewerage collector km	Construction of manholes pcs
7,038	3,144	262
10,182		

5. DESCRIPTION OF THE ENVIRONMENTAL IMPACT DURING THE IMPLEMENTATION OF THE DESIGN (CONSTRUCTION) AND OPERATION OF THE SYSTEM

The environmental impact of the rehabilitation works for Dilijan town water supply system and wastewater network is assessed both in the construction and operation stages.

5.1 Construction Works

The total duration of the construction works implementation stage will be 10 months, including the preparatory works, earth works, installation of pipes and installation and testing of equipment. Each part of the works has its duration, based on which the environmental impact of the separate works has been assessed.

5.1.1 Impact on the atmosphere during the construction works

a) *Calculation of dust emissions during the excavation-loading works*

The calculations are done in accordance with the acting methodological procedure (5).

$$Q = (P_1 \times P_2 \times P_3 \times P_4 \times P_5 \times G \times 10^6 \times B \times P_6)/3600 \text{ t/h, where (1)}$$

P_1 – is the share of dust fraction, 0.05
P_2 – is the share of 0-50 mkm sized particles in the spreading dust aerosol, 0.02
P_3 – coefficient, which takes into account the speed of wind in the area of operation of the construction machines, 1.0
P_4 - coefficient, which takes into account the humidity of the material, 0.2
P_5 - coefficient, which takes into account the largeness of the material, 0.5
P_6 - coefficient, which takes into account the terrain conditions, 1.0
B - coefficient, which takes into account the height of unloading, 0.6
G – the volume of the processed soil, 38242 m^3.

According to the working design time-schedule the duration of the earth works is 8 months,

8 months x 30 days/month x 8 hours/day = 1920 hours/constr.

G - 38.242 m^3 . 1920 hours/constr. = 20 m^3/hour or , taking into account the specific weight -

20 m^3/hour x 2.7 t/m^3 = 54 t/hour

$Q = (0.05 \times 0.02 \times 1.0 \times 0.2 \times 0.5 \times 54.0 \times 10^6 \times 0.6 \times 1.0)/3600 = 0.81$ g/s or

0.81 g/s x 1920 hours/constr. x 3600s/hour : 10^6 = 5.6 t/constr. period

b) *Emissions related to diesel fuel*

The emissions related with the diesel fuel are calculated in accordance with the methodological directive[1] about "Defining the volumes of emissions of hazardous substances from automotive transport".

The specific emissions from heavy automotive transport and machinery are presented in the Table below in accordance with the above mentioned methodological procedure.

Table 5-1. Specific emissions (g/kg of fuel)

Type of fuel	Substances						
	NO_x	CH	EOP	CO	N_2O	CO_2	SP
Diesel	42.3	0.243	8.16	36.4	0.122	3138	4.3

The adjustment coefficients for the hazardous emissions based on the average age and technical conditions of the vehicles are presented below:

Table 5-2. Adjustment coefficients for the hazardous emissions

Vehicle category	Hazardous substance	Impact coefficient	
		for average age of the vehicles	for technical condition
Automotive transport with high load capacity	CO	1.33	1.8
	CH	1.2	2.0
	NO_x	1.0	1.0
	CO_2	1.0	1.0
	N_2O	1.0	1.0

The coefficients for carbon monoxide (CO), hydrocarbons (CH), and nitrogen oxides (NO_x) are taken from the "Methodological instructions for calculation of the emissions of hazardous substances to atmosphere from automotive transport" (Moscow, HydrometHrat -1983), whereas the coefficients for carbon dioxide (CO2) and nitrous oxide (N2O) have been assumed as 1, because no other values are proposed for them.

A total of 13 technical means, which use diesel fuel, will be operated during the construction works (2 trucks, 1 bulldozer, 2 mini excavators, 1 pipe-laying crane, 2 compactors, 2 wheel-based excavators, 1 asphalt compactor, 2 welding machines).

The average daily consumption of diesel fuel will be 640 l, and taking into account the specific weight - 640 x 0.85 = 540 kg/day.

The quantities of the machines and fuel used during the construction stage are shown in Table 5-3.

Table 5-3. The quantities of the machines and fuel used during the construction stage

N/N	Name of machine	Quantity	Daily normative fuel consumption	Amortisation coefficient	Daily fuel consumption	Cumulative fuel consumption
		pcs	l/day		l/day	l
1	Mini excavator	2	60	1	60	6120
2	Wheel-based excavator	2	100	1	100	6600
3	Crane	1	40	1.2	48	1488
4	Compactor	2	15	1.2	18	1152
5	Dump truck	2	60	1	60	8640
6	Welding machine	2	20	1	20	440
8	Asphalt compacting machine	1	30	1.2	36	864
9	Bulldozer	1	40	1	40	920
	Total	**13**			**640**	**26224**

The operation of the heavy machines and trucks will be done for 5 months and the volumes of emissions during that period will be as follows:

5 months x 30 days x 540kg/day = 81000 kg/constr. period.

Table 5-4. Specific volumes of emissions

Vehicle category	Hazardous substance	Specific emissions, g/kg	Emissions, t/constr. period	Emissions, g/s
Automotive transport with high load capacity	CO	87.14	7.0	1.5
	NO_x	42.34	3.4	0.8
	Hydrocarbons	8.4	0.7	0.15
	Solid particles SP	4.3	0.3	0.07

Sulfur Dioxide
The emissions of sulfur dioxide (SO_2) are calculated based on the approach, where all the sulfur contained in the fuel fully transforms into SO_2. In this case the formula of CORINAIR inventory system is used:

$$ESO2 = 2\Sigma ksb, \text{ where}$$

ks - is the sulfur content in the fuel - 0.002 kg/kg
b – is the fuel consumption - 323 kg, or 0.3 t/constr. period

$$SO2 = 2 \times 81000 \text{ kg} \times 0.002 = 324 \text{ kg/constr. period or}$$

$$324 \times 1000 : 5 : 30 : 8 : 3600 = 0.07 \text{ g/s.}$$

c) Emissions related to the welding works

The welding works are implemented using E42A type electrodes, which results in estimated emissions of welding aerosol - 17 g/kg, manganese oxides - 1.1g/kg and chrome oxides - 0.43g/kg. The welding works are carried out during 22 days.

It is foreseen to consume up to 20 kg of electrodes per day, thus the emissions will be:

- welding aerosol - 0.01 g/s or 0.007 t/constr. period
- manganese oxides - 0.0006 g/s or 0.0004 t/constr. period,
- chrome oxides - 0.0003g/s or 0.0002 t/constr. period.

d) Bitumen works

During the bitumen works performed on the pipes, concrete and metallic constructions, there are evaporation of solvents used for thinning of bitumen, as well as emissions of hydrocarbons. The calculation of emissions has been done in accordance with Corinair (6) methodological procedure (SNAP CODE 040611).

$$G = V_{asf} \times K_1 \times K_2 , \quad \text{where}$$

G – emission of organic solvent during construction period, t/const.

V_{asf} - bitumen volume, 2.2 m^3,

K_1 – solvent containing ratio, 0.25

K_2 – share of hydrocarbons emission according to solvent volume, 0.05;

G = 2.2 x 0.25 x 0.05= 0.0275 t/const. period

Bitumen works are implemented during 10 months, however their total duration is 6 days.
$G = 0.0275t \times 10^6$ g/t : 0.2 month : 30 days/month : 8 hours/day : 3600 s/hour = 0.16 g/s
Table 5-5 presents the volumes of emissions for both short-term and whole construction period by types of works.

Table 5-5: Emission volumes during construction period

Stages of construction works	Emission volumes, t/const. period (g/s)								
	Dust	**CO**	**NO_x**	**Hydrocarbons (CH)**	**Solid particles (SP)**	**SO_2**	**Welding aerosol**	**Manganese compounds**	**Chrome oxides**
1	2	3	4	5	6	7	8	9	10
1.Excavation-loading works	5.6 (0.81)	-	-	-	-	-	-	-	
2. Emissions related to diesel fuel	-	7.0 (1.5)	3.4 (0.8)	0.7 (0.15)	0.3 (0.07)	0.32 (0.07)	-	-	-
3. Welding works	-	-	-	-	-	-	0.007 (0.01)	0.0004 (0.0006)	0.0002 (0.0003)
4. Bitumen works	-	-	-	0.0275 (0.16)	-	-	-	-	-
TOTAL	**5.6 (0.81)**	**7.0 (1.5)**	**3.4 (0.8)**	**0.7275 (0.31)**	**0.3 (0.07)**	**0.32 (0.07)**	**0.007 (0.01)**	**0.0004 (0.0006)**	**0.0002 (0.0003)**

As seen in the table, the emission volumes are not high and cannot have significant environmental impact. The works are of a temporary nature and emissions will stop after the completion of the works.

5.1.2 Water resources

Water usage

During the construction works the water is used for domestic and technical needs of the staff and for watering (dust prevention).

a) The domestic water usage for the staff if calculated as follows:

$W_{d.t.}$ = (n x N + n_1 x N_1) x T, where
n – ET staff 5 persons
N – ETS water usage normative 0.016 m^3day/person
n_1 – service staff (including drivers) 30 persons
N_1 – service staff water usage normative 0.025 m^3day/person
T – number of working days 300 days
$W_{d.t.}$ = (5 x 0.016 + 30 x 0.025) x 300= 249 m^3/const. period or 0.83 m^3/day:

Drinking water will be provided by water trucks and will be stored in a special tank.

b) Water consumption for watering is defined as follows:

$M_1 = S_1 \times K_1 \times T$, where:

S_1 – surface of watered area, 46000 m^2 (working site),
K_1 – 1 m^2 daily watering norm, 0.0015 m^3,
T – number of warm and dry days, 150
M_1 = 46000 x 0.0015 x 150 = 10350 m^3/const. period or 69 m^3/day
Total water usage will be 69.83 m^3/day.

Wastewater

Water consumption for watering (dust prevention) is categorized as non-returning and there is no generated outflow. Wastewater from the domestic water consumption is calculated by the following formula:

$W_{w.w.d.} = W_{d.t.} - (W_{d.t.} \times LS)$, where LS is water losses ratio - 0.05,

$W_{w.w.d.}$ = 249 – (249 x 0.05) = 236.5 m^3/const. period or 0.8 m^3/day.

Biotoilets will be installed for the staff, which will be uninstalled and transported elsewhere after the completion of the works.

5.1.3 Soil resources

Total soil mass will be 38242 m^3/const. period, backfill - 36881 m^3/const. period. Surplus of soil mass will be used for leveling of the nearby area. 1361 m^3 of excessive soil will be generated during the construction works, which will be transported to the site allocated by the local governing body.

5.1.4 Biodiversity

The construction works will be carried out in an urban area, thus no vegetative cover will be damaged, no trees and bushes will be cut and fauna will not be endangered during excavation of pipeline trench. The biodiversity of the area will not be damaged during the implementation of the works planned within the project.

5.2 Operation stage

The environmental impact in the operation stage is assessed to be positive. In the result of the planned rehabilitation works the losses of drinking water will decrease drastically, which will allow

saving regional water resources. Due to the rehabilitation of sewerage collection network and collector, the wastewater of Dilijan town will be directed to the treatment plant and will not be discharged to Aghtev river bed instead. This will contribute to the protection of Aghstev river water resources from pollution. The implementation of the works will contribute to the improvement of social-economic condition of the population.

6. POSITIVE AND NEGATIVE ENVIRONMENTAL AND SOCIAL IMPACTS

The activities for improvement of water supply system of Dilijan will have essential positive environmental and social impacts.

Positive impacts are:

- Reduction of water losses,
- Increase of the usage of water resources efficiently due to the implementation of water measure system
- Protection of water resources from inefficient usage,
- Sustainable water supply
- Increase of water supply duration
- Provision of appropriate quality of drinking water
- Reduction of drinking water contamination
- Prevention and elimination of penetration of infections in drinking water
- Improvement of health condition of residents.

Rehabilitation of the water distribution network will result in satisfying population's water demand and in eliminating high water losses. Thus the water resources will be used more efficiently and economically.

By-passing of the cemetery area will sharply reduce population risks to diseases and solve health problems. Improvement of the distribution network will assist in improving the livelihood and social condition of the town's population.

During implementation of works it is intended to prepare the mitigation measures in order to prevent or mitigate the possible negative impacts.

The initial evaluation showed that no irrevocable negative impact is expected in the residential areas of the improvement of water supply system.

The possible negative impacts are related to construction works, therefore they are limited and short. Under the project scope the Environmental Management Plan has been developed (see Annex 1), where the activities for mitigatin or preventing the negative impacts are projected.

The following negative environmental and social impacts may occur during rehabilitation of Dilijan's water supply and wastewater systems:

- Air pollution
- Noise
- Soil erosion and landslide processes
- Pollution of the environment by construction waste and garbage
- Contamination of soil and water resources by fuel and lubricants
- Contamination of soil and water resources with chloride.

The description of possible negative environmental and social impacts during implementation of works and their prevention and/or mitigation measures are presented in the following chapters.

7. ENVIRONMENT AND SOCIAL IMPACT MITIGATION MEASURES

The following preventive and mitigation measures have to be implemented in order to mitigate negative environmental and social impacts:

1. Prior to commencement of water supply system's rehabilitation works relevant permits and agreements shall be obtained from local authorities, in particular for disposal of excessive soil and construction wastes in special locations. If wastes contain high rate of harmful components, the appropriate passport of the Ministry of Nature Protection of the RA shall be obtained for their removal and location.

2. The location of access roads, construction sites, vehicles and heavy equipment parking stations, warehouses for construction materials and equipment, warehouses or accumulation sites for storage of dismantled pipes, units, liquid wastes and others shall be determined in advance and be organized in a manner not harming the environment. In particular, where possible the construction site shall be fenced by plastic material. The parking sites for vehicles and heavy equipment, the warehouses and the sites of preliminary accumulation (if relevant) of construction materials and dismantled equipment, liquid wastes and others shall be clearly delimited from the surroundings. The leakage of fuel/lubricants, spreading of wastes or their storage in arbitrary places shall be excluded. After completion of rehabilitation activities those warehouses and accumulation sites shall be completely eliminated and the original appearance of the area be restored.

3. The demolished asphalt has to be adequately collected placed in the special places allocated for the construction waste.

4. Special tanks shall be prepared for collection and storage of liquid wastes. Leakage of liquid wastes into the environment shall not be allowed. The liquid wastes shall be reused or removed according to procedures specified by the Armenian legislation.

5. At the beginning of construction works the fertile soil layer shall be removed and stored and used after construction works for restoring the original appearance of the area (recultivation). While restoring the original appearance of the site, plants typical for the landscape shall be used.

6. Only trucks and construction machines in good technical state shall be used as their emission is within the permissive standards.

7. Use closed/covered trucks for transportation of dusting construction materials and wastes. Regularly water construction sites to reduce dust. Construction sites shall be washed periodically in order to prevent the spread of dust

8. As the construction works will be implemented within inhabited areas, maximally new and good machinery shall be used to reduce noise and vibration as much as possible. The working hours shall be agreed with local authoritative body to disturb them as little as possible.

9. The garbage shall not be stored or removed to places not allocated for that purpose in order not to damage flora and fauna. It is prohibited to use and store very explosive and poisonous

substances. It is prohibited to park, wash, repair vehicles and heavy construction equipment in places not allocated for that purpose. It is prohibited to collect or destroy plants including cutting shrub and trees.

10. The labor shall be ensured with adequate working clothes and personal protecting equipment, in particular with helmets, gloves and others.

11. If historical and cultural monuments and artifacts are found during construction works, the works shall be ceased immediately and the appropriate agency of Ministry of Culture of the RA be informed.

The Environment Management Matrix is presented in Annex 1.

8. ENVIRONMENTAL MANAGEMENT

The organizational obligations for the implementation of proposed mitigating measures are distributed among the following agencies:

8.1 Agencies responsible for obtaining permits for project implementation

At the design stage, prior to commencement of works, the **Consultant** (JV Fichtner Water & Transportation GmbH/ Jrtuc LLC) has obtained the required agreements, consents and permits from the State and local authorities, including:

- written consent from the local governing authorities for the sites allotted for transportation of excessive soil and construction wastes.

Upon commencement of construction works, **AWS CJSC** shall obtain the following permits and certifications:

- electric supply technical condisions and land usage permissions,
- written consent for crossing the infrastructures/communications (gas pipes, electric and telecommunication cable, water pipes) from utility operators;
- construction permits;
- architectural and planning assignments.

Contractors (responsible for construction works implementation, to be selected through tendering) will be responsible for physical implementation of mitigating measures planned under the EMP and for obtaining any additional permissions/consents if a need for such documents emerges during construction. This includes, but may not be limited to obtaining of:

- permission from the State Agency for Protection of Historical and Cultural Monuments in case of encountering chance finds in the course of earth works.

8.2 Supervising agencies responsible for controlling implementation of the EMP measures

- The **Consultant** (JV Fichtner Water & Transportation GmbH/ Jrtuc LLC) will provide technical supervision of the construction works, including environmental and safety supervision. Technical supervisors will implement control of in time, due and reliable implementation of mitigating measures during the construction, prepare regular reports (quarterly) and submit to the Client.

- Environmental and Social Impact Specialist of AWSC will be responsible for timely, due and reliable implementation of the works and measures provided under the EMP. The Environment and Safety Specialist of the Consultant and the Environmental and Social Impact Specialist of AWSC will regularly visit the construction sites to supervise due imple-

mentation of the measures aimed at mitigation of work impact. During the visits the possible shortcomings and omissions will be identified in implementation of mitigating measures and infringement by the Contractor during construction will be discovered. AWSC's environmental and social impact specialist oversees performance of the Technical Supervision Company from the environmental perspectives. For provision of quality assurance of environmental works, TSC should present quarterly reports to the AWSC`s environmental and social impact specialist.

8.3 State monitoring agencies responsible for controlling EMP implementation efficiency

- State Environmental Inspectorate of RA Ministry of Nature Protection,
- State Hygiene and Anti-Epidemiological Inspectorate
- The State Agency for Protection of Historical and Cultural Monuments, if needed,
- The RA local governance bodies,
- The RA Ministry of Transport and Communication, if needed.

9. SUBMISSION OF REPORTS

Taking into account the launching period for rendering the services, the Consultant will submit Quarterly Progress Reports by the fifteenth day of the following quarter.

The report shall be submitted in Armenian and English and will include description part (quarterly progress on environmental and social), photos and environmental mitigation measures monitoring table.

10. ENVIRONMENT MANAGEMENT PLAN

The EMP has been developed based on the results of environmental screening under the investment program and includes appropriate mitigation measures.

EMP consists of two components:

- **Mitigation measures and agencies responsibilities for implementation**;
  The **Contractor** shall strictly follow the environmental mitigation measures prescribed in the EMP. The costs foreseen for the implementations of all the measures prescribed in the EMP are included the total value of the Contract and reflected in the bill of quantities.
- **Environmental monitoring**. On a quarterly basis Consultant should update information on monitoring of environmental mitigation measures and incorporate that table in quarterly report (during construction).

Notice on the failure to implement measures prescribed by the **Consultant** or the **Client** would be sent to the **Contractor** in written. After the Notice to Correct, the next recorded violation would trigger charging of liquidated damages in the amount of 0,1% of the total value of the contract. The liquidated damages do not relieve the **Contractor** from remedying the violation. The recorded violation should be remedied in two working days period. Liquidated damages would be retained from the next Performance Certificate and after the completion of the construction activities the liquidated damages for the recorded violation will be retained from the Retention Money. In case of three liquidated damages the Contract may be terminated unilaterally.
The above described pharagraphe of EMP violation will be included in the Contract for provision of works concluded by AWSC under the Project.

11. ANNEXES

Annex 1: Environmental management matrix
Annex 2: Meeting Photos

ANNEX 1

Environmental management matrix

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
Disruption of the natural and urban landscapes and loss of biodiversity	Selection of routes of water mains and internal network taking into account engineering-geological conditions of the area, minimizing the adverse impact on natural and urban landscapes.	Presence of instructions in design documents	Review of design documents	Upon delivery of draft design documents	Consultant	AWSC, LSGB
	Instructions provided for washing and disinfecting the water main and the network with chlorine, with reference to formal guidelines.					
Activation of land erosion and landslide process	Selection of routes of water mains taking into account engineering-geological conditions of the area	Sensitivity of design to geological conditions of the project site	Review of design documents	Upon delivery of draft design documents	Consultant	AWSC LSGB
Construction and household wastes (garbage) accumulation and transportation	On-site collection of waste in the designated locations and timely out-transportation to the destinations of final disposal	Construction sites free of litter and scattered construction waste	Site inspection	During construction works	Contractor	TSC, AWSC
	Obtaining written consent for disposal of construction waste from local self-governing bodies	Presence of waste disposal permission	Inspection of documents at Contractor's office	Before commencement of construction works	Contractor	
	Waste disposal to the formally designated locations	Absence of large volumes of the household and construction waste	Field visit	During construction Prior to hand	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
		at the construction site Absence of waste on site upon completion of construction		over of the completed works		
Generation of dust	Dust emission from transportation of construction materials	Use of closed/covered vehicles for transportation of powdery construction materials	Field visit	During construction	Contractor	TSC, AWSC
	Regular watering of construction sites in populated areas	No excessively dusty conditions on-site	Field visit	During construction	Contractor	TSC, AWSC
Contamination of soil and water with fuel and lubricants	Storage and application of fuel/ lubricants in the conditions excluding spillage and leakage	Area allocated for storage and application of fuel/lubricants insulated and confined No fuel and/or lubricant spills observed on-site	Field visit	During construction	Contractor	TSC, AWSC
	On-site storage and storage and safe disposal of used lubricants and their removal to designated disposal sites or recycling facilities	Presence of containers for storing used lubricants Presence of formal arrangements for disposal or hand over of used lubricants	Field visit, Inspection of documents	During construction	Contractor	TSC, AWSC
Noise and vibration	Limiting of construction works to working	No excessive noise out of working hours No complaints from affected communities	Field visit, Consultation with affected communities	During construction	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
	Technical condition of construction vehicles and machinery	Absence of excessive noise from engines No complaints from affected communities	Field visit	During construction	Contractor	TSC, AWSC
Safety of pedestrians and traffic in and around construction sites	Installation of appropriate road signs and provision of temporary by-pass arrangements as required	No disruption of traffic and no constraint for pedestrian access	Field visit, Consultation with affected households	During construction	Contractor	TSC, AWSC
Impact on archaeological monuments	Immediate termination of earth works in case of chance finds and prompt communication to the Agency of Protecting Cultural Heritage	No damaged archaeological items	Field visit	During construction	Contractor	TSC, AWSC RA MC
Landscape degradation and soil erosion	Separate storage of top soil and its restoration upon completion of construction works	Top soil stored in separate piles Top soil re-deposited over the construction site	Field visit	During construction	Contractor	TSC, AWSC
	Timely backfilling of excavated trenches	No trenches left open for excessive periods of time	Field visit	During construction	Contractor	TSC, AWSC
	Installation of gabions for laying pipelines in the sloped terrain	Presence of gabions	Field visit	During construction	Contractor	TSC, AWSC
	Harmonization of construction sites with landscape promptly upon completion of works	Construction site restored to quasi-original condition to the permissive extent	Field visit	Prior to hand over of constructed infrastructure	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
Environment pollution with chlorine use for disinfection of newly constructed pipelines	Prevention of release active and highly concentrated disinfectants to nature	Deactivation and delusion of chlorine prior to release of disinfectant to nature	Field visit	During disinfection of pipelines	Contractor	TSC, AWSC
Workers' exposure to dust and noise	Provision of protective gear (masks, ear phones) to workers for the use industry and noisy environment	Workers equipped with- and wearing protective gear	Field visit	During construction	Contractor	TSC, AWSC
Maintenance of work site and work camp (if existing)	Provision of water, sanitation, and household waste containers on work site	Satisfactory sanitary conditions	Field visit	During construction	Contractor	TSC, AWSC
Safety of construction machinery	Standard technical condition of construction machinery formally certified	Presence of positive expertise reports for operating cranes and other machinery deployed at the construction site	Inspection of documents at Contractor's office	During Construction	Contractor	TSC, AWSC
Conduct of excavation works	Demarcation of open trenches and other dig-outs	Open trenches and other dig-outs demarcated	Field visit	During Construction	Contractor	TSC, AWSC
Conduct of earth works in sites with asbestos pipes currently in operation	Accurately demarcate location of asbestos pipes and excavate cautiously along the marked area to avoid contact with existing pipes. In case of unintended unearthing of asbestos pipes, immedi-	Respectively marked asbestos pipe location	Field visit	During Construction	Contractor	TSC, AWSC

Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
	ately backfill the dug-out area, compact soil, and place warning signs.					
Preparedness for accidents at work site	Provision of the first aid medical kits and fire-fighting equipment	The first aid kits and fire-fighting equipment present on site	Field visit	During Construction	Contractor	TSC, AWSC
Safety of staff involved in chlorination processes[2]	Continuous control of chlorination stations Training of operators (conducted by HTH tablets providers) Provision of protection and emergency response equipment for operators	No health damage of operators of chlorination stations incurred from exposure to chemicals	Visit to chlorination stations	During operation of the water supply system	AWSC	SCWM
Soil and water contamination by water treatment sludge (river, well, spring catchments)	Sludge disposal strictly at the sites formally designated according RA legislation	Sludge safely disposal at approved sites	Visit to treatment station, observation	During operation of water supply system	AWSC	SCWM
Pollution of water sources from domestic sources and domestic	Protection of sanitary zones from trespassing	Sanitary zones secure and clean	Visits to sanitary zones	During operation of water	AWSC	SCWM

[2] RA Government Decree N-529Ա dated April 21, 2011 on "Approval of safety rules during production, use, storage and transportation of chlorine".

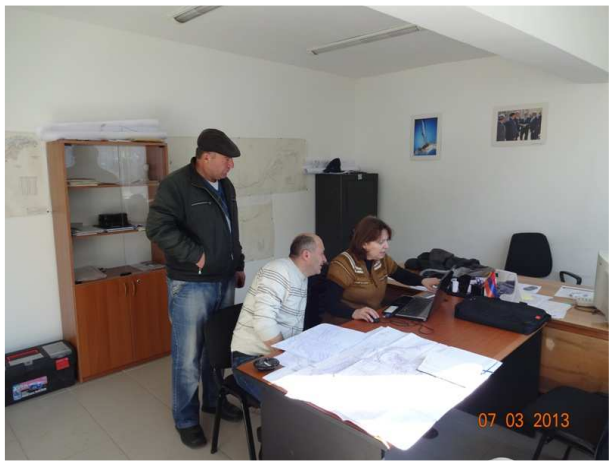
Expected Impact	*Mitigation measures*	*Monitoring indicator*	*Monitoring method*	*Monitoring duration*	*Executing agency*	*Supervising agency*
animals				supply system		

ANNEX 2

Meeting Photos

Meeting in Dilijan

Discussion in the municipality of Dilijan



Discussion of technical issues in Dilijan

Discussion about sewer collector of Dilijan

Public hearings in Dilijan