

Ministry of Urban Development  
of the Republic of Armenia

**Kotayk Solid Waste  
Management -  
Environmental and Social  
Due Diligence**

ESIA

Draft for public comments

November 2011



COWI A/S

Parallevej 2  
DK-2800 Kongens Lyngby  
Denmark

Tel +45 45 97 22 11  
Fax +45 45 97 22 12  
[www.cowi.com](http://www.cowi.com)

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Project No. P-75143-A-1  
Document no. 3  
Version 5  
Date of issue 22.11.2011

Prepared LLA, KRB, NH, NAA, ASB, Armine Simonyan  
Checked CASK  
Approved CASK

## Table of Contents

<b>1</b>	<b>Introduction</b>	<b>7</b>
1.1	Why to improve waste management system in Kotayk Region?	8
1.2	Reasons for including Sevan town	9
1.3	Who will pay for the improvements?	9
1.4	Amount and types of waste	10
<b>2</b>	<b>Analysis of Alternatives</b>	<b>13</b>
2.1	No-Project alternative	14
2.2	Alternative location of regional landfill	16
2.3	Alternative type of waste disposal facility	17
2.4	Alternative waste collection system	20
2.5	Alternative transportation of waste	21
2.6	Alternative treatment and disposal of waste	22
2.7	Alternative area of Project coverage	27
2.8	Alternative implementation schedule	28
2.9	Alternative financing mechanism for full cost recovery of the new waste management system	28
2.10	Comparison of alternatives	28
<b>3</b>	<b>Recommended waste management system</b>	<b>37</b>
3.1	Collection of waste	37
3.2	Transportation	45
3.3	Disposal at regional landfill	46
3.4	Design of regional landfill	47
3.5	Operation of landfill	54
3.6	Closure of landfill	56
3.7	Aftercare	56
3.8	Landfill capacity and period of operation	57
3.9	Institutional set-up of new waste management system	57
3.10	Staffing	58

<b>4</b>	<b>Assessment of impacts</b>	<b>62</b>
4.1	Introduction	62
4.2	Legal and administrative context of ESIA	64
4.3	International standards	64
4.4	National Requirements	65
4.5	Administrative context for national EIA	67
4.6	Major development plans	67
4.7	Ongoing projects	68
4.8	Project's area of influence	69
<b>5</b>	<b>Description of the Existing Environment</b>	<b>72</b>
5.1	Geomorphology and Geology	73
5.2	Climatic Conditions	74
5.3	Land Use and Settlement Patterns	76
5.4	Water Resources	77
5.5	Biological and Ecological Resources	80
5.6	Air Quality and Existing Emissions Load	90
5.7	Noise and Vibration	96
5.8	Existing Sources of Pollution and Extent of Contamination	96
5.9	Availability of Solid Waste Management Facilities	102
5.10	Baseline conditions of Hrazdan site recommended for establishment of regional landfill	102
<b>6</b>	<b>Existing Social and Socio-Economic Issues</b>	<b>110</b>
6.1	Socio-economic context of Armenia	110
6.2	Demography	111
6.3	Social Composition	115
6.4	Power Relationships and Governance Issues	115
6.5	Waste Pickers	117
6.6	Land Use	118
6.7	Economic Activities (formal and informal sector)	119
6.8	Distribution of Income, Goods and Services	120
6.9	Population Health Profile	124
6.10	Gender Issues	126
6.11	Vulnerable groups	128
6.12	Cultural Heritage	133
<b>7</b>	<b>Project implementation phases</b>	<b>135</b>
7.1	Pre-construction phase	135
7.2	Landfill construction	136
7.3	Establishment of new waste collection and transportation system	143

7.4	Operation and maintenance phase	143
7.5	Closure	144
7.6	Aftercare	144
<b>8</b>	<b>Impacts and Mitigation Measures during Pre-construction Activities</b>	<b>145</b>
8.1	Methodology of impact assessment	148
<b>9</b>	<b>Environmental Impacts and Mitigation Measures during Construction</b>	<b>150</b>
9.1	Change in drainage pattern	150
9.2	Flooding potential	152
9.3	Landscape impacts of excavation and construction	152
9.4	Pollution of surface water and groundwater	152
9.5	Air pollution	153
9.6	Wastewater generation and disposal	154
9.7	Hazard vulnerability	155
9.8	Noise	156
9.9	Odour	157
9.10	Spillage of hazardous or medical waste	157
9.11	Biodiversity	157
9.12	Sustainable natural resources management	157
9.13	Greenhouse gas emissions	158
9.14	Climate change and adaptation	158
9.15	Assessment of environmental impacts during construction	158
<b>10</b>	<b>Social Impacts and Mitigation Measures during Construction</b>	<b>160</b>
10.1	Socio-economic and cultural impacts	160
10.2	Labour and Working Conditions	161
10.3	Occupational health and safety issues	162
10.4	Visual impacts, including view from the main road	164
10.5	Population movements	165
10.6	Economic impacts	165
10.7	Community Health, Safety and Security	165
10.8	Education	166
10.9	Social Conflict	166
10.10	Gender	167
10.11	Impacts on vulnerable groups	167
10.12	Assessment of social impacts during construction	168

<b>11</b>	<b>Environmental Impacts and Mitigation Measures during Operation and Maintenance</b>	<b>170</b>
11.1	Change in drainage pattern	170
11.2	Flooding potential	170
11.3	Landscape impacts of excavation and construction	171
11.4	Pollution of surface water and groundwater	171
11.5	Air pollution	172
11.6	Wastewater generation and disposal	173
11.7	Hazard vulnerability	174
11.8	Noise	175
11.9	Odour	176
11.10	Spillage of hazardous or medical waste	176
11.11	Biodiversity	177
11.12	Sustainable natural resources management	177
11.13	Greenhouse gas emissions	178
11.14	Climate change and adaptation	178
11.15	Summary of environmental impact assessment during operation phase	179
<b>12</b>	<b>Social Impacts and Mitigation Measures during Operation</b>	<b>180</b>
12.1	Socio-economic impacts	180
12.2	Impact on cultural heritage	181
12.3	Occupational health and safety issues	182
12.4	Visual impacts, including view from the main road	183
12.5	Labour and Working Conditions	184
12.6	Population movements	184
12.7	Economic impacts	185
12.8	Community Health, Safety and Security	186
12.9	Education	187
12.10	Social Conflict	187
12.11	Gender	187
12.12	Impacts on vulnerable groups	188
12.13	Summary of social impacts during operation phase of the Project	189
<b>13</b>	<b>Environmental Impacts and Mitigation Measures during Final Closure and Aftercare of the Landfill</b>	<b>190</b>
13.1	Landscape	191
13.2	Assessment of environmental impacts for the Project phase of landfill closure and aftercare	191

<b>14</b>	<b>Social Impacts and Mitigation Measures during Closure and Aftercare</b>	<b>193</b>
14.1	Labour and Working Conditions	193
14.2	Population movements	193
14.3	Economic impacts	193
14.4	Community Health, Safety and Security	194
14.5	Education	194
14.6	Social Conflict	194
14.7	Gender	194
14.8	Impacts on vulnerable groups	194
14.9	Assessment of social impacts during the phase of landfill closure and aftercare	195
<b>15</b>	<b>Management of Residual Impacts and Risks</b>	<b>196</b>
15.1	Residual environmental impacts and risks	196
15.2	Residual social impacts and risks	197
<b>16</b>	<b>Project Benefits and Opportunities for their Enhancement</b>	<b>198</b>
16.1	Enhancement of environmental benefits	199
16.2	Enhancement of social benefits	201
<b>17</b>	<b>Environmental and Social Monitoring</b>	<b>204</b>
<b>18</b>	<b>Preparation and Implementation of Environmental and Social Action Plan</b>	<b>215</b>
<b>19</b>	<b>Supplementary Environmental and Social Appraisal Studies to be Carried Out</b>	<b>216</b>

## **Table of Appendices**

<b>Appendix 1</b>	<b>Names of those responsible for preparing the ESIA</b>	<b>218</b>
<b>Appendix 2</b>	<b>References and Sources of Information</b>	<b>219</b>
<b>Appendix 3</b>	<b>Proposed layout of regional landfill at Hrazdan site</b>	<b>223</b>
<b>Appendix 4</b>	<b>Timetable of landfill construction and extension</b>	<b>224</b>

<b>Appendix 5</b>	<b>Artist image of proposed regional landfill at Hrazdan site</b>	<b>225</b>
<b>Appendix 6</b>	<b>Proposed elements of landfill cross-section upon the closure</b>	<b>226</b>

## 1 Introduction

The Republic of Armenia (“RA”) is divided into ten Marzes (provinces). Kotayk Marz (“Kotayk”) has a population of 240,000 and an area of 2100 square km. The capital of Kotayk is the City of Hrazdan. The Ministry of Urban Development (“MUD”) has approached the European Bank for Reconstruction and Development (the “EBRD” or the “Bank”) with a request to prepare and finance a regional sanitary landfill in Kotayk. This would be the country’s first sanitary landfill. Kotayk was selected due to its proximity to Yerevan, with the intention of creating a demonstration project for the entire country.

At present solid waste is disposed at 6 dumpsites in Kotayk. Waste collection is carried out by communal service companies or is tendered out to private companies. In residential areas households dispose of waste into small containers, which are emptied by collection trucks. In other areas, due to the lack of containers and bins, waste is piled up at a small dump site with subsequent loading onto collection vehicles manually with spades. This is inefficient and results in street litter and illegal dumping. The estimated daily solid waste volume in Kotayk is 100-120 tons. In 7 towns of Kotayk Marz 82 staff are employed to manage solid waste, with another 150 involved in street cleaning. The average salary of the employees is AMD 55,000-60,000 (EUR equivalent 112 - 122). The solid waste tariffs ranges from AMD 100-150 per person per month, corresponding to approximately AMD 5,000 – 8,000 per household per year (12 – 19 EUR/household/year). At present average waste tariff collection rate is less than 50 per cent.

Kotayk Region (Kotayk Marz) is located in the central part of Armenia to the north from Yerevan. The location map is included in Figure 1. There are 7 cities, including the administrative centre Hrazdan, and 60 rural communities in Kotayk Region. The town of Sevan is located in Geharkunik Region (Marz) on the Lake Sevan coast at a distance of about 10 km from the northern administrative border of Kotayk Region.

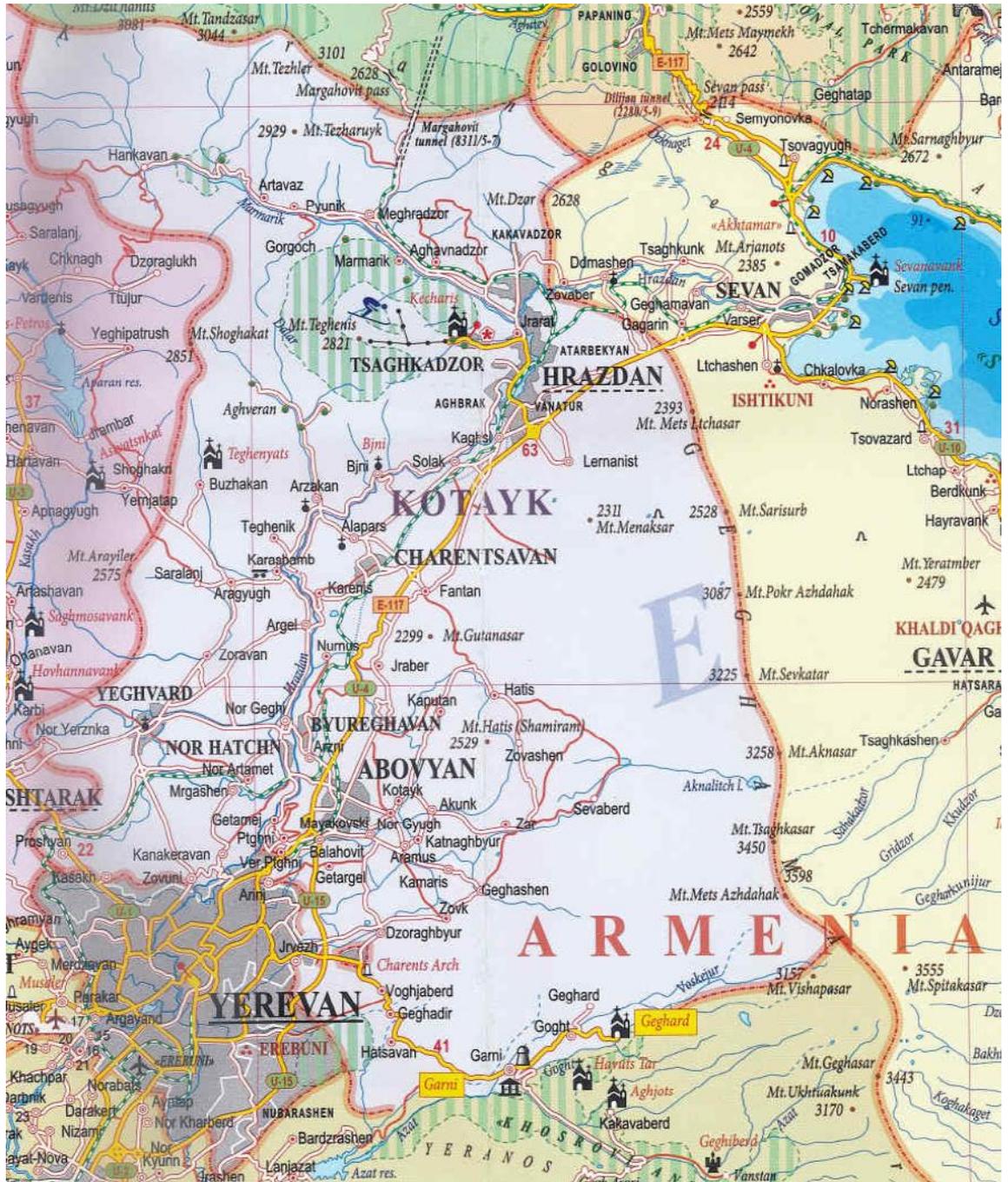


Figure 1 Location of Kotayk Region and Sevan city in Armenia

### 1.1 Why to improve waste management system in Kotayk Region?

With the system existing now in Kotayk Region, all solid waste collected from containers on the streets and from people bringing their waste directly to waste collection vehicles in cities is taken to the big municipal dumpsites. Waste at the dumpsites is spreading over the areas, it is often burning, it causes visual and odour nuisance and poses various negative impacts on the adjacent areas

(soil, water bodies, flora, fauna, etc.) and their residents (visual and odour nuisance, spreading of waste by wind, uncontrolled dumping along the roads to dumpsites, etc.). Waste from about 30% of Kotayk Region population living in villages is accumulated at smaller dumpsites not far from villages.

Numerous dumpsites could be seen in many places in Kotayk Region. Waste collection and transportation companies can not provide good services because the tariff for waste collection is low, not all families actually pay the waste bills and waste dumping "somewhere" is a known practice in many regions of Armenia.

People and authorities can see that spreading of waste should be stopped in order to keep the residential areas and their vicinities clean and nice. MUD of Armenia asks the European Bank for Reconstruction and Development (EBRD) to support the improvement of waste management in Kotayk Region as the first project with procurement of modern waste containers, trucks and with establishment of regional sanitary landfill for safe placing of waste according the best standards of the EU. At sanitary landfills the waste is paced on impermeable bottom and is regularly covered with soil.

According to Master Plans prepared by MUD and approved by the Government of Armenia, there is an area of former clay quarry next to existing dumpsite of Hrazdan city preliminary allocated for a big landfill. If a regional sanitary landfill can be constructed, the dumpsites could be closed and covered with soil, so that they look like natural hills.

## **1.2 Reasons for including Sevan town**

Sevan town is located in Gegharkunik Region, but close to the border of Kotayk Region. Waste collected in Sevan town is at present taken to dumpsite located on the coast of Lake Sevan, a wonder of Armenia. Waste trucks have to drive to the dumpsite along mountainous terrain almost without road. The distance from Sevan to this dumpsite is the same as the distance to Hrazdan city, and the road is good, it is the main road Yerevan-Sevan. Many tourists from Yerevan and other regions during summer time spend their weekends and holidays in Sevan municipality. They stay for a day or longer at hotels, summer houses or just in "wild camps" in the coastal zone. During weekends there can be 10 times more tourists in Sevan municipality than the local residents. The tourists leave a lot of waste. Sevan municipality needs support for collection and disposal of waste in order to keep the Lake Sevan coast clean.

## **1.3 Who will pay for the improvements?**

The existing waste management system is very simple and includes only collection of some waste from residential areas and dumping of waste at local dumpsites. Introduction of a modern waste management system will be a major change requiring additional investments and operational costs, which should be covered by higher fees paid by the customers of the system. Required costs and willingness of the customers to pay for the improved services should be care-

fully considered when the type of the new waste management system is selected and the system components are designed. It is proposed to develop the solid waste management system gradually, starting from establishment of a modern regional landfill, improvement of collection services with trial simple collection of recyclable materials, to make this system convenient for the customers, to ensure that it is economically viable, and then to introduce further improvements when they are affordable.

EBRD is considering a loan and a grant provision for covering the costs of establishing modern waste collection services for Kotayk Region and Sevan town with safe disposal of waste in one specially equipped place. The grant would cover half of the costs. The other half should be covered by the loan provided for 15 years, which needs to be repaid from new tariffs, which should be established for households and other users of the new waste management system. Part of the loan could be repaid from sales of separately collected recyclable materials.

#### 1.4 Amount and types of waste

##### Municipal waste

The project includes mainly mixed household and commercial municipal solid waste from Kotayk Region and Sevan town.

Based on the results of a waste characterisation survey carried out in Hrazdan from 26 August to 01 September 2010, the interviews with waste collection companies in all municipalities and experience from other regions in Armenia the unit waste generation and total waste generation is presented in Table 1.1.

Table 1.1 Waste generation (2010) for low, medium and high level scenarios

	Low	Medium	High
Unit generation 2010 in urban communities (kg/cap/day)	0.6	0,65	0,75
Unit generation 2010 in rural communities (kg/cap/day)	0.4	0.5	0.6
Waste generation 2010 in urban communities (ton/year)	43,504	47,129	54,380
Waste generation 2010 in rural communities (ton/year)	18,956	23,695	28,434
<b>Total waste generation (ton/year)</b>	<b>62,460</b>	<b>70,824</b>	<b>82,814</b>

The waste generation assessments in 2035 calculated for low, medium and high level development scenarios are presented in Table 1.2.

Table 1.2 Waste generation (forecast for 2035) for low, medium and high level development scenarios

	Low	Medium	High
Yearly increase in unit waste generation	1.5%	2.5%	4%
Unit generation 2035 in urban communities (kg/cap/day)	0.77	1.21	2.00
Unit generation 2035 in rural communities (kg/cap/day)	0.51	0.93	1.60
Yearly increase in population, urban communities	0%	0.5%	0.75%
Yearly increase in population, rural communities	0%	0.25%	0.5%
Waste generation 2035 in urban communities (ton/year)	55,791	98,979	174,743
Waste generation 2035 in rural communities (ton/year)	24,310	46,758	85,866
<b>Total waste generation 2035 (ton/year)</b>	<b>80,101</b>	<b>145,737</b>	<b>260,609</b>

Figure 2 below presents the result of the waste generation forecast in the period 2010 to 2035.

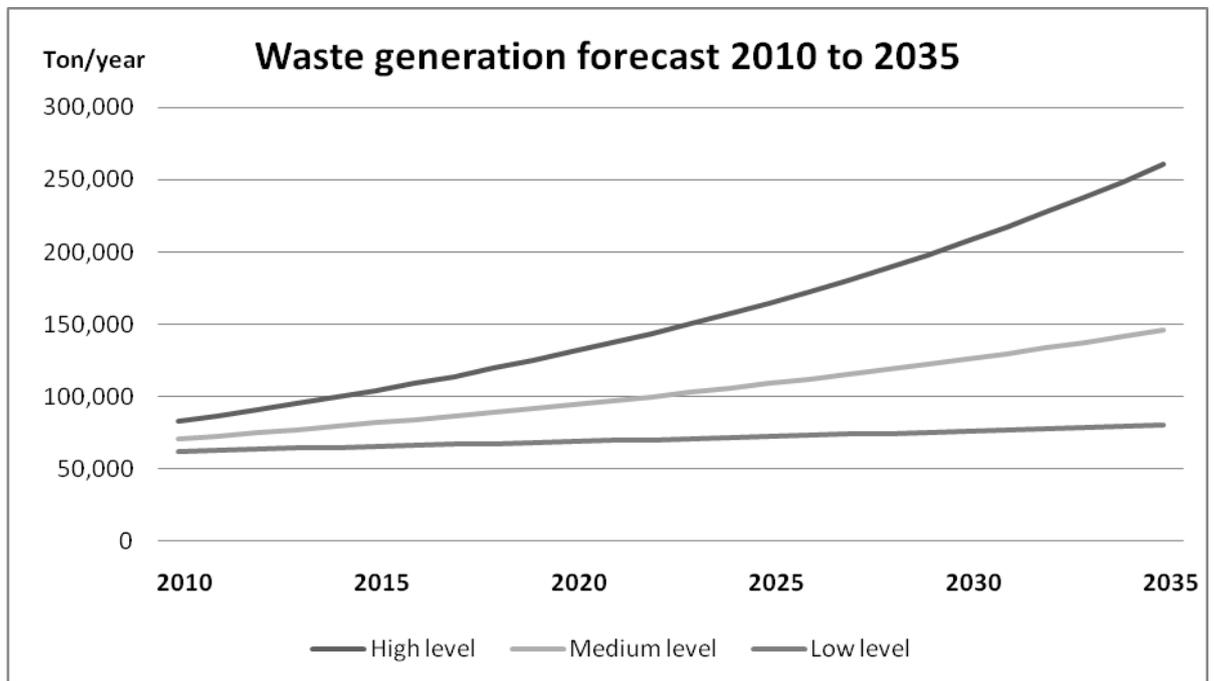


Figure 2 Waste generation forecast for Kotayk Region and Sevan Town, 2010 to 2035

Waste composition

The waste composition was found in the waste characterisation survey is presented in Table 1.3. It is assessed that the waste composition found in the waste characterisation survey provides a reasonable representative waste composition for urban municipalities in the project area. There will be yearly fluctuations in

the waste composition depending on the season. For rural communities it is expected that the content of food waste will be lower.

Table 1.3 Result of pilot waste characterisation survey in Kotayk Region

Waste fractions		Hrazdan Centre 1		Hrazdan Centre 2		Kotchor village (old Hrazdan)		Ahpurak village (Hrazdan)		Average	
		kg/day	%	kg/day	%	kg/day	%	kg/day	%	kg/day	%
1	Food waste	29.03	20.99%	19.00	18.70%	11.60	12.24%	18.07	14.76%	77.70	17,00%
2	Garden waste	21.00	15.18%	8.93	8.79%	20.36	21.47%	20.00	16.33%	70.29	15,37%
3	Paper	5.86	4.24%	5.71	5.62%	3.50	3.69%	3.90	3.18%	18.97	4,15%
4	Cardboard	10.07	7.28%	11.57	11.39%	4.40	4.64%	7.69	6.28%	33.73	7,38%
5	PE	20.29	14.67%	16.93	16.66%	11.93	12.58%	16.50	13.47%	65.64	14,36%
6	Other plastics	6.71	4.85%	3.86	3.80%	1.61	1.70%	2.60	2.12%	14.79	3,23%
7	Metal (not aluminium)	2.79	2.01%	1.86	1.83%	1.36	1.43%	2.46	2.01%	8.46	1,85%
8	Aluminium	0.66	0.48%	0.71	0.70%	0.26	0.27%	0.43	0.35%	2.06	0,45%
9	Glass	8.86	6.40%	9.14	9.00%	4.14	4.37%	12.64	10.32%	34.79	7,61%
10	Bulky waste	3.64	2.63%	4.36	4.29%	2.64	2.79%	3.79	3.09%	14.43	3,16%
11	Concrete, soil and construction waste	23.21	16.79%	15.43	15.18%	22.43	23.66%	25.71	21.00%	86.79	18,98%
12	Hazardous waste	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0.00%	0.00	0,00%
13	Electrical and electronic waste	2.33	1.68%	2.11	2.08%	0.79	0.83%	0.90	0.73%	6.13	1,34%
14	Remaining waste	3.86	2.79%	2.00	1.97%	9.79	10.32%	7.79	6.36%	23.43	5,12%
<b>Total</b>		<b>138.30</b>	<b>100%</b>	<b>101.61</b>	<b>100%</b>	<b>94.80</b>	<b>100%</b>	<b>122.47</b>	<b>100%</b>	<b>457.19</b>	<b>100%</b>
<b>Unit amount kg/capita/day</b>		<b>0.58</b>		<b>0.85</b>		<b>1.19</b>		<b>0.82</b>		<b>0.77</b>	

Construction and demolition waste

The survey revealed that the inhabitant dispose relatively large amounts of concrete, soils and construction waste in the containers (15% - 24% of total waste amounts). It can be expected that additional amounts of construction and demolition waste will be delivered directly to a new regional landfill from construction contractors.

Hazardous waste

Treatment and disposal of hazardous waste is very costly and is normally carried out at dedicated facilities established at national level and not at local or regional level. No hazardous waste was identified in municipal solid waste during the survey completed in Kotayk region in 2010 during the Feasibility Study. Hazardous waste management in general is not addressed by the proposed project for Kotayk Region and Sevan municipality. Minor amounts of hazardous waste (e.g. paints, batteries, chemicals, etc.) occasionally collected with the municipal solid waste could be temporary stored at the landfill until they can be delivered to a national treatment/disposal facility of a facility outside Armenia.

## 2 Analysis of Alternatives

The Project Proposal elaborated during the Feasibility Study recommends to establish the so-called ordinary collection system of mixed municipal solid waste, its transportation to and disposal at one regional sanitary landfill located next to the existing dumpsite in Hrazdan city.

The procedure of ESIA assumes systematic comparison of feasible alternatives in terms of location, technology or design carried out for comparison of potential environmental and social impacts.

The first alternative to the proposed Project will be the "no Project" alternative, i.e. continuation of waste management "business as usual".

The other alternatives to be considered include other location of regional landfill, i.e. its location on a site other than the Hrazdan site.

Table 2.1 presents a spectrum of concepts typically discussed during feasibility studies and impact assessments related to development of regional waste management systems.

*Table 2.1 Alternative concepts for consideration during ESIA*

<b>Alternative concept</b>	<b>Concept title</b>	<b>Details of the concept</b>
-	Project proposal	New ordinary waste collection system including containers/hooting, bring banks, direct transportation of waste for disposal to regional sanitary landfill near Hrazdan developed in phases, landfill management company owned by 8 cities (7 cities of Kotayk Region plus Sevan town) and providing paid services to rural communities
1	No Project	No changes in the existing waste collection and disposal practice
2	Alternative location of the regional landfill	Location near Abovyan Location near Geghashen
3	Alternative design of	No liner

Alternative concept	Concept title	Details of the concept
	regional landfill	Facility of other category
4	Alternative collection system	Separation at source (e.g. in plastic bags of different colours) Sorting of collected mixed waste
5	Alternative transportation scheme	Operation with waste transfer station(s)
6	Alternative treatment and disposal technology	Baling and landfilling Incineration Anaerobic digesters, composting, bioreactors Recycling of construction and demolition waste
7	Alternative project implementation area	Not all cities/villages Only cities, not villages
8	Alternative implementation schedule	Start with pilot projects in selected area(s) Construction of all landfill sections in one go
9	Alternative financing mechanisms for full cost recovery	Combined bill for all housing services Subsidies

The alternatives may also include other combinations of facilities within the waste management centre, other timing for construction and implementation of source separation schemes, combination of various schemes in specific areas and a variety of other alternatives. However, it is important during the ESIA to assess and compare the major impacts which may occur at some of the Project phases and to consider the adequate measures for mitigation of negative impacts as well as the measures for enhancement of possible positive impacts. It is also important to communicate information about the impacts and mitigation measures to the Project stakeholders.

## 2.1 No-Project alternative

This alternative would mean that collection, transportation and disposal of municipal solid waste in Kotayk Marz and Sevan town is continued in the same way as these services are provided today.

### **Typical features of open dumpsites present in Kotayk Region and Sevan municipality**

- The geological or topographical suitability of the site has not been considered.
- The dumpsite location has been chosen because it was the cheapest land available that did not affect interest groups within the municipality.
- No site engineering or preparatory earthworks have taken place.
- Little or no control is carried out on site operations or the manner in which waste is disposed of.
- Fires, pests, unconstrained horizontal spread of the landfill area and slope failures are common.

All waste disposal sites currently existing in Kotayk Marz and Sevan municipality belong to this category. Open dumpsites exist in many lower-income countries. However, it is widely recognised by central authorities in these countries that this practice must be stopped. In Kotayk Region and Sevan municipalities this perception is also well recognised by authorities in urban and rural communities, by various public institutions, commercial organisations, NGOs, the mass media and the general public.

The environmental and social impacts related to the existing waste management operations include:

- Uncontrolled spreading of waste
- Emissions to air and leaks of fuel, lubricants and leachate from inefficient waste collection trucks
- Spills of waste during collection, transportation, disposal, by wind
- Leachate emissions to soil from dumpsites
- Pollution of surface water bodies
- Impact on land use pattern, land devaluation
- Visual impact (poor aesthetics)
- Odour nuisance from waste and its burning
- Community health hazards from waste dumping and waste burning
- Road safety issues due to poor access roads to waste disposal locations
- Disruptions in services due to poor conditions of waste collection equipment
- Poor services for multi-storey buildings with chutes
- Limited collection hours in areas with hooting collection system
- Absence of waste registration system
- Low revenue collection rate
- Low recovery rate of recyclable waste fractions
- Biological impact factors (insects, birds, animals)
- Spreading of waste by informal waste pickers
- Poor working conditions and occupational health risks for staff of waste collection and transportation companies

## **2.2 Alternative location of regional landfill**

A number of alternative locations have been considered during the Feasibility Study prepared by COWI for the EBRD. The selection criteria and procedure are presented in the Landfill Site Selection Report available in English and Armenian.

A comprehensive site selection study was carried out within the framework of this feasibility study in the period from August 2010 until March 2011. The purpose of the site selection study was to identify the most feasible site for construction of the future regional sanitary landfill, serving as the sole final disposal facility for all municipal solid waste collected within the entire Kotayk Marz and Sevan City.

The landfill site selection process was based on the recognition of many interests, including environmental sensitivity and protection, human health protection, economic and technical feasibility for the existing and future pattern of waste generation in the region. Furthermore, one of the search criteria was that the landfill should have sufficient capacity to meet the waste disposal needs of the entire region for a period of at least 20 - 25 years. Therefore, it was calculated that the landfill should have a total area of at least 20 ha.

In order to keep the landfill construction and operation costs at an affordable level, it was also defined as a precondition that as much as possible of the required quantities of different types of soil materials (clay, gravel, sand, loam needed for the landfill construction and for covering the waste during landfill operation) should be available either at the landfill site itself or within short distance.

Seven potentially possible landfill sites were identified during the study. For various reasons, three of them were deemed unsuitable at a relatively early stage. The four most promising sites were described and assessed in details.

A multidisciplinary assessment of the sites was performed under consideration of a large number of different planning, technical, social and cultural, environmental, health and safety, and economic aspects. The summary of the assessment is presented in Table 2.2. The four sites have been given scores according the degree of meeting the criteria: -1 in case of the criteria not being met, 0 in case the criteria more or less met, and 1 in case the criteria being met with certain advantage.

Table 2.2 Evaluation of the four most promising sites for the new landfill

Criteria	1: Hrazdan dumpsite	3: Abovyan dumpsite	6: Abovyan gravel pit	7: Geghashen gravel pit
<b>Planning:</b>				
Public ownership of the land	1	0	0	1
Present land-use	1	1	1	1
Low value/demand land	0	1	0	0
Future plans for the area	1	1	0	1
Potential for extension	1	1	1	1
<b>Technical:</b>				
Presence of clay deposits for liner	1	-1	-1	-1
Presence of soil for construction and cover	1	1	1	1
Suitable access to the area	1	1	1	0
Groundwater table level	1	1	1	1
<b>Social + Cultural:</b>				
Distance from residential areas	1	0	0	1
Resettlement, economic displacement	0	0	0	1
Visual impact of operations	1	0	1	1
Traffic nuisance	1	1	1	-1
Cultural heritage	0	0	0	0
<b>Environmental, Health and Safety:</b>				
Groundwater interests	0	0	0	0
Sensitivity and impact on surface waters	0	-1	0	-1
Habitat disturbance	0	1	1	0
<b>Economic:</b>				
Land acquisition	1	-1	-1	1
Transportation distance from major waste sources	1	1	1	-1
Construction costs	1	0	1	1
<b>TOTAL SCORE</b>	<b>14</b>	<b>7</b>	<b>8</b>	<b>7</b>

From the evaluation carried out during the Feasibility Study it became clear that the clay quarry near the existing dumpsite of Hrazdan city is by far the best location for the future regional landfill. In the Hrazdan Master Plan developed for the Ministry of Urban Development of Armenia and approved by the RA Government in 2007 this site is also defined as suitable for disposal of waste.

### 2.3 Alternative type of waste disposal facility

Waste disposal facilities could be of different types. Open dumpsite is the most primitive option for waste disposal, which could hardly be called a facility. A more sound option is a controlled dumpsite facility. A more advanced type of facility is an engineered landfill. The most safe waste disposal facility from the viewpoint of environmental and social impacts associated with facility operation, closure and aftercare is a sanitary landfill.

In addition to landfill a waste management facility could also include a number of areas equipped for receiving, storage, handling and/or recycling of separate fractions of waste (construction and demolition waste, garden waste, waste of electrical and electronic equipment, paper, etc.). A facility of this type is often defined as a waste management centre.

Key features of waste disposal facilities of the four types are briefly described in the four sections below.

### **2.3.1 Controlled dumpsite**

The main features of a controlled dumpsite are:

- The working area of the site has been reduced to a smaller and more manageable size.
- The side slopes and the top are covered with soil to prevent new fires from being started, to reduce nuisances (pest, odour, windborne waste in the surroundings, and visual impact).
- Simple measures are introduced to collect surface water at the site and thereby reduce infiltration into the waste.
- Establishment of basic rules of on-site work with site workers, drivers and scavengers (if the latter cannot be removed).
- The purpose and advantages of these operational improvements is that they may be introduced quickly, need only little or no additional investment and they introduce the concept of control into the waste disposal operation.
- Controlled dumpsites represent the level of landfill development that may be achieved in most middle and lower-income countries in the short term at existing open dumpsites.

### **2.3.2 Engineered Landfill**

An engineered landfill is characterised as a disposal site where, through planning before construction or through modifications at an existing site, there is a gradual introduction of engineering techniques to control one or more of the following:

- Control and limitation of surface water entering the deposited wastes by installing a well designed and constructed surface water drainage system and/or by limitation of the actual waste disposal area.
- Spreading and compacting wastes into smaller layers.
- Spreading of soil materials to cover wastes.
- Collection and removal of leachate away from wastes into lagoons or similar structures for treatment and further disposal.

- Passive venting of landfill gas out of the wastes.
- New parts of the landfill are prepared before receiving wastes.
- A clear indication that this stage of landfilling has been reached is that:
- The routine development of detailed engineering designs prior to new landfills being developed.
- The presence of detailed waste disposal plans showing how the site will be filled with waste and subsequently closed.

All new, large landfills that are developed should as a minimum incorporate the above mentioned engineering techniques.

### **2.3.3 Sanitary Landfill**

Development of sanitary landfills, as recognised in high-income countries, involves the continuing refinement and increasing complexity in engineering design and construction techniques of landfills. This also involves changes in the operational practices at the site. Sanitary landfills typically have many additional features to those found on engineered landfills, such as:

- Extensive environmental monitoring and environmental protection obligations.
- An organised and well-qualified work force.
- Detailed record-keeping and reporting.
- Where required, on-site leachate treatment as an additional feature to the leachate collection system.
- Pre-planned installation of landfill gas and utilisation systems.
- Wide range of specialised mechanical equipment used.
- Complex, multi-layered lining systems to isolate waste and leachate from the surrounding geology.

Since the construction and operation of a sanitary landfill requires considerable capital investment and high operational costs, the Armenian society as a whole may not be able to achieve and sustain this level of landfill development in the near future. A project on improvement of the solid waste management situation in Kotayk Region, including construction of a modern regional sanitary landfill may therefore be seen as a pilot project that can serve as a model for future similar improvement in other regions of Armenia.

### **2.3.4 Waste management centre**

The regional landfill could be supplemented by other waste disposal facilities established within areas adjacent to the regional landfill. The facilities could receive and treat certain waste fractions and produce valuable materials of interest for the market (e.g. crushed construction and demolition waste after treatment could be re-used in building and road construction materials, garden waste can be treated and used as compost). A regional waste management centre could be considered as an alternative to the proposed Project, which would be implementable at a later stage of the regional waste management system development for Kotayk Region and Sevan municipality.

## **2.4 Alternative waste collection system**

A dual collection system can be considered as an alternative to the proposed ordinary waste collection system. In case of the dual collection system the individual consumers/households will separate waste into two fractions (one fraction will contain a selection of recyclable materials and the second fraction will contain all other waste) before these two waste fractions are collected and transported by the municipal waste collection company to the regional landfill. A new sanitary landfill will be established in the outskirts of Hrazdan to serve as the only regional waste disposal facility for all municipalities of Kotayk Region and for Sevan municipality. The landfill in this alternative scenario should include a sorting plant for sorting/refining of a recyclable fraction that was at source separated from the remaining mixed waste.

The system can be introduced at the same time all over Kotayk Marz and in Sevan town. The alternative schedule could assume gradual introduction with pilot projects in a few locations during the initial phase.

Waste will be collected from the eight municipalities and from the rural communities as described above for the ordinary waste collection solution. However, in municipalities (not in rural communes) waste will be collected by means of a dual collection system - in two main fractions - one recyclable ("dry") fraction - including paper, cardboard, plastic, glass, metal - and one residual ("wet") fraction - including remaining waste items.

Six of the municipalities (Hrazdan, Tsaghkadzor, Charentsavan, Yeghvard, Abovyan and Sevan) will be provided with 2 different sets of 700 ltr. containers for the dual collection - each set consisting of containers painted in different colours (e.g. green for the recyclable fraction and red for the residual fraction). Sets of containers will be placed all over towns and at shops, institutions, public squares etc. Furthermore, municipalities will be provided with new compaction trucks for mechanical separate emptying of each container type and for separate transport to the Hrazdan landfill for emptying at a sorting plant (recyclables) and at the disposal unit (residuals) respectively.

Two of the municipalities (Nor Hachn and Byureghavan) in case of the dual collection system implementation will be provided with compaction trucks with two chambers for the two waste fractions as the two municipalities prefer to

have a "hooting" system as described above. The collected waste will be transported directly to the Hrazdan landfill for emptying at a sorting plant (recyclables) and at the disposal unit (residuals) respectively.

Both fractions (recyclables and residual waste) collected separately and transported to the new regional landfill will be weighed and registered at the landfill entrance. From thereon the trucks will be directed to either a sorting plant for unloading of recyclables or to the landfill disposal unit for unloading of residuals. If undesired waste items are discovered at the unloading of residuals, such as e.g. drums or other containers with hazardous waste, this will be removed and stored at the hazardous waste storage belonging to the landfill, where it is kept until it will be taken for further treatment/disposal elsewhere.

The recyclable fraction unloaded at a hopper at the sorting plant will by means of a conveyor be taken to a horizontal sorting conveying belt, where workers placed at both sides of the sorting belt will manually sort individual material fractions (paper, cardboard, plastic, glass and metal) into separate compartments/containers located below the sorting belt. Workers will be provided with protective clothes and gloves and masks. Furthermore, the sorting belt will be provided with an effective ventilation system placed directly over the belt, ensuring that any odours from the sorting belt will be removed effectively.

The individual material fractions sorted from the incoming amount will be separately packed and baled and taken to an interim storage at the sorting facility, from where it is transported to the relevant recycling industry for further processing. Residual waste from the sorting plant will be disposed at the landfill.

Trucks with residual waste will come to the waste disposal unit, where the waste is unloaded, homogenised/crushed and covered as described for the ordinary waste collection solution.

## **2.5 Alternative transportation of waste**

The Feasibility Study has shown that waste collection truck would be the optimal vehicles for transportation of waste to the regional landfill. The trucks will use the existing road network in Kotayk Region and Sevan municipality. Given the transportation distances and availability of rather small waste collection trucks in municipalities, establishment of a transfer station for re-loading of waste collected in the municipalities other than Hrazdan by smaller trucks into bigger trucks for long-distance transportation to the landfill could be considered and an alternative. However, calculations completed during the Feasibility Study confirmed that it is practically and economically unfeasible for the distances within Kotayk Marz and Sevan town, as well as for the amounts of waste subject for transportation.

Optimal routing of waste transportation should be elaborated for lowering the environmental and social impacts of the transport operations.

## **2.6 Alternative treatment and disposal of waste**

Alternatives considered during development of regional waste management systems typically include baling and landfilling of waste, incineration of waste and chemical/biological treatment of waste.

### **2.6.1 Baling and landfilling**

Compacting of waste and its packing in bales can be carried out for minimisation of waste volume before transportation of waste to a distant landfill and thus the number of trucks transporting waste to the landfill. Baling can also lower the risk of waste spreading by wind during landfilling, when the waste bales could be disposed in regular rows and immediately covered with a temporary tent. Baling facilities can be established at waste transfer stations. However, the establishment of baling facilities close to residential areas, where it make sense for reduced transportation of loose waste to baling station, could cause noise, vibration and odour nuisance, and the construction and operation of waste baling facility require considerable costs and is deemed feasible, when the waste is collected from a major city (population of several hundred thousand) and is to be taken to a landfill located far away from the city along a transportation route via roads with heavy traffic.

According to the Feasibility Study completed by COWI in 2011, for the specific conditions of Kotayk Region and Sevan municipality the establishment of transfer or baling station(s) were considered as associated with unnecessary additional investment and operational costs and thus not considered feasible.

### **2.6.2 Treatment at waste incineration plant**

One of the alternatives actively discussed in Armenia assumes establishment of a regional waste incineration plant for Kotayk Region and Sevan municipality. A landfill will be required for safe disposal of residual materials generate during waste incineration. As for the proposed ordinary waste collection solution, a new sanitary landfill should be established in the outskirts of Hrazdan to serve as the only facility for disposal of the waste for Kotayk Region and Sevan municipality. The landfill may include a sorting plant for sorting/refining of a recyclable fraction that may or may not have been separated from the general waste at source. The incineration alternative does not depend on whether the waste is sorted at source or not. The regional waste incineration plant could be established either at the landfill area or elsewhere in the region.

Waste will be collected from the eight municipalities and from the rural communities as described above for the ordinary waste collection solution or for the dual collection alternative.

The recyclable fraction (in case of the dual collection system) will be transported for further processing at the sorting plant at the landfill. Other waste will be transported for treatment at the incineration plant.

Waste entering the landfill and/or the incineration plant will be registered at a weighbridge (either comingled waste or the two fractions from the dual collection system) as described for the previous alternatives.

Upon registration, the recyclable fraction is directed to the sorting plant as described above. Mixed waste or residual waste from the dual waste collection system is taken for treatment at the incineration plant. Also residual waste from the sorting plant is taken for incineration.

The purpose of incineration is to reduce the quantities of waste to be disposed at the landfill and the subsequent generation of leachate and other emissions at the landfill. Furthermore, the incineration plant will be equipped with an energy recovery system for production of power and possibly also heat (if a demand for heat is identified in the area)

The incineration plant will be based on the mass burning technology for treatment of the mixed waste without pre-treatment. The incoming residual waste is unloaded in a reception and storage terminal with capacity to store the waste in 2-3 days so that the operation of the incineration plant can continue in shorter periods of non-delivery of waste. From the storage the waste is loaded into a combustion unit equipped with combustion chamber for combustion of the waste under high temperature (up to 1,000°C), a heat recovery system and a system for taking out produced ash and slag of the combusting unit.

The flue gas will undergo an effluent flue gas cleaning process in an advanced flue gas cleaning system. The concentration of pollutants in the exhaust air will be in compliance with international regulations. The exhaust air will be discharged via an induced draught fan and a high stack.

End products are approximately 20 weight % (5 vol.%) bottom ash (slag) that to some extent (3/4) can be reused as gravel in road construction and 2-4% heavily contaminated fly ash and residual products from the flue gas cleaning system that has to be disposed of in a special cell in the landfill.

Residual waste from the incineration plant is taken to the open waste disposal unit at the landfill for final disposal.

The closure of dumpsite will be carried in the same way as in case of the ordinary waste collection solution.

### **2.6.3 Waste treatment at composting facility, anaerobic digesters or bioreactors**

Generally speaking, the organic components of municipal solid waste could be decomposed in the presence of air and humidity. The resulting product could be valuable as soil conditioner. Waste categories that are ideal for composting are park and garden waste, paper, paper packaging, food waste and other types of organic waste. There are several methods applicable at composting facilities.

The most common and simple is windrow composting where the waste is kept in rows under certain humidity and with active and/or passive ventilation.

The organic waste can also be treated in closed anaerobic containers/digesters/bioreactors with generation of biogas, which can be recovered for use as a fuel source. The residual waste from anaerobic digesters is normally treated by aerobic digestion and may be used as agricultural fertilizer.

Economic advantages of waste treatment by composting, anaerobic digestion and in bioreactors include the reduction in the volume of waste deposited in landfills. This allows extending the duration of landfill operation time and delaying the investment in construction of the next landfill. At the same time this kind of treatment generates soil nutrients, which could be commercially valuable.

However, waste treatment in anaerobic digesters or composting facilities can not overtake the role of a modern landfill. The mentioned facilities can only be considered as a supplement to treatment of collected municipal waste, because only organic fraction of the collected municipal solid waste can be treated. A comparison between anaerobic and aerobic treatment of the organic fraction of waste collected in Kotayk region is presented below.

According to the waste surveys the total amount of waste and the fraction of organic waste (about 30 - 35 per cent of waste weight) will be as follows:

Year	2014	2033
Waste amount	40,000tons	80,000tons
Organic waste	15,000 tons	26,000 tons

The incoming waste subject for biological treatment should undergo a pre-treatment and screening before the treatment in biological treatment facilities. The pre-treatment will include a rough sorting where unwanted larger elements are sorted out. Hereafter the waste should be shredded and screened in a screen with 80 - 100 mm holes. The costs of equipment, building etc. required for a capacity of 40,000 tons per year would be about 2.0 mill € corresponding to 50 € per ton of waste. The operation costs will be approx. 20 % of the investment corresponding to 10 € per tons including depreciation.

The biological treatment itself can be performed by either an anaerobic process or an aerobic process. There is also an option when both treatment processes can be performed within the same facility.

#### Anaerobic and aerobic process

In this process the pre-treated organic waste is mixed with structure materials and placed in a reactor unit. In this unit the waste will be percolated under anaerobic conditions in 6 weeks producing methane gas. After 6 weeks the percolating is stopped and the conditions are changed into aerobic by blowing in air. This aerobic treatment will last for about 3 weeks. After 9 - 10 weeks the

treated waste is ready for final screening, hereafter it can be sold (if possible) as fertilizer. The capacity of such a facility can be increased by adding process modules when needed. Investments required for such a facility will be approx. 7.0 mill € corresponding to approx. 470 € per ton of waste at a capacity of 15,000 tons per year. The operation costs will be approx. 70 - 80 € per ton of waste inclusive the benefits from production of electricity and/or heat and the depreciation.

#### Aerobic treatment (composting)

Aerobic treatment or composting is used at facilities, where oxygen can perform the decomposition of organic matter.

In case of in-vessel (reactor) composting facility, the process will take 8 weeks in closed reactor modules and followed by 3 months of maturing. If the treatment is carried out inside buildings, the investment costs required for a capacity of 15,000 tons waste per year will be approx. 11 mill € corresponding to approx. 730 € per ton waste at. The relatively high investments are related to a large building complex. The operation costs will be approx. 120 - 130 € per tons waste inclusive depreciation of the investments.

In case of open windrow composting the incoming waste will be set up in windrows, where it will stay and 4-5 times turned during 12 weeks. After the composting process the materials will be placed in bigger piles for 3 months for after-maturing. The facility will require a paved area of 20,000 - 21,000 m<sup>2</sup> and machinery for operation (front-end loaders, screen, windrow turner etc.). The total investments needed for a capacity of 15,000 tons waste per year will be approx. 2.5 mill € corresponding to approx. 170 € per ton waste. It is assumed that the pavement of the composting area will be underlined by a soil stabilisation layer and a layer of stable gravel. The operation costs will be approx. 30 - 35 € per ton of waste inclusive depreciation of the investments.

Assessments of investment and operation costs required for pre-treatment of organic waste and its further treatment by the biological processes described above are presented in Table 2.3.

*Table 2.3 Investment and operation costs required for biological treatment of organic waste generated in Kotayk Region and Sevan municipality*

	Investment Million €	Investment €/ton	Operation €/ton
Pre-treatment	2	50	10
Anaerobic&aerobic process	7	470	70 - 80
In-vessel composting	11	730	120 - 130
Open windrow composting	2.5	170	30 - 35

Biological treatment of organic waste would require additional investments and operation costs related to collection of waste, which should be separated into organic and inorganic fraction at the sources of waste generation (households, catering companies, shops, etc). If the municipal solid waste is not separated at source and collected as mixed waste, its separation at a central sorting facility will require very high investment and operation costs for ensure the proper sorting and the proper working conditions at the facility. Introduction of waste separation at source and collection of separate waste fractions will require the public education campaign and follow-up activities, as well as management of the organic waste treatment product. An implemented biological treatment process for organic waste would in any case assume that the inorganic waste is disposed off at another facility (e.g. sanitary landfill).

A review of the project alternative including biological treatment of waste allows concluding the following:

- 1 - Biological treatment is applicable only for the organic fraction of the waste and assumes disposal of the residual waste at a landfill.
- 2 - Construction and operation of facilities for biological treatment of organic fraction of municipal solid waste would require considerable investments, but will not exclude the need for construction and operation of landfill in Kotayk Region.
- 3 - Biological treatment of organic fraction of municipal solid waste could generate a soil conditioner/fertiliser, but no market for this product has been identified in the region, so the market value of this product is not known and thus can not be immediately taken into consideration as a revenue source in the context of Kotayk Region. If there is no market for compost in the region, the produced compost will have to be disposed or used at the landfill, e.g. as cover material, and in this case there will be no expected reduction of waste subject for landfilling.
- 4 - Composting in windrows could be considered as the alternative waste treatment process requiring the lowest costs and thus potentially feasible at the next stage of waste management system development in Kotayk Region.

#### **2.6.4 Recycling of construction and demolition (C&D) waste**

The waste characterisation survey described in the baseline report revealed that the citizens dispose relatively large amounts of concrete, soils and construction waste in the containers (15% - 24% of total waste amounts). It can be expected that additional amounts of construction and demolition waste will be delivered directly to a new regional landfill from construction contractors.

The small sized C&D waste (mainly from containers) mixed with other municipal waste can be disposed at the regional landfill as part of the municipal waste.

The amount of C&D waste from construction contractors is not known. The waste can e.g. be used for construction of internal interim roads during the operation of the landfill. Large sized items have to be disposed separately at the landfill or crushed before it can be used for interim roads or cover materials at the landfill.

Depending of the amount of C&D waste generated and delivered to the regional landfill it might be feasible to establish a facility for recycling of C&D waste at the regional landfill. Sorting and crushing of the C&D waste is required in order to be able to reuse the waste (clean materials), herewith reducing consumption of the natural resources as well as the amount of waste to be disposed at the regional landfill. End products of this treatment are secondary raw materials sorted in fractions according to the aggregate size plus fine fraction similar to soil. In many countries these materials successfully replace mineral materials from quarries in the construction and/or other industries, for example as a general bulk fill, fill in drainage projects, aggregate for new concrete manufacture or sub-base material in road construction. However, introduction of such materials may require revision of the present regulations/norms for the re-use of C&D waste. With the mining industry and production of mineral construction materials from quarries being one of the most developed in Armenia and in Kotayk Region it would be questionable whether materials from recycling of C&D waste will be competitive on the market.

Optional it might be feasible to procure and operate a mobile crushing plant. The plant will be removed around in the project area and used in connection with larger construction and demolition works so that the long transportation distances to the regional landfill will be avoided. Such mobile facility could be operated by the Landfill Company or by private contractors. The technology is well known worldwide and successfully used for recycling of C&D waste. The Landfill Company should follow the development of the amount of C&D waste and assess the feasibility of its recycling in the future.

## **2.7 Alternative area of Project coverage**

The proposed Project assumes participation of 8 urban municipalities (all 7 urban municipalities of Kotayk Region and the municipality of Sevan located in the adjacent Gegharkunik Region) in establishment of the regional landfill management company, collection of mixed waste with separate collection of some recyclable fractions, transportation of mixed waste from urban and rural municipalities for disposal at the common regional landfill. However, it could appear that not all of the 8 largest municipalities will be ready to cooperate for implementation of the Project. For example, one or several urban municipalities will decide not to transport their waste to the regional landfill in Hrazdan and to continue disposal of waste at their dumpsites or at their own landfill(s).

Positive outcome of this alternative would be participation of at least some of the municipalities in establishment of the modern waste collection system with sound disposal of waste at regional sanitary landfill, landfill site will be sufficient for longer time of landfill operation. The negative outcomes would be as

follows: new equipment and vehicles will be available only for the participating municipalities, construction and operational costs related to the regional landfill will be a heavy burden in terms of tariffs for the participating municipalities; there is a chance that dumping of waste will be continued in municipalities not participating in the Project cooperation, and if a municipality decides to establish its own landfill, the landfill construction and operation costs will be very high and would require higher tariffs than in case of participation in the regional cooperation.

## **2.8 Alternative implementation schedule**

The main Project proposal assumes gradual procurement of equipment, gradual introduction of the new waste collection system starting from pilot project(s) and gradual construction of the landfill.

Alternative implementation schedule could assume one-go procurement of equipment and machinery, simultaneous introduction of new waste collection system in all municipalities, construction and filling of several cells at the landfill at the same time.

One-go procurement of equipment could result in wasting the Project resources for unsuitable equipment. Simultaneous introduction of new waste collection system in all municipalities will require additional resources and can generate social and psychological barriers for implementation of the Project.

Construction and filling of cells at landfills is carried out with one cell at a time, so that the proper quality and safety is achieved during installation of liner, registration and tipping of waste, compacting and covering of waste, leachate monitoring and management, etc.

## **2.9 Alternative financing mechanism for full cost recovery of the new waste management system**

A number of regulatory, economic, administrative and community mobilisation measures could be considered by municipalities participating in the Project in order to ensure full recovery of costs related to operation of the regional waste management system including the sanitary landfill, as well as the required prevention of waste dumping. The proposed measures, their impacts (mainly social impacts) and impact mitigation measures should be presented and discussed during the ESIA.

## **2.10 Comparison of alternatives**

A brief comparison of the proposed Project and some of alternatives, which were mentioned and discussed by participants of the meetings held during the Feasibility Study and the Environmental and Social Due Diligence assignments, is presented in Table 2.4.

Table 2.4 Comparison of key features of the Project and its selected alternatives

	Features included in the alternative	Alternatives			
		No Project (existing situation)	Ordinary waste collection, sanitary landfill	Dual collection system, sanitary landfill	Waste collection, incineration, landfill for residual
Handling of waste at households / at waste generation sources	Source separation of waste	-	-	√	√
Waste collection	Separate collection of recyclables	-	√	√	√
Transportation	Direct transport to disposal / treatment	√	√	√	√
	Transport via transfer station	-	-	-	-
Treatment	Central sorting of mixed waste	-	-	-	-
	Central sorting of recyclable fraction	-	-	√	√
	Interim storage of hazardous waste	-	√	√	√
	Treatment of construction & demolition waste	-	-	-	-
	Composting of organic fraction (optional)	-	-	-	-
	Incineration of waste	-	-	-	√
Disposal	Disposal at open dumpsites	√	-	-	-
	Disposal at sanitary landfill	-	√	√	√
Required investment for Kotayk Region and Sevan municipality, MEUR		n/a	6.7 <sup>*)</sup>	8.7 <sup>*)</sup>	180 <sup>**)</sup>
Operation and management costs per ton of safely disposed waste, EUR		n/a	100 <sup>*)</sup>	120 <sup>*)</sup>	200 <sup>**)</sup>
Average monthly tariff for waste collection (AMD/person)		150	459 <sup>*)</sup>	550 <sup>*)</sup>	950 <sup>**)</sup>

<sup>\*)</sup> Assessment based on the Feasibility Study

<sup>\*\*)</sup> Assessment based on Consultant's international experience

A detailed comparison of the Project and its feasible alternatives with assessment of environmental and social impacts was presented at public meetings held in Hrazdan on 18 May and 21 June 2011 during preparation of the Project Proposal within the Feasibility Study assignment and the ESIA within the Environmental and Social Due Diligence assignment.

### 2.10.1 Two most feasible technical options

The two most feasible technical options for the Project taking into consideration the present status of the waste management system in the region are as follows:

- Landfill and ordinary waste collection system,
- Landfill and dual waste collection system.

Main advantages and disadvantages of these two options discussed at the meetings are presented in Table 2.5.

*Table 2.5 Main advantages and disadvantages of ordinary and dual waste collection systems*

	Ordinary collection system	Dual collection system
Main advantages	Simple, robust and cost effective waste collection Certain collection of recyclables through bring banks	High collection rate of relatively clean recyclable materials High selling price for recyclable materials due to their high quality
Main disadvantages	Less efficient recycling system	Needed change of habits for waste separation at source (at home and in correct containers) Requires available recycling industries and reliable market for materials

Based on the existing status of waste management in Kotayk Region, Sevan municipality, in other regions of Armenia, as well as taking into account the findings during the Feasibility study and the Consultant's international experience from introduction of new waste collection systems in various regions of other countries it was recommended during implementation of the Project to introduce for Kotayk Region and Sevan municipality the ordinary waste collection system.

### 2.10.2 Comparison of financial implications

Financial implications of the two options are discussed in the Business Plan section of the Project Proposal prepared based on financial modelling completed within the Feasibility Study. The financial implications were also discussed during the meeting held in Hrazdan on 18 May 2011.

The financial model for the Project assumes that revenues are received from the two main sources:

- Tariff payments by customers;
- Proceeds from sale of recyclables.

In case of the dual collection system, the revenues from recyclables will be received by the Landfill Management Company. In case of the ordinary collection system, such accrues to the local collection company. Tariff payments by customers (households and other customers) cover the entire cost of collection, transportation and disposal. From tariff proceeds, the collection companies compensate the Landfill Management Company in the form of Gate Fee payment for each tone of delivered waste.

Gate fee is the main source of income for Landfill Management Company. In the case of the dual collection system, it will be supplemented with proceeds from sales of recyclables.

On the basis of projected operating costs, the proposed Investment Programme and implied financing package, the required revenues (tariffs) have been analysed. Several key principles have been set for such analysis:

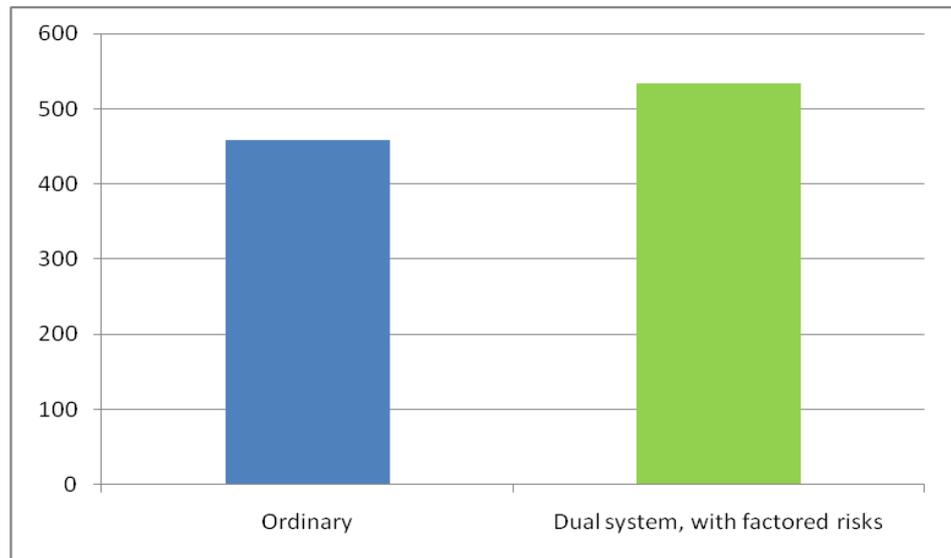
- Waste collection in urban municipalities will be carried out by the local collection companies;
- Waste collection in rural municipalities will be carried out by the Landfill Management Company;
- Customers in the rural and urban municipalities are to cover full cost of local collection (this will result in increase of tariffs, if compared with their partial coverage of costs related to the present waste collection and dumping);
- Cost of driving to landfill has been averaged based on the following principle - all costs of driving to the landfill have been pulled into one fund and then distributed between towns on the proportional basis to the amount of waste generation;
- Costs related to landfill operation has been treated similarly and distributed between towns on the proportional basis to the amount of waste generation;

- Sorting facility related costs for dual collection system have been treated similarly and distributed between towns on the proportional basis to the amount of waste generation;
- The estimates made within the Feasibility Study showed that 80% of municipal solid waste in Kotayk Region and Sevan municipality are generated by households and 20% are generated by other sources, That is why it has been assumed that following the Polluter Pays Principle the households will account for 80% of the total cost base and the other customers will account for 20% of cost base, in correspondence with the share of generated waste amount;
- The calculated tariffs should cover all costs of system operation, taking into account collection rate and service coverage rate.

While both options have been considered in calculations, it is important to note that the dual collection system relies for the part of its revenues on the assumptions made regarding ability to recycle and sell the recyclables at the assumed market prices. In particular it is presumed that:

- The rates of recycling that has been assumed above are actually met;
- That the prices of recyclable sales are at the levels assumed in the model;
- Population coverage, and hence the amount of recyclables generated in the system, are also met;

Such conditions certainly impose substantial element of risk in the financial viability of the system since the recycling market is underdeveloped in Kotayk Region and in Armenia as a whole. To take into account and estimate the monetary implication of such risks the Consultant modelled various sensitivities regarding sale of recyclables in case of the dual collection scenario. And the final comparative figures of the costs between two systems are presented in Figure 3.



*Figure 3 Dual collection related tariff is significantly higher in sensitivity testing, AMD/person/month*

As a result, it is suggested that the most cost-efficient (also from households' point of view) approach would be to start with the ordinary collection system. This will require increase of waste collection tariffs. However, it will not be as high as in the case of the dual collection system.

When the main components of the waste management system are in place and well functioning, and the recyclables market is developed, tested and relatively stabilised, a gradual switch to a dual collection system may be considered.

The ordinary collection system that is recommended implies that the average household tariff will stand at 459 AMD/person/month across Kotayk Region to provide for financial viability of all the operating companies (collection and landfill management companies). This level of tariffs is relatively low, compared to the waste tariff limit of 400 AMD/person/month established by the Law on Waste Collection and Sanitary Cleaning Services adopted by the RA Parliament on 21 June 2011. It should be underlined that the tariff limit of 400 AMD/person/month is established for the existing waste management system in Armenia, which actually assumes disposal at dumpsites and not at the proper waste disposal facilities.

An affordability assessment on the calculated tariff has been carried out, showing that it will account for about 1% of the average household income. While such levels certainly do not indicate affordability problems, the nominal increase from the current levels is high (more than doubling of the current tariff levels).

It is, therefore, recommended, that a gradually increase of the tariff fare should start now in order to reach the required levels by the year 2014.

In terms of other customers, they will have to account for 20% of total cost of the new system. That translates into average tariff per tonne of waste for the recommended ordinary collection option of EURO 50/tonne. The modality of receiving such payments from non-household customers can vary. If the amount of waste actually generated and collected from non-household customers would be possible to record, the charging system would be simple and based on the actual tonnages of waste collected. However, the technical set-up of collection system in most of the cities is such that a substantial number of non-household entities dispose their waste into the common containers together with households. In such circumstances the only viable option is to establish fixed price per month linked to some parameter related to the size of the non-household entity (area of premises, number of persons, etc.).

For specific cases, when dedicated containers are to be allocated to non-household entities, charging can be actual waste amount based.

Whatever option is selected, the key remains that revenue in the amount of EUR 50/tonne times 20% of the waste generated in the respective city is collected from non-household customers.

Detailed analysis of two possible options for waste management system development has been made - dual collection system with substantial amount of recyclables generated/sold, and ordinary collection system with bring banks that provide some collection of recyclables. Besides, the critical difference between the options is that dual collection system presumes construction of sorting facility at the landfill, while the ordinary collection system provides direct disposal of all waste delivered to the regional landfill.

Key conclusions from analysis are following:

- Dual collection option is more costly (cost of additional sorting facility and more expensive collection system to the need for elaborated infrastructure - containers, vehicles - for collection of recyclables);
- At the same time dual collection option provides for the opportunity to capitalise on the sale of recyclables, and in such way, to reduce the tariff burden on customers;
- However, such opportunity is subject to many risks, most of which are related to significant uncertainties regarding potential path for recycling market and recycling habits development. If such does not materialise, the dual collection system will experience difficulties in sustaining financially viable operations at all levels;
- Ordinary collection system, on the other hand, is rather simple to implement, is not related to many risk elements (except risk of project implementation), and once operational will deliver stable collection and disposal services.

- In addition, ordinary collection system will include number of bins for recycling collection, hence will serve as an adequate starting point for stimulation of waste separation and preparation of grounds for future dual collection system.

Even for the ordinary collection system implementation, substantial tariff growth is expected. The graph in Figure 4 compares the required household tariff level in 2014 to the expected current tariff growth pattern reflecting only inflation indexation. In other words, even if we take the current tariff level in the cities where it is highest at the moment, and assume it would steadily increase by inflation rate each year, then doubling of household tariff would be required in 2014, when the facilities are to become operational. It is, therefore, recommended, that tariff levels are increased by more than inflation rate, in order to provide for smoother transition to required tariff levels in 2014.

It must also be noticed, that the tariff level quoted for the recommended option is average across Kotayk Region and presumes payment of such level by all households. No subsidies or cross subsidies across areas has been included into calculation, and such issues will have to be resolved by the local authorities and Landfill Management Company depending on the specific subsidy and tariff increase policies adopted in different areas of Kotayk Region. The key element, however, remains, that waste management system is capable of generating required revenue of 459 AMD/person/month times the amount of waste collected from population.

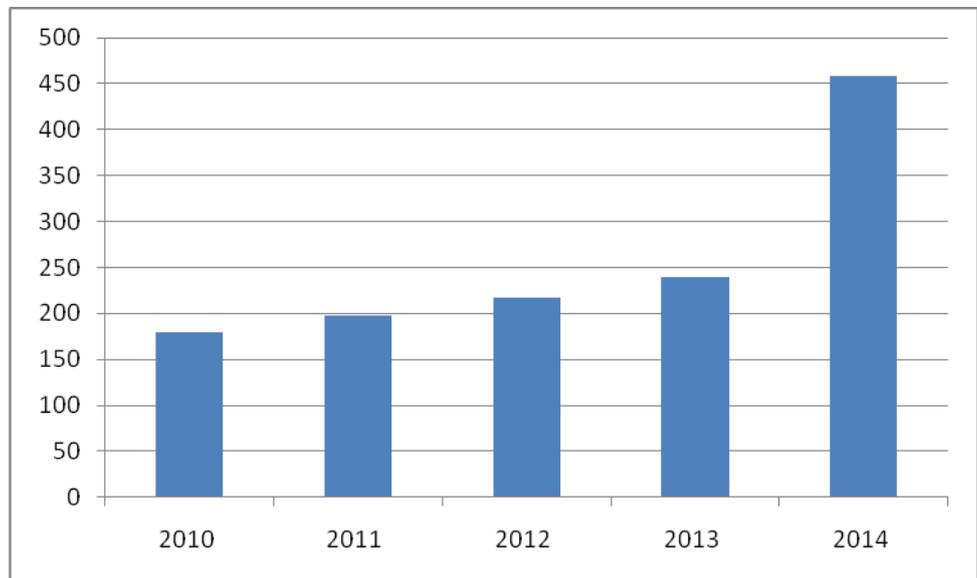


Figure 4 Required tariff growth in 2014 compared to potential tariff growth in the period 2011-2013, AMD/person/month

Landfill Management Company will in 2015 start to repay the EBRD loan's principle amount. This year will be rather challenging, because the Company will just start generating sufficient cash flow to meet the payments. Improvements in the financial position of the Company can be reached if the revenue

collection rate in Kotayk Region and Sevan municipality is above 70% assumed in the financial model.

Over the remaining period of time, the LMC remains financially strong and able to meet its debt service obligations, provided that all the assumptions regarding tariff increase, cost levels, revenue collection rates, population coverage, and waste generation and collection are practically materialised.

Based on comparison of pros and cons, and taking into account results of the analysis from the point of view of minimum risk, maximum certainty for the project financial feasibility, and cost implications for population, the ordinary waste collection system seem to be the right starting point for the Kotayk Region and Sevan municipality.

### 3 Recommended waste management system

The proposed waste management system includes the following elements:

- Ordinary waste collection system supplemented with bring banks for recyclable materials
  - Collection points to be planned and constructed by the municipalities
  - Containers and vehicles for mixed household waste to be distributed to shareholding communities according to the defined need
  - Containers and vehicles to be used by the Company for waste collection from rural communities that are not covered by the collection services
  - Containers for collection of recyclables from bring banks to be distributed to shareholding municipalities
- Regional landfill to be commonly used by all 8 municipalities, together with the machinery and equipment required for its operation.

The following includes a description of the system components.

#### 3.1 Collection of waste

General description of the solid waste collection system

The overall idea of the proposed solid waste collection system is to improve the existing waste collection system in the municipalities by supply of sufficient number of collection points, sufficient number of containers at the collection points and sufficient number of collection vehicles. Furthermore, the system will be supplemented with establishment of bring banks for collection of recyclable materials. A bring bank is a place, where specific collection containers are placed for each type of recyclable materials (paper, cardboard, plastic and glass). People, have to separate the waste in the households (at source). The recyclable materials have to be delivered at the bring banks and the residual waste (remaining waste excluding recyclable materials) to the municipal collection system.

Municipalities will also in future be responsible for organising the waste collection services in each municipality. On their own choice, municipalities may arrange collection through their own utility or they may decide to have it carried out by a private contractor. Individual waste disposal will no longer be allowed,

but municipalities will be obliged to bring the waste to the new regional landfill in Hrazdan.

#### Improved waste collection coverage

Currently not all inhabitants and commercial enterprises in the towns in Kotayk Marz and Sevan municipality are covered by public waste collection services, so not all generated municipal waste are currently being collected but littered in the surroundings, buried or burned. In some of the municipalities 100% of the households are currently covered by public waste collection services. In the other municipalities the coverage rate varies between 50% and 86%. In the 60 rural communities less than 10% of the households are currently covered by waste collection services.

The public collection system will gradually be extended and improved in the planning period so that almost all households and commercial enterprises in the towns will be covered with public waste collection services at the end of the planning period in 2033. For the rural areas a public collection system will be introduced in 2014 and the services coverage increased from approximately 10% coverage in the beginning of the planning period to approximately 64% in 2033 at the end of the planning period.

The waste collection coverage rates in the urban municipalities and rural communities are presented in Table 3.1 below.

*Table 3.1 Households covered by waste collection services in the planning period*

	<b>2010 (and 2014)</b>	<b>2028</b>	<b>2033</b>
Hrazdan municipality	50%	95%	95%
Charentsavan municipality	100%	100%	100%
Tsaghkadzor city and tourist areas	100%	100%	100%
Abovyan municipality	83%	95%	95%
Byureghavan municipality	59%	95%	95%
Yeghvard municipality	63%	95%	95%
Nor Hatchn municipality	86%	95%	95%
Sevan town	80%	95%	95%
Sevan tourist areas	100%	100%	100%
Rural communities	< 10%	50%	64%

#### Waste collection systems

The future waste collection system in the urban municipalities will as described above be based on modernisation and improvement of the existing collection systems. The following collection schemes will be used for collection of mixed household and commercial waste:

- Waste collection from collection points; and
- "Hooting" system; in Byureghavan and Nor Hatchn municipalities

The major problems with the existing waste collection point system are insufficient number of collection points (too long walking distance for the citizens) and insufficient number of containers at each collection point as well as irregular waste collection. Therefore, the containers are often overloaded and waste scattered on the ground around the collection point when the collection truck arrives. This also encourages waste burning, which is common. Scavengers collect recyclable material from the containers and contribute to littering of waste around the collection points. Furthermore, a number of the containers are broken. A handy man has to clean up before the collection truck can leave to the next collection point, which is time consuming.

It appears that the collection point system provides a high level of service to the citizens and institutions without causing major environmental problems if the collection point system is properly designed, operated and maintained. The system is already well known for the citizens and the waste collection companies and therefore, upon discussion with the municipalities, it is proposed to base the future collection system in the urban municipalities (except Byureghavan and Nor Hatchn municipalities) on an improved collection point system.

Needed improvements that will be implemented include: (i) extending the number of collection points and containers at each collection point, (ii) establishing collection points with a firm bottom (asphalt/concrete) in order to make the cleaning at the collection point easier, (iii) replacing broken containers inappropriate for loading, and (iv) increasing collection frequency, as needed. Information and awareness raising campaigns will be arranged in order to increase the citizens' awareness of the problem.

The waste collection point system will also be introduced gradually in the 60 rural communities during the planning period.

Byureghavan and Nor Hatchn municipalities have recently changed from a system with waste collection from collection points with containers to the hooting system as they consider that the hooting system keeps the town more clean and free from waste littering. The two municipalities do not have any plans or wishes to change the hooting system and it is assumed that the system continues in the entire planning period for the two municipalities.

Reconstruction or closing of existing garbage chutes

There are currently a number of high-rise buildings equipped with garbage chute and waste storage room for municipal solid waste pre-collection. Waste collection from the garbage chutes and the storage rooms at the end of the garbage chutes are a major source of odours, nuisances, hygienic problems and vector propagation. The waste from garbage chutes is collected every 3-5 days or on a daily basis. Loading of the waste to the collection vehicle is generally unhygienic, labour-intensive and time consuming work. In most cases the waste needs to be manually shovelled from the garbage storage rooms to the collection vehicle.

The current system with waste collection from garbage chutes will be phased out e.g. by:

- Close down the garbage chutes and replace them by a collection point system, and/or
- Reconstruct the garbage chutes to be able to place wheeled containers below the chutes and daily emptying of the containers

A couple of the municipalities informed that they had already closed the garbage chutes due to the problems with rats and vermin and due to the inefficiency of this collection system. In a study in Yerevan it was revealed that there is significant resistance by some of the condominiums about a recommendation to close down the garbage chutes.

Ordinary collection system in 6 urban municipalities

Six of the urban municipalities (Hrazdan, Tsaghkadzor, Charentsavan, Yeghvard, Abovyan and Sevan) will be provided with 700 litres containers for waste collection. Containers will be placed in collection points all over the towns and at shops, institutions, public squares etc. Furthermore, the municipalities will be provided with new compaction trucks for mechanical emptying of containers and for transport to the Hrazdan regional landfill for emptying.

A detailed plan of the actual locations of collection points and the needed number of containers at each collection point will be prepared by the municipality before introduction of the improved system.

The waste flow in the system is presented in Figure 5.

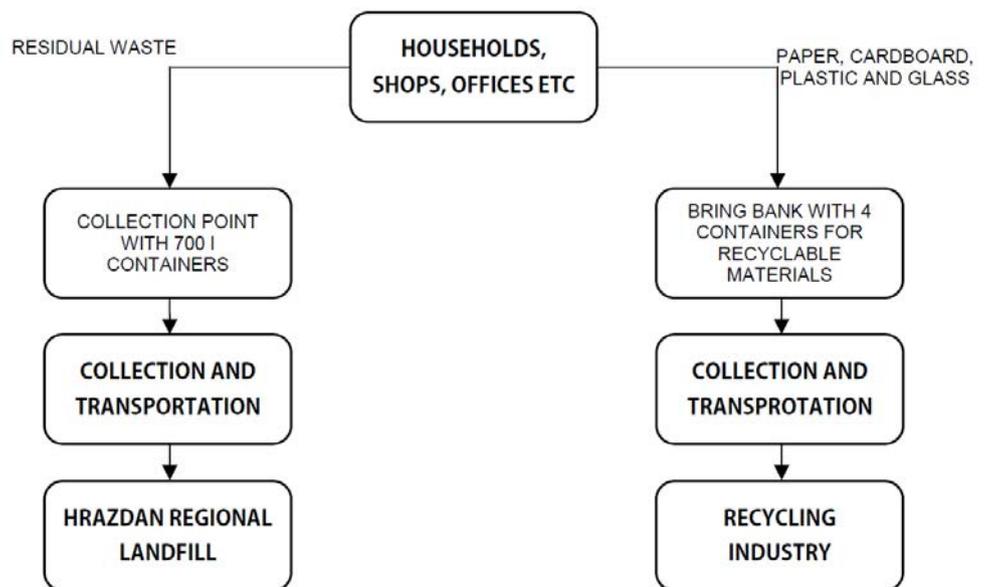


Figure 5 Waste flow in ordinary waste collection system with bring banks in 6 municipalities

"Hooting" collection system in two urban municipalities

Two of the urban municipalities (Nor Hatchn and Byureghavan) will only be provided with compaction trucks as the two municipalities prefer to have a collection system where people have to bring the waste to the collection vehicle when it passes the house and gives a signal with the horn ("hooting" system). The collected waste will be transported directly to the Hrazdan regional landfill for emptying.

The waste flow in the system is presented in Figure 6.

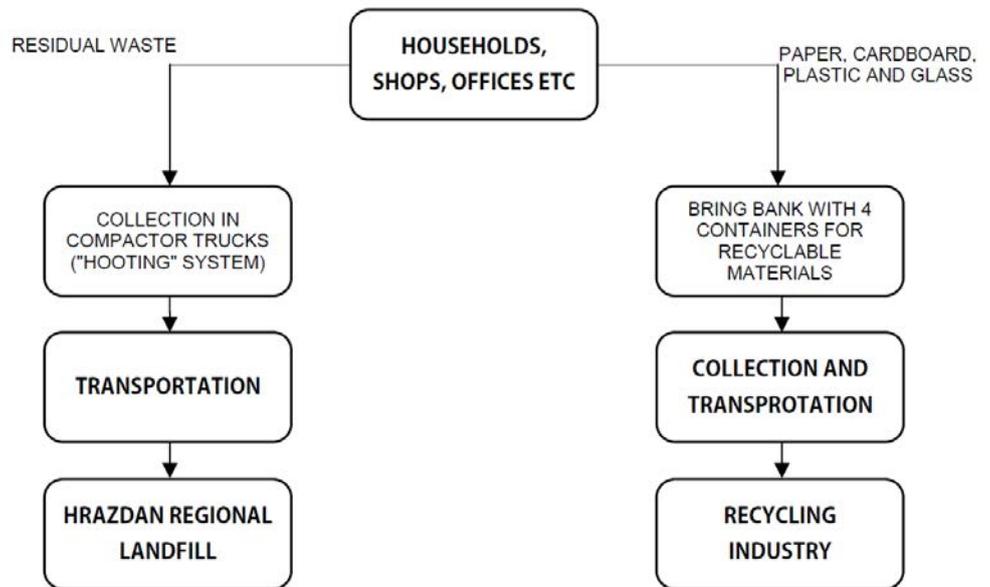


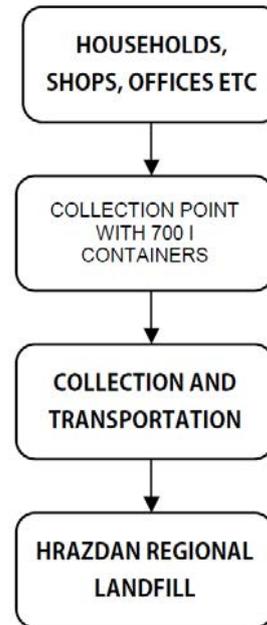
Figure 6 Waste flow in "hooting" waste collection system with bring banks in 2 municipalities

Ordinary waste collection without recycling in rural municipalities

Rural communities will be clients to the new landfill - not shareholders. This means that they will be provided with containers to be placed at central places (squares, shops etc.) in each community. The containers will be emptied by compaction trucks belonging to the Company and the waste will be taken for disposal at the new regional landfill. Rural communities will pay for these services according to fees to be determined by the Company and to be approved by the Government. Rural communities were consulted during the landfill site selection process.

No recycling system are foreseen introduced in the rural communities as it is assumed that the amount of recyclable materials in the generated waste will be low

The waste flow in the system is presented in Figure 7.



*Figure 7 Waste flow in ordinary waste collection system in rural communities*

#### Collection vehicles

Almost the entire existing fleet of collection vehicles is Russian-made and many of the vehicles are special collection compaction vehicles with side-mounted hydraulic grapping device for containers used for the collection of solid waste from the containers at collection points. In some areas open dump trucks are used for the waste collection. A number of the vehicles are procured in 2008 and 2009 and may be used in the beginning of the planning period. However, most of the trucks are between 10 to 20 years old, worn out and have to be repaired frequently, which highly reduces the availability of the vehicles.

Waste collection vehicles which will be scrapped during the project are listed in Table 3.2.

Table 3.2 Scrapping schedule for waste collection vehicles in Kotayk Region and Sevan municipality

	Volume	Year of manufacturing	Number	Scrapped latest in 2013	Scrapped later	
<b>Hrazdan</b>						
ZIL, KO449	10 m3	2006, 2008	2		2	2015, 2017
ZIL, KO 413 (GAZ53)	4 m3	1981	4	4		
Tipper MZ555 - rented	6 m3	1990	1	1		
Tipper GAZ53-rented	8 m3	1990	1	1		
Tipper MAZ	10 m3	1990	1	1		
<b>Total Hrazdan</b>			<b>9</b>	<b>7</b>	<b>2</b>	
<b>Charentsavan</b>						
KAO 143 (GAZ53)	8 m3	1990	2	2		
Tipper GAZ53	8 m3	1990	1	1		
ZIL 130 KAO	8 m3	1989,1988	2	2		
ZIL 449-10	10 m3	2008	1		1	2017
<b>Total Charentsavan</b>			<b>6</b>	<b>5</b>	<b>1</b>	
<b>Tsaghkazor</b>						
GAZ53	4 m3	2005	1		1	2014
GAZ53	4 m3	1989	1	1		
GAZ53,1	4 m3	1985	1	1		Not in operation
<b>Total Tsaghkazor</b>			<b>3</b>	<b>2</b>	<b>1</b>	
<b>Abovyan</b>						
ZIL	10 m3	2009	3		3	2018
GAZ53	8 m3	2007	4		4	2016
Kamaz	24 m3	1985	3	3		
Rear loader ZIL 130	6 m3	1985	2	2		
Rear loader GAZ53	4 m3	1985,1991	3	3		
GAZ53	4 m3	1985	1	1		
<b>Total Abovyan</b>			<b>16</b>	<b>9</b>	<b>7</b>	
<b>Byureghavan</b>						
ZIL	14 m3	2008	1		1	2017
ZIL	6 m3	1990	1	1		
GAZ53	8 m3	1989	1	1		
<b>Total Byureghavan</b>			<b>3</b>	<b>2</b>	<b>1</b>	
<b>Yeghvard</b>						
GAZ53	4 m3	1989,1991	3	3		
ZIL 131	6 m3	2008	1		1	2017
<b>Total Yeghvard</b>			<b>4</b>	<b>3</b>	<b>1</b>	
<b>Nor Hatchn</b>						
GAZ53	8 m3	1985	1	1		
ZIL 131	6 m3	1988	1	1		
ZIL 131 - rear loader	6 m3	1988,1998	1	1		
<b>Total Nor Hatchn</b>			<b>3</b>	<b>3</b>	<b>0</b>	
<b>Sevan</b>						
ZIL	6 m3	2009	1		1	2018
ZIL	6 m3	1989	1	1		
GAZ53	4 m3	2007	1		1	2016
GAZ53	4 m3	1985	3	3		
<b>Total Sevan</b>			<b>6</b>	<b>4</b>	<b>2</b>	
<b>TOTAL in project area</b>			<b>50</b>	<b>35</b>	<b>15</b>	
<b>In operation in 2010</b>			<b>49</b>	<b>34</b>	<b>15</b>	

The project will prior to the start of the planning period 2014 provide supply of new collection vehicles as well as of new containers and collection points covering the total capacity in the beginning of the planning period. Existing trucks and containers not totally worn out in 2014 may be used as reserve for the municipalities as reserve/extra capacity during running in of the new more efficient collection and transportation system.

The waste collection fleet as well as containers and collection points will be extended during the planning period as needed. Furthermore, it is assumed that

the collection vehicles are worn out and will be replaced every 10<sup>th</sup> year and containers every 5<sup>th</sup> year.

An environmental problem with the existing compactor collection trucks is the spill of leachate from the waste when it is compressed in the vehicle. The new collection vehicles will be equipped with a tank for collection of the leachate. The tanks will be emptied at the leachate collection points.

Furthermore, it will be requested that emission from engine for the new collection vehicles shall comply with EURO 4 Standard Specifications in order to reduce the emission from waste collection and transportation

#### Recycling activities

Currently there is no formal system for separation or collection of recyclable materials in the project area. Recycling is carried out by the informal sector and does not form sole livelihood for the involved persons, who participate in collection of food waste and recyclables from time to time and have living conditions not much different from the ones of other residents. Waste picking as a behaviour is not respected by the communities, because the pickers (typically during night or early morning hours) spread the waste from containers at collection points and do not clean up the areas. The quantities of materials collected by the informal sector are not noticeable for the communities. The number of people participating in waste picking is estimated being a few people in each of the cities. In Byuregavan, where waste collection is carried out based on "hooting system", i.e. without containers in the streets, the Consultant observed small accurate heaps of pre-sorted paper and cardboard near shops which are reportedly collected by local residents for recycling or household purposes (e.g. kindling material). The number of waste pickers in rural communities is not known.

Most of the waste separation is being done by waste pickers from the waste containers in the towns and by scavengers at the landfills (metal, glass bottles, plastic bottles, paper, plastic, food waste and combustibles in the winter). The recyclable materials are often sold to informal buy-back centres in Yerevan, which sell them to recycling companies or larger dealers specialised in various fractions of the recyclable materials.

The current informal recycling system has serious deficiencies with regard to health and safety issues.

#### Bring bank system operated by the municipalities

It is important that there is a market for the products if a recycling system is introduced. A brief survey of possibilities to sell recyclable materials nearby the project area has revealed that there currently exist local companies/factories with sufficient capacity to buy the potential amount of recyclable materials from the project area:

As mentioned the recycling system will be based on a Bring Bank concept where the inhabitants have to bring the recyclable materials to the bring bank themselves.

Collection and transport of recyclable materials from the bring banks for processing at the industry will be organised by each municipality. Each municipality will be provided with a number of containers for collection of recyclable materials. The containers are to be placed at shopping centres and at other central squares in Bring Banks. The containers will be emptied by means of compaction trucks or an open truck with a crane and transported directly to the relevant recycling industry for further processing.

The project will not provide trucks for emptying the containers at the bring banks and it is assumed that the municipality hires a contractor or that the materials are collected by the processing industry.

A formal recycling system is proposed to be introduced gradually during the planning period. It is planned to implement a small-scale pilot project with placing of bring banks equipped with containers for collection of paper/cardboard, glass, plastic and metals at 3 different locations in each of the towns Hrazdan, Charentsavan, Abovyan and/or possibly Sevan (e.g. at shopping centres, markets, bus stops, etc.) in order to test the system before introduction in full scale in entire Kotayk Region. It is recommended that introduction of the bring banks and options for management of recyclables is discussed with waste pickers, the existing formal and informal recyclers, so that the opportunities for their involvement could be addressed adequately. After three years operation period of the system it should be decided if the system should be extended or closed down and replaced by other facilities for collection of recyclable materials.

### 3.2 Transportation

Purpose of transfer station

With a location of a new regional landfill in Hrazdan in the northern part of Kotayk Marz it could be considered feasible to locate and construct a waste transfer station in the southern part of Kotayk Marz, e.g. near Byuregavan.

Transfer stations are typically established in order to reduce the cost for transportation of waste to the regional landfill. Transportation by vehicles with large capacity can reduce transportation cost (cost/ton/km) compared to transportation by smaller vehicles, which are typically used for waste collection in the towns. Furthermore, a transfer station provides an increased service level for small enterprises that collect and transport waste themselves, due to a shorter transportation distance to the transfer station than to the regional landfill.

Direct transport versus transport via transfer station

In order to illustrate the feasibility of transport via a transfer station versus direct transport by the collection vehicles estimates of unit transfer cost (EUR/ton) have been made for the following schemes:

- Collection vehicle carrying 10 m<sup>3</sup> (5 ton) per transfer to the transfer station, operation of transfer station and transfer vehicle carrying two 30 m<sup>3</sup> containers, altogether 60 m<sup>3</sup> per transfer (20 ton)

- Collection vehicle carrying 10 m<sup>3</sup> (5 ton) per transfer directly to the landfill

#### Conclusion

The conclusion is that it is not economical feasible to establish a transfer station. In each year of the 20-years planning period it will be more expensive to transport via transfer station than to transport the collected waste directly in the compaction collection vehicles from the collection districts to the regional landfill. It is recommended not to include a transfer station in the future waste management system for the project area. Only at the end of the planning period it might be considered to establish a transfer station, once it may be justified due to the increasing waste amounts.

#### Direct transport from collection districts to regional landfill

Based on above conclusion the collected mixed household and commercial waste will be transported directly to the regional landfill by the collection vehicles. In order to provide a cost efficient waste collection and transport of waste 10 m<sup>3</sup> compacting vehicles will be used in all municipalities except in Tsaghkadzor municipality where 4 m<sup>3</sup> compactor vehicles are proposed due to low waste generation. In rural areas 18 m<sup>3</sup> compacting trucks are assumed to be used due to long collection distances. Most of the municipalities currently use 10 m<sup>3</sup> compacting trucks for the waste collection.

### 3.3 Disposal at regional landfill

The collected municipal solid waste will be disposed at a modern sanitary landfill. The minimum total disposal volume at the regional landfill should be at least 1,200,000 m<sup>3</sup> to enable 20 years operation.

The landfill will be a part of a future regional waste management centre. Facilities for temporary storage of hazardous waste and a special section for construction and demolition waste will be established prior to start of the operation of the regional waste management centre. Area reservations will be made for future establishment of a composting facility and a sorting facility for additional sorting and refining of collected source separated recyclable materials.

#### Building, facilities, equipment and supply systems in the first phase

The first phase of the waste management centre will include the following buildings, facilities, equipment and supply systems:

- Paved access road designed for heavy traffic (7 m wide and 2x1.5 m wide shoulders with drain ditches as required)
- Paved entrance area and parking area
- Weighbridge (50 tonnes capacity and with a length/width of 18 x 3 m)
- The 3 first landfill cells for mixed household and commercial waste
- Leachate collection, transport, storage, treatment and discharged facilities
- Administration, control, staff facilities including sanitary facilities (wastewater collection tank)
- Garage and workshop for machinery and collection trucks including storage rooms
- Landfill compactor and other landfill operation equipment

- 2 m high perimeter fence (concrete posts with a 40 x40 mm steel mesh and not barbed wire on top=)
- Entrance gate 8 m wide steel bar gate manual operated)
- Wheel wash facility (at exit)
- Surface water collection and treatment system (sand trap and oil separator)
- At least 3 wells for groundwater monitoring (one upstream the landfill and at least two downstream the landfill). Based on the results of the ESIA some additional monitoring wells may be established for the municipal waste landfill after the start of the operation of the landfill.
- Supply systems - sewage water, electricity, drinking water and communication
- Fire protection system
- Quarantine area (for suspicious waste)
- Permanent and temporarily internal roads
- Facility for temporarily storage of hazardous waste (capacity 2x240 m<sup>3</sup>)

Roads will be established inside the landfill/bioremediation plants in the first phase and during the operation of the facility. The internal roads will be of two categories:

- Roads with permanent traffic (Front gate to landfill cell, reception area etc.)
- Roads with occasional traffic (e.g. service and inspection roads, roads prepared for future extension with new cells, etc.)

Lighting poles will be established at gate, at weighbridge, in front of administration building, in front of garage and workshop and along the internal road from gate to first landfill disposal cell.

Furthermore the area is prepared for future facilities for crushing and sorting of Construction & Demolition waste (10,000 m<sup>2</sup>), sorting facility for source separated recyclables (4,000 m<sup>2</sup>) and composting of organic waste (17,000 m<sup>2</sup>).

Proposed layout of the regional landfill is presented in Appendix 4.

### **3.4 Design of regional landfill**

Design of landfill cells

Proposed design of the landfill cells for waste disposal is presented in Table 3.3 below:

Table 3.3 *Design parameters of elements of the regional landfill*

Element	Design parameters
Geological barrier	<p><math>k &lt; 1,0 \times 10^{-9}</math> m/s and thickness <math>&gt; 1</math> m or equivalent protection</p> <p>Maybe enhanced existing soils (e.g. bentonite mixed with the soil) and/or an artificial barrier (GCL)</p>
Artificial liner	1,5 mm HDPE liner
Geometric shape of cells	<p>Bottom slope min. 1.0 %</p> <p>Volume of cells constructed in first phase:</p> <p>Cell I approx. 55000 m<sup>3</sup>.</p> <p>Cell II approx. 90,000 m<sup>3</sup>.</p> <p>Cell III approx. 185,000 m<sup>3</sup>.</p> <p>The area for each cell is kept relatively small and more or less in same size, approx. 14,000 m<sup>2</sup>, to reduce leachate generation.</p> <p>Expected completion date for cells in first phase assuming commencement of the landfill 01.01.2014 and a compacted waste density of 1.0 t/m<sup>3</sup>:</p> <p>Cell I: April 2015</p> <p>Cell II: January 2017</p> <p>Cell III: April 2020</p> <p>Total lifetime for first phase is expected to be 6-6.5 years.</p> <p>For the remaining cells the implementation (and operation) is as follows :</p> <p>Cell IV: 2019 (operation 2020-2023)</p> <p>Cell V: 2022 (operation 2023-2027) Cell VI: 2026 (operation 2027-2030)</p> <p>Cell VII: 2029 (operation 2030-2033)</p> <p>Cell VIII: 2032 (operation 2033-2037)</p> <p>The area is optimal utilised by including the existing slopes towards south, however this is not 100% possible for the two first cells.</p> <p>Perimeter and internal embankments will have a slope of 1:3.</p>

Administration building

An administration will be established at the landfill site which will include all required rooms including control office for the weighbridge, see Table 3.4 below.

The building will be an on-site construction or a prefabricated building.

Table 3.4 Room and facilities in administration building

Room	Facilities and staff for landfill operation	Facilities and staff for waste collection
Number of staff	Managing Director: 1 Financial administrator: 1 Secretary: 1 Foreman: 1 IT specialist: 1 Vehicle operators: 3 Guard at gate: 1 Unskilled labour: 3	Director: 1 Foreman: 1 Drivers: 2
Control office for weighbridge	1	-
Administration office	Included in control office	Included in control office
"Canteen" (Room with table, chairs, small facility for storage and preparation food/coffee)	For 12 persons	+4 persons
Changing room and bathing facilities (for men)	For 10 persons	+2 persons
Changing room and bathing facilities (for women)	For 2 persons	-
Toilet facility for trucks drivers and visitors etc	1	-
Laboratory	Not required	-
Entrance room, storage room, corridors etc.	As required	As required

Garage and workshop for machinery and storage rooms

There will be established one garage at the landfill site which will include all facilities for both landfill operation equipment and collection trucks. Storage room and workshop facilitate will be for both activities, see Table 3.5 below.

The building will be an on-site construction or a prefabricated building. The garage will be connected to the water and electricity system.

Table 3.5 Garage and workshop for machinery and storage room

Room	Required facilities for landfill equipment	Required facilities for landfill equipment
Assumed number of machinery	- 1 compactor - 1 excavator or front wheel loader - 1 articulated truck (dumper) - 1 Tractor including water	- 2 waste collection trucks

Room	Required facilities for landfill equipment	Required facilities for landfill equipment
	tank, trailer, road sweeper	
Number of gates in garage	2 (One with oil pit)	1
Storage room (oils, spare parts etc.)	Yes	Shared storage room
Workshop	Part of the garage	Shared workshop
Toilet	No	No

Temporary storage facilities for hazardous waste

A building for temporarily storage of hazardous waste will be located in connection to the reception area. The building is divided into two sections for organic hazardous waste and for inorganic hazardous waste. The storage facility can not receive liquid waste in bulk.

The building will be 10 x 12 m and with a minimum floor-to-ceiling height of 4 m. This will facilitate stacking of e.g. pallets, drums etc. if required. In front of the building a 200 m<sup>2</sup> paved area is established for unloading of hazardous waste.

2 ports in building will have a size of 4 x 3 m (width x height) which makes it possible for a forklift to enter inside the building.

The building is with concrete floor resistant to corrosive liquids and with drainage channels and sumps to collect any spillage.

The building will be connected to the water (sprinkling system and emergency shower facility) and electricity system.

An area at the landfill site is reserved for minimum one more building of same size for storage temporarily storage of hazardous waste.

Leachate management facilities

Design parameters for leachate collection in waste cells, leachate transport, leachate storage, handling and treatment are presented in Table 3.6 below.

Table 3.6 Design parameters for management of leachate

System	Design parameters
Leachate collection in waste cells	<p>0,50 m granular layer, permeability <math>&gt; 1 \times 10^{-3} - 10^{-4}</math> m/s. The grain size distribution will be from 0-70 mm.</p> <p>Ø160 mm main drainpipes along the low laying embankments and in diagonal of cell. It will be possible to carry out high pressure cleaning of the main drainpipe from a leachate collection chambers located downstream the cells.</p> <p>Side drains is Ø110 mm located approximately with 15 m distance between each drain. This will reduce the maximum leachate depth inside the landfill to less than the thickness of the gravel drainage layer.</p> <p>Drainpipes will be with slots 5-8 mm wide and surrounded by a filter material.</p>

System	Design parameters
	<p>The materials for filter element will be gravel 20mm / 40 mm with a maximum grain size of 60 mm.</p> <p>No structures will be located inside the cell. The collection chamber is located outside the cell.</p>
Leachate transport	<p>All transport of leachate by one common <math>\varnothing 200</math> mm HDPE Pn10 gravity pipes for all cells including future cells.</p> <p>(No pumps to be installed).</p>
Leachate collection, handling and treatment	<p>Leachate will be collected in a leachate pond with a 0,5 m low permeable (<math>&lt;1 \times 10^{-9}</math> m/s) loam/clay bottom and covered with a 1,5 mm HDPE liner and 0,25 m protective sand/gravel.</p> <p>The basic treatment of leachate will by evaporation. However the expected leachate generation will in period excide the potential evaporation rate (see Figure 8 below).</p> <p>The figure is based on using an evaporation pond with 4,000 m<sup>2</sup> in area and with 3,000 m<sup>3</sup> in volume. The leachate generation is based on that cell 1 is taken into operation in January 2014 and cell 2 in January 2015. The leachate generation is assumed to be more or less the same for the entire lifetime of the landfill but this require that only 1 cell is in operation and the previous cell is filled but not with final cover and all older and filled cells are with top cover.</p> <p>The capacity of the pond is excided in the period March-June and the monthly amount to recycle is around 200-700 m<sup>3</sup>/month (~1.500 m<sup>3</sup>/year), however this figure can differ properly +100% from wet years to dry years. The estimate is based on average precipitation and evaporation.</p> <p>A collection well shall be installed for collection of leachate in case of leachate is exciding an upper level limit. Leachate is collected in a tank truck/leachate tank and transported back to the disposal cell and spread over the waste (not sprinkling) for recirculation. This will increase evaporation of leachate and the waste body will act as a buffer.</p> <p>In time this will most likely not be sufficient as the buffer capacity has its limits and the increase in evaporation is limited.</p> <p>An emergency overflow pond with a low permeable bottom (natural loam) and planted with reeds is proposed located next to the leachate pond. The area is designed for 600 m<sup>2</sup> which should be sufficient for treatment of up to 7.000 g BOD/day which correspond to 1.500 m<sup>3</sup>/year of leachate assuming a BOD content of 2.000 mg/l.</p> <p>Both the leachate pond and emergency overflow pond will require cleaning up of settled sediments from time to time (every 5-10 years depend on load).</p> <p>The treatment of leachate is based on:</p> <ol style="list-style-type: none"> <li>1. evaporation</li> <li>2. recirculation</li> <li>3. treatment in reed bed plant of excess leachate</li> </ol> <p>It is most likely in time not a sufficient solution for treatment of leachate. The volume of the pond will most likely be filled after 1-1½ year and the next 1-2</p>

System	Design parameters
	<p>years recirculation of leachate is practically possible and hereafter the reed bed treatment possibility needs to be considered for discharging some of the leachate from the system. Establishment of reed bed plant can be problematic as the reeds can be difficult to grow, but there will be a 3-4 years period to create a healthy and well growing reed bed plant.</p> <p>It is assumed that the annual amount of leachate from Hrazdan landfill (1 cell in operation and previous cells closed) is approximately 2,000 m<sup>3</sup>/year.</p> <p>A typical leachate composition from a landfill for domestic waste is:                      COD: 10,000 mg/l, BOD: 5,000 mg/l, Tot-N: 1,000 mg/l</p> <p>Total load will then be:                      COD: 20,000 kg/year, BOD: 10,000 kg/year, Tot-N: 2,000 kg/year</p> <p>The leachate overflow from the lagoon to be treated is approx. 500 m<sup>3</sup> (assuming no recirculation or other means to extract leachate from the lagoon) or 1,000 m<sup>3</sup> including rainwater falling into the lagoon.</p> <p>The quality of the treated (and diluted) leachate after treatment in the reed-bed lagoon is assumed to be:                      COD: 400 mg/l, BOD: 15 mg/l, Tot-N: 100 mg/l</p> <p>Total load will then be:                      COD: 400 kg/year, BOD: 15 kg/year, Tot-N: 100 kg/year</p> <p>The degree of removal can then be calculated to:                      COD: 96% in concentration and 98% in total load                      BOD: 99,7% in concentration and 99,85% in total load                      Tot-N: 90% in concentration and 95% in total load</p> <p>With less than 1,500 m<sup>3</sup>/year it is assumed that quality of the treated leachate will be:                      BOD &lt; 15 mg/l, COD &lt; 400 mg/l, Total-N &lt; 100 mg/l</p> <p>These concentrations will be comparable with the EU requirements for Urban wastewater treatment specified in the Council Directive of 21 May 1991 concerning urban waste water treatment (91/271/EEC) :</p> <p>BOD: 25 mg/l, COD: 125 mg/l, Total N: 10-15 mg/l</p> <p>The Directive also contains requirements for total Phosphorus and suspended solids: Total P: 1-2 mg/l, SS: 35 mg/l</p> <p>Phosphorus concentration in leachate is typically low. Reed bed treatment plant is basically a sand filter capable to ensure the low outlet concentration of suspended solids (10-30 mg/l) depending on particle size in the reed bed.</p>

System	Design parameters
	<p>Operation of reed bed treatment plant depends on the composition of the leachate which can differ very much. The basic handling of leachate is based on evaporation and recirculation, meaning that discharge of leachate to surroundings could occur only in case of a year with extraordinary high precipitation and low evapotranspiration.</p> <p>Other leachate treatment options might be required to install in the long term. This could be reversed osmosis, nano-filter or other membrane technologies, chemical oxidation, super critical wet oxidation or a combination of two or more of the different methods.</p> <p>The problem with all the mentioned leachate treatment technologies is a relatively high construction cost and a very high operational cost plus it will require skilled and experienced staff to run the plant.</p> <p>Biological treatment, as used for treatment of household wastewater, will not be effective on leachate as the ratio COD/BOD is too high and the ratio BOD/Total-N is too low in leachate, which results in insufficient biological processes and low treatment results.</p>
Leachate disposal off	<p>The landfill is located in a closed drainage area. Leachate will be disposed off by evaporation from the leachate collection pond and from the waste cells, where it will be spread over by irrigation.</p>

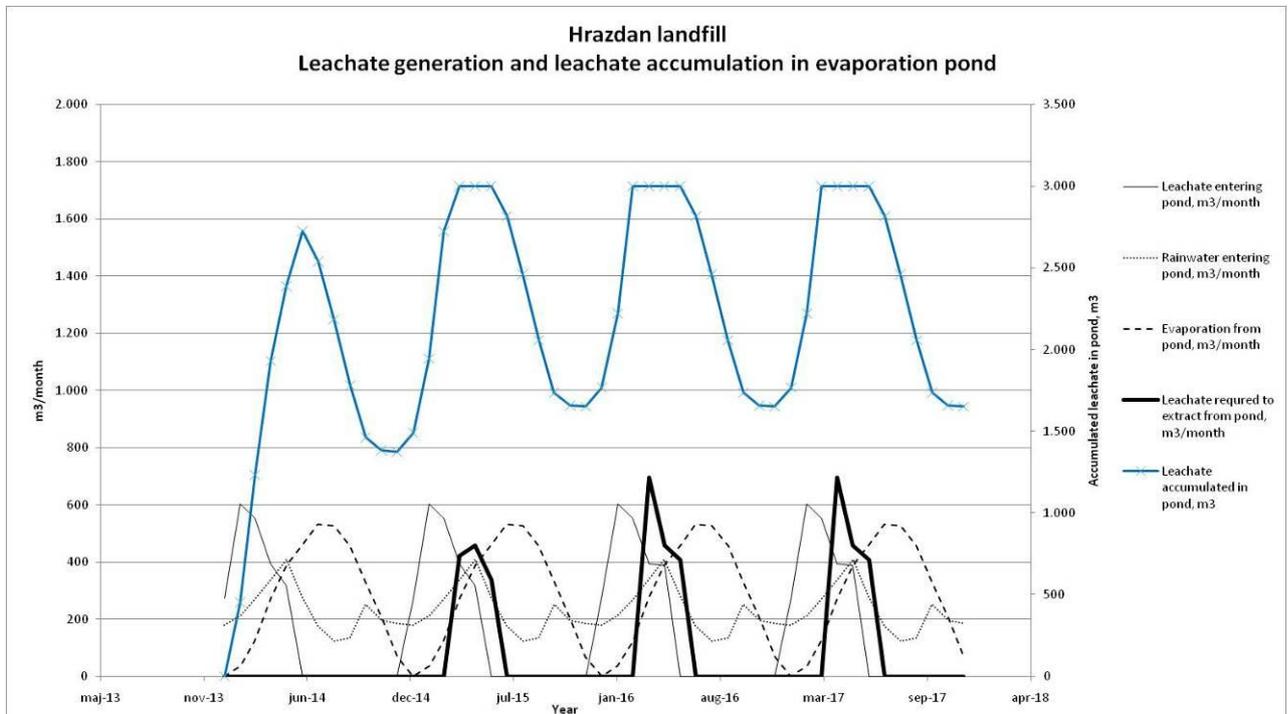


Figure 8 Leachate generation and leachate accumulation in evaporation pond at Hrazdan landfill (Leachate pond 4,000 m<sup>2</sup> and 3,000 m<sup>3</sup>)

The graph is based on data for precipitation, evaporation/evapotranspiration, top layer model for the waste disposal cells of the landfill and the proposed landfill development phases.

The graph shows the quantity of leachate required to be extracted from the pond for recirculation (increased evapotranspiration) and/or other treatment. The conclusion is that after 2-3 years of operation there will be a need for handling some excess leachate, but an amount of 500-1000 m<sup>3</sup> per year should be possible to evaporate/evapotranspire by irrigation of leachate on active or closed cells of the landfill.

### 3.5 Operation of landfill

Operation of landfill The opening time of the landfill will be 10-12 hours/day in 7 days/week.

The landfill will be operated as a modern sanitary landfill. It will be equipped with a landfill compactor and front end loader for spreading and compression of the waste and daily cover of the waste with soil.

The operation and filling of the landfill is assumed as follows:

- The landfill will be divided in smaller areas, allowing for one days waste to be spread in the area.
- The waste in each small cell with be spread in layers not exceeding 0.3 m
- The levelled waste will be covered by dredged soil of at least 200 mm thickness on a daily basis.
- The expected average height of the landfill is around 11 m. The filling is expected to take place from one corner of the landfill. The mixed municipal waste will be collected in compactor trucks and brought to the site. At site further compaction will be performed with the landfill compactor;
- Final cover when the landfill has reached the filling height

Wheel washing facility

A wheel wash facility will be established at the reception areas in front of the administration building. Trucks required for wheel cleaning have to pass the wheel wash facility prior to exit from the site and prior the weighbridge, if reweighing is required. Wheels and bottom of trucks are cleaned by automatic opening of high pressured nozzles while passing through the washing plant. Water is reused and treated (by settlement) in prefabricated treatment unit.

Surface water collection and storage

There is no natural surface water run-off from the site but several local depressions where occasional water is dammed up and subsequently evaporated or infiltrated to the ground.

All collected storm water from Hrazdan landfill plant outside the disposal cells will be discharged to a surface water pond in the deepest layer area of the site (level 1819 in northeast part of the area).

Surface water from areas where there is a risk for spillage of oil etc. (e.g. reception area) will pass an oil separator before discharge to the surface water pond.

A collection well will be installed for collection of water in case of surface water exceeding an upper level limit or if water is required for sprinkling, irrigation etc.

The bottom of the collection pond consists of natural laying clay/loam layers and no particular action is taken to construct a low or impermeable bottom. The area will also be used as borrow pit for loam/clay used for geological barrier if sufficient amount of suitable loam/clay is not present in the cell areas.

Sewage water, electricity, drinking water

Sewage water from administration building is collected in a closed tank for frequently emptying.

Electricity is provided from local network. If net connection is not practically possible (too far away or with not enough power), an on-site generator is included as an option.

Drinking water is provided from local water network. If connection to the water network is not practical possible (too far away) an on-site 10 m<sup>3</sup> water tank is included as an option.

Phone and Internet communication will be established either by connection to the local network or by a wireless (mobile) communication.

Landfill gas

The existing dumpsite at Hrazdan will not have a gas potential which justifies collection and flaring/utilization of the gas. The amount of organic waste in the dumpsite is quite limited, due to relatively small waste amounts and due to the fact that the waste has decomposed under open air over the years and/or was burning. It will not be necessary to establish drains to collect/control the small gas amounts that can migrate from the dumpsite after its closure, as it is not considered posing a risk for the surrounding environment. Furthermore, most of methane migrating from the dumpsite will be aerobically decomposed when passing through the topsoil of the dumpsite cover layer.

Landfill gas flaring/utilisation system will be established at the regional landfill after the final cover is installed for landfill cells.

Operation of a gas collection system at any landfill can not be started before 2-3 years of landfill operation. Based on the waste amount assessment prepared during the Feasibility Study for Kotayk Region and Sevan municipality, the gas collection at the regional landfill will not be feasible before 3 years of the landfill operation time.

Installation of initial gas collection wells and connecting pipes is included in the design for the new landfill. It is proposed that the collection and flaring units are not installed before after 2-3 years of active operation of the landfill. Supply of gas pumps, flaring unit etc. is not included in the specifications as it is recommended to wait for this until it actually can be put directly in operation. The international experience shows that many deliveries of flares etc. for new landfill projects happen too early and after some years of storing the delivered valves, pipes etc. are corroded and need upgrading. The performance guarantee and defects liability period should be valid for a flare and other equipment during operation.

Appropriate measures for control the accumulated gas and migration of gas is included in the project and satisfy the EU landfill directive.

Fire protection system

A fire protection system will be established in connection to the hazardous waste storage facility and at the administration building.

Operation of other facilities

Operation of facilities for temporary storage of hazardous waste fractions of municipal solid waste and facilities for construction and demolition waste should be scheduled according to the respective waste flows.

### 3.6 Closure of landfill

The landfill will be established with a 3 cells in the first phase and a number of landfill cells during the operation of the landfill when the existing cells are filled up. Gas collection and flaring system as well as top cover for disposed waste will be established during when a landfill cell is filled up.

The final lay-out of the landfill and top cover system for closure of the total landfill will include:

- 0.1 -0.2 m top soil
- 0.8 m clayed soil
- gravel drainage layer
- HDPE liner
- gravel protection and gas distribution layer
- 0.1 -0.3 m regulation layer

Schematic profile of the covered landfill is included in Appendix 6.

The final shape of the landfill when completed and covered will have maximum slopes of 1:5. The shape will be developed to make a general impression of the site matching the surrounding landscape to the extent possible.

### 3.7 Aftercare

The most significant long-term environmental issues related to landfills are associated with the production of polluted waters (leachate) and generation of landfill gas. As described above the landfill will be provided with a final cover

layer. Depending of the actual and potential development of landfill gas, systems for the longer term collection and treatment of the landfill gas will be designed and implemented. The generation of leachate and landfill gas may continues (maybe more than 50 years after the closure) depending of the rate of composition of organic waste and the rate of wash out from the landfilled materials. Proper control and monitoring procedures for the aftercare period should be developed.

The landfill can be finally closed when the emission of landfill gas and leachate has reached a level where the environmental impact is insignificant and acceptable with regard to maintaining air and groundwater quality.

In the aftercare phase regular monitoring of emission of landfill gas and leachate will take place. Furthermore, the final top cover with soil will be regularly inspected and maintained and repaired if the top layer has been damaged, e.g. due to erosion.

### **3.8 Landfill capacity and period of operation**

The actual planned total area for disposal of waste is 147,000 m<sup>2</sup> and with a total volume of 1,600,000 m<sup>3</sup>. The average height of waste is approximately 11 m. This will give a total expected life time for the landfill of 23 years (2014 to 2036) assuming a waste density of 1.0 t/m<sup>3</sup>. Daily cover contributes for 10 % of the volume and a 1.0 m top cover layer is included in the life time estimate.

Certain changes in waste composition can be expected during the planning period. The changes result from separate collection of certain waste fractions, e.g. glass, paper, etc.

### **3.9 Institutional set-up of new waste management system**

It is recommended that the Landfill Management Company (the Company) shall be incorporated as a shareholding company, jointly owned by the communities of the conceptually new Kotayk Waste Management Region, i.e. the region formed by the following communities for the purpose of creating the regional waste management system:

- Hrazdan
- Abovyan
- Charentsavan
- Eghvard
- Nor-Hachn
- Byureghavan
- Tsaghkadzor
- Sevan

The 8 municipalities will continue providing waste collection services to their citizen as prescribed by the laws. To improve service coverage, a number of

containers and vehicles for mixed household waste will be distributed to the communities by the Company on contract basis.

The Company will also distribute to the communities containers for the collection of source separated recyclables. Municipalities will be responsible for arranging emptying of these containers and for the sale of recyclables to the industry. Separate collection of recyclables will reduce the amount of the waste disposed at the landfill and will respectively extend its lifetime, thus the related investments will be delayed.

In the future, new shareholders may join in such as, for example, small communities, which are 60 in Kotayk Marz, or even communities from neighbouring regions.

Before establishing the inter-municipal Company, the distribution of costs, revenues and liability among the participating communities must be decided in a form of agreements/contracts. The contracts should also contain mechanisms regulating and to the extent possible balancing the influence of the individual communities.

### **3.10 Staffing**

The Proposed project assumes that staffing adequate for waste collection and transportation services provided in 8 urban municipalities will be the responsibility of the municipalities. It is expected that with increased number of containers and waste collection vehicles the waste collection companies will be able to provide better services within larger areas. For example, in Byuregavan the area with numerous garden houses located very close to the urban centre is not serviced at present, but could be serviced after establishment of the new system. The staff requirements may be changed, when the new regional waste management system is introduced and the new equipment for waste collection and transportation is provided. Recruitment of additional staff could be required for management of recyclables, for maintenance of vehicles and containers.

It can be envisaged that the staff of waste companies working in municipalities will be guided and trained by the landfill management company to ensure the proper coordination of working routines and technical issues. The landfill management company will recruit staff for operation of the landfill facility, but also staff for collection of waste from customers in rural areas.

#### **3.10.1 Jobs during landfill construction**

During construction of the regional landfill and establishment of the regional waste collection system will be the responsibility of contractors. One of the EBRD's recommendations for contractor is to employ the competent local workforce and to provide adequate accommodation conditions in the contractor camps.

### 3.10.2 Jobs during operation

It is proposed that the Company operates the regional landfill and provides waste collection services to rural communities. The functions delegated to the Company by the communities may change in the longer run, depending on the future planning and system development. By the start of landfill operation scheduled for 2014 the Company should have the following departments:

- Management/administration
- Finance department
- Operation department

Organisation chart presented in Figure 9 provides an example of the future organisational structure of the Company operating the landfill.

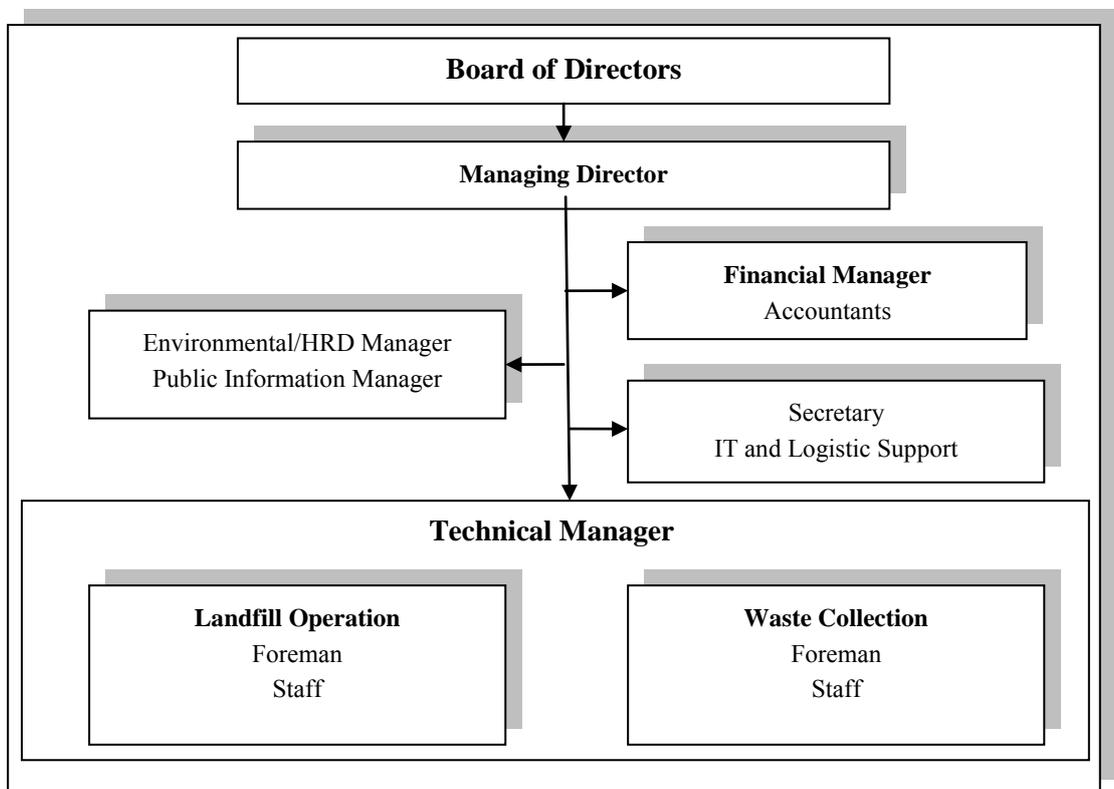


Figure 9 Organizational structure for the Company, performing waste management operations

#### Management /Administration

The functions of the management/administration are:

- general management of the Company, including reporting to the Board of Directors;
- financial management and book-keeping according to the country's laws;
- HRD (human resource development) functions, including staff training
- environmental management to secure compliance to the environmental requirements and to the operational health and safety standards

- presentation of information to the public, arrangement of public awareness campaigns, representation of the Company in communication to the mass media, handling complaints
- secretarial assistance and office administration
- IT support to all units, including waste registration system, leachate operation system etc.

The following staff of 6 persons is required for management/administration:

- 1 Managing Director/head of administration
- 1 Financial Manager
- 1 Accountant
- 1 Environmental/HRD/ Public information Manager
- 1 IT specialist
- 1 Secretary

In addition to ordinary financial management and accounting, the major workload of the financial department will include financial management of contracts, billing, payment/revenue monitoring and cost recovery required to secure debt repayment.

The IT specialist will be responsible for the following:

- Installation, maintenance and upgrading the IT systems (operational, intranet, financial etc.) required for the Company's operation
- Maintenance and upgrading of the IT systems required for the operation of the landfill (waste registration, leachate treatment plant operation)

The functions of the Operation Department:

- Proper operation of a sanitary landfill and related installations demanding specific knowledge (weighbridge and waste registration system, leachate treatment plant, gas collection system once it is established).
- Waste acceptance according to environmental requirements and performance specification (laws, landfill operation manual and the like).
- Placement and compaction of waste, establishment of daily cover etc. according to the best practices and operation manual;
- Directing hazardous waste for temporary storage; and
- Collection of mixed household waste from rural areas according to performance specifications routes and schedules

Technical Director of the Company will be part of the management and the head of Operation Department.

Operation  
Department

The functions of the Operation Department:

- Proper operation of a sanitary landfill and related installations demanding specific knowledge (weighbridge and waste registration system, leachate treatment plant, gas collection system once it is established).

- Waste acceptance according to environmental requirements and performance specification (laws, landfill operation manual and the like).
- Placement and compaction of waste, establishment of daily cover etc. according to the best practices and operation manual;
- Directing hazardous waste for temporary storage;
- Collection of mixed household waste from rural areas according to performance specifications routes and schedules

The following staff of 17 persons is required for the Landfill Operation Department:

- 1 landfill foreman
- 6 skilled workers for the operation of landfill installations and vehicles,
- 4 unskilled workers for routine work
- 1 collection foreman
- 2 drivers for waste collection
- 3 guards for permanent watching of the entire facility.

Thus, the Company will need 23 permanent employees to meet the requirements related to the operation of the landfill, financial management, public information, HRD, environmental protection, health and safety.

Staff required  
on ad-hoc basis

For landfill monitoring (testing of leachate wells, effluent criteria of leachate treatment and runoff) the Company will contract a specialised undertaking dealing with the monitoring according to an approved monitoring programme and reporting to environmental authorities.

### **3.10.3 Jobs during landfill closure**

Jobs during the landfill closure will be mostly related to soil works and maintenance of the topcover. During landfill closure the number of staff will be reduced.

### **3.10.4 Jobs during landfill aftercare**

Aftercare will include monitoring, maintenance of leachate collection system and possibly landfill gas collection and flaring system.

## 4 Assessment of impacts

### 4.1 Introduction

This ESIA document elaborated within the ESDD assignment provides a background for the national EIA process, which will need to be completed by the Armenian client according to the Armenian regulatory requirements during the Project pre-construction phase.

The ESIA document includes an assessment of the most advisable Project proposal and a number of alternatives. The assessment of impacts is focused on activities and facilities posing highest risk of negative environmental and social impact during the Project implementation.

The following types of impacts should be considered:

- Direct and indirect impacts
- Reversible or irreversible
- Impacts of major or minor significance
- Short-term impacts (e.g. only during construction) and long-term impacts (e.g. during construction and operation)

The present assessment is made based on currently available information and the Project Proposal elaborated as a result of Feasibility Study prepared by COWI under the consultancy contract with the EBRD. A need for additional investigations is defined, when the available baseline data are not sufficient. The ESIA is prepared as a background for development of the Environmental and Social Action Plan which should be an integral part of the Loan Agreement between the EBRD and the Armenian client.

ESIA has a dual nature, each with its own methodological approaches:

- It is a technical tool for analysis of the consequences of a planned intervention (policy, plan, program, project), providing information to stakeholders and decision-makers; or of unplanned events, such as natural disasters, war and conflicts.
- It is a legal and institutional procedure linked to the decision-making process of a planned intervention.

ESIA aims to:

- Provide information for decision-making that analyzes the biophysical, social, economic and institutional consequences of proposed actions.
- Promote transparency and participation of the public in decision-making.
- Identify procedures and methods for the follow-up (monitoring and mitigation of adverse consequences) in policy, planning and project cycles.
- Contribute to environmentally sound and sustainable development.

Table of contents of this document comprises the sections meeting requirements of the EBRD and the Armenian framework for ESIA. Community health and socio-economic impacts and issues are likely to occur over different time scales and may well be inter-related with each other and environmental ones; hence there is a need for integrated impact assessment.

The ESIA provides description of legal, regulatory, administrative and institutional context of ESIA for the proposed Project in Armenia, as well as the ongoing and planned activities, which may be relevant for assessment of the cumulative environmental and social impact relevant for the Project's area of influence.

The present document contains the readily available baseline data collected from governmental and non-governmental organisations for description of the existing environmental and social conditions in Kotayk Region and Sevan town.

Description of environmental and social impacts and mitigation measures essential for the pre-construction phase of the Project is followed by description of the environmental and social impacts and mitigation measures for construction phase, for operation and maintenance phase and for the landfill closure and aftercare phase. The document also includes an assessment of the Project's risks and residual impacts in case of emergency situations.

Environmental and social benefits of the proposed Project are discussed together with opportunities for their enhancement during the Project implementation.

Based on the present ESIA the Consultant prepared Non-Technical Summary (NTS), Stakeholder Engagement Plan (SEP) and Environmental and Social Action Plan (ESAP) as separate documents in accordance with requirements of the EBRD and the ESDD consultancy contract with the RA Ministry of Urban Development.

Approach to preparation and implementation of the ESAP during the EBRD funded Project is discussed in the final chapter of the present ESIA.

Persons involved in preparation of the present ESIA are listed in Appendix 1, the key sources of information are listed in Appendix 2. Records of public meetings held during the Feasibility Study, the Environmental and Social Due Diligence are included as appendices to the Stakeholder Engagement Plan.

Layout drawing of the landfill facility is presented in Appendix 3. Proposed time schedule for the landfill construction and development is included in Appendix 4.

## 4.2 Legal and administrative context of ESIA

Possible involvement of the EBRD in financing of the proposed Project requires that the environmental and social due diligence is carried out in accordance with the EBRD Environmental and Social Policy (2008). The Project has been categorised A, thus the ESIA is required for the Project including an environmental and social review of the existing facilities and activities.

The ESIA requirements of the EBRD are typically based on the European Union Directive (85/337/EEC) on Environmental Impact Assessments (known as the *EIA Directive*) first introduced in 1985 and amended in 1997. The directive was amended again in 2003, following EU signature of the 1998 Aarhus Convention.

According to the EBRD Environmental and Social Policy the ESIA should be disclosed and a meaningful public consultation carried out.

The Armenian legal framework for ESIA based on the Law on Environmental Impact Assessment (1995) contains similar requirements and defines the procedure for preparation of environmental impact assessment documentation, for public consultation and for an expert review and approval of the assessment documentation by the Environmental Expertise Organisation (Environmental Expertise SNCO).

The standards for ESIA of an international investment project in Armenia are defined by the international standards, national laws, regulations and development programs.

## 4.3 International standards

International standards most relevant for the Environmental and Social Impact Assessment of the proposed Project in Armenia would include the following major documents:

- EBRD Environmental and Social Policy and Performance Requirements;
- EIA Directive as amended (Directive 85/337/EEC and Directive 97/11/EC);
- EC Guidance on EIA;

- EHS guidelines of IFC
- EBRD Sub-sectoral Environmental and Social Guidelines: Building and Construction Activities.

Involvement of the EBRD in the Project financing requires preparation of an ESIA and arranging meaningful public consultation. The issues of public interest should be represented in the ESIA. Public interest may be reflected in ongoing media coverage, public meetings and seminars, information boards and leaflets, publications in Internet, etc.

The ESIA for a Project consists of a number of reports covering environmental investigations made either prior to the Bank's involvement or as part of the Bank's environmental requirements. The ESIA Executive Summary is a document produced by the Sponsor for the Bank that summarises these reports.

For category A projects, the EBRD procedures require a public comment period of at least 120 calendar days between the date of the ESIA disclosure for the public and the date of the meeting during which the EBRD Board of Directors considers financing the Project. The comment period, and thus the timeline for the Project's consideration by the EBRD Board of Directors, will begin only after the following steps:

- Following adequate notification, the Sponsor makes the ESIA and its Executive Summary available to the public in locations previously agreed with the Bank;
- The Bank discloses the ESIA to the public in its Resident Office in the Country and Business Information Centre in London;
- The name of the project is added to the list of available ESIA's on the EBRD Internet web site; and
- The EBRD Directors are provided with English language copies of the Executive Summary.

#### **4.4 National Requirements**

The national standards of Armenia are defined in the documents including laws, secondary legislation, international agreements, as well as decrees of the Government, orders of ministries and other documents, including the national and regional development programs.

International environmental Conventions and Protocols signed and ratified by the Republic of Armenia are presents in Table 4.1.

*Table 4.1 International agreements signed and ratified by the Republic of Armenia*

Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 1998)	1998	22 Oct 03
UNECE Convention for the Protection and Use of Trans-boundary Watercourses and International Lakes (Helsinki, 1992)	1998	22 Oct 03
- Protocol on Water and Health (London, 1999)		17 Jun 99
Stockholm Convention on Persistent Organic Pollutants (Stockholm, 2001)	23 May 01	22 Oct 03
European Landscape Convention (Florence)	14 May 03	23 Mar 04
Convention on the Means of Prohibiting and Preventing the Illicit Import, Export and Transfer of Ownership of Cultural Property		22 Jun 93
Convention Concerning the Protection of World Culture and Natural Heritage		22 Jun 93
European cultural convention		22 Jun 93
European Convention for the Protection of the Archaeological Heritage	18 Jun 05	
Convention for the Protection of the Architectural Heritage of Europe	19 May 06	
Convention for Protection of Non-material Cultural Heritage		20 Mar 06
Bern Convention - Council of Europe Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979)	2006	

The following laws provide a framework for EIA (ESIA) process in Armenia:

- Law on the Principles of Environmental Protection (1991)
- Law on Environmental Impact Assessment (1995)
- Law on Specially Protected Nature Areas (1991)
- Law on Waste (2004)
- Law on Atmospheric Air Protection (1994)
- Law on Nature Protection and Nature Use Payments (1998)
- Law on Environmental Fees (2000)
- Law on Ensuring Sanitary and Epidemiologic Wellbeing of the RA Population (1992)
- Law on the Protection and Use of Cultural and Historic Monuments and Historic Environments (1998)
- Law on Flora (1998)
- Law of Fauna (2000)
- Land Code (2001)
- Code on Underground Resources (2002)
- Water Code (2002)
- Law on Environmental Supervision (2005)

The minimal scope of the EIA in Armenia is defined in Article 5 of the Law on Environmental Impact Assessment. The scope is as follows:

- forecasting, description and appraisal of possible direct and indirect impacts of intended activity related to weather conditions, flora and fauna, individual elements of eco-systems, their inter-relations and stability, specially protected natural areas, landscapes, geomorphological structures, air, surface and ground waters, and soils;
- the health and well-being of the population;
- the environments of towns;
- use of natural resources;
- monuments of history and culture;

- alternative solutions, including: zero option (rejection of the intended activity), their comparative analysis and selection of the most acceptable options.
- measures for the elimination or minimization of the possible impact of the intended activity on the environment;
- detailed appraisal of consequences for economic and social development and the environment in case of zero option due to hazardous impact of the intended activities;
- possible impact on the environment is appraised during the period of construction, operation, decommissioning and aftercare, as well as in emergency situations.

Standard procedures for establishment and operation of landfills in Armenia are regulated by the MUD Guideline on Landfills issued in 2010.

Procedures regulating fees for collection and disposal of municipal solid waste are established by the Law on Waste Collection and Sanitary Cleaning Services adopted by the RA Parliament on 21 June 2011.

#### **4.5 Administrative context for national EIA**

The key departments within the MNP that have administrative authority over the EIA and the project approval process are two State Non-commercial Organizations:

(i) The SNCO Nature Protection Expertise (NPE) is responsible for reviewing and approving EIA reports and projects for implementation and adding conditions when necessary to protect the environment; and

(ii) The SNCO State Environmental Inspectorate (SEI) is responsible for inspecting projects to ensure compliance with conditions imposed by the NPE and with the project ESAP.

The national EIA process and the SEI's power to inspect are the principal tools used by the MNP to achieve compliance with environmental protection principles.

To satisfy relevant regulations and to gain project approval of the MNP, an EIA, in accordance with the Law on Environmental Impact Assessment (EIA) (1995), has to be prepared in Armenian. The MNP EIA will have to meet requirements similar to the ones of the EBRD.

The Ministry of Culture has jurisdiction over archaeological, historical, and cultural sites.

#### **4.6 Major development plans**

The major development plans prepared in Armenia present the environmental and social priorities for development projects. The following development

plans are most relevant for ESIA of the Kotayk Solid Waste Management Project:

- Second National Environmental Action Plan (Second NEAP) for 2008-2012,
- Sustainable Development Program (2008) incorporating the Second Poverty Reduction Strategy Paper (2003),
- Master Plans for towns and villages of Armenia,
- Socio-Economic Development Program of Kotayk Region for 2011-2014.

#### **4.7 Ongoing projects**

According to the international standards the ESIA should address the cumulative effect of waste management initiatives and projects known so far. One of the relevant activities would be the USAID/UNDP funded project started in March 2011 with the objective to improve recycling of plastics in various regions of Armenia including Kotayk Marz.

Other specialized waste management initiatives in Armenia include projects funded by the Ministry of Emergency Situations, local and international NGOs, and OCSE to secure obsolete pesticide stockpiles and burials which have stimulated preparation of potentially major Global Environmental Facility (GEF) Project through UNDP. A parallel GEF project through UNIDO is addressing PCB contaminated equipment.

Reduction of poverty and income inequality in Armenia is supported by UNDP and other international organisations through introduction of innovative income generation schemes and mechanisms. In particular, UNDP supports the implementation of the SME State Support Program and introduces/improves business support services to small and medium enterprises at central and regional levels. Moreover, UNDP develops SME support mechanisms and strengthens the capacity of SME Development National Center. It improves the knowledge and business skills of start-up SMEs and contributes to the increase of employment and business opportunities for the poor and socially disadvantaged.

The ongoing and future projects in Hrazdan municipality of Kotayk Region include the following activities:

- Completion of clay quarry operations close to Hrazdan dumpsite and closure of the cement plant scheduled for the end of 2011
- Commissioning of Block 5 of Hrazdan Combined Heat-and-Power Plant scheduled for the end of 2011
- Construction of greenhouses, which will be heated after commissioning of Block 5 of Hrazdan CHPP.

- Rehabilitation of roads, streets, roofs and elevators
- Open mining and dressing/concentration of iron ore in 2012-2014 on a site located within 2-3 km from the centre of Hrazdan city
- Construction of additional hotels and guest houses in Tsaghkadzor municipality

Infrastructure development and other activities ongoing and planned in other locations within Kotayk Region and Sevan municipalities will be identified and their impacts reviewed prior to start of any construction works for the Project..

The cumulative impact of the proposed Project and other urban development activities in Kotayk Region and Sevan municipality is expected to be positive in terms of the improvement of environmental conditions, establishment of additional workplaces, and the improvement of waste management services provided to the households and other users as an integral part of the regional infrastructure development program. A detailed assessment of cumulative environmental and social impacts of the ongoing and planned activities and the proposed Project will be carried out during preparation of the national EIA.

#### 4.8 Project's area of influence

According to the EBRD PR1 the environmental and social impacts and issues should be appraised in the context of the project's area of influence. This area of influence can be considered as an indication for the magnitude of the Project impacts. The area of influence may include, as appropriate, one or more of the components of the types distinguished by the EBRD, as specified in Table 4.2. The EBRD and its Client in case of the Kotayk Solid Waste Management Project will need a common understanding of the area of influence of the proposed Project.

Table 4.2 Components of area of influence of the Project

No	Type of component according to the EBRD PR1	Components of area of influence for Kotayk Solid Waste Management Project
1	The assets and facilities directly owned or managed by the client that relate to the project activities to be financed (such as production plant, power transmission corridors, pipelines, canals, ports, access roads and construction camps).	The MUD is responsible for the planning of solid waste management facilities in municipalities of Armenia in accordance with the Master Plans. The Project will finance procurement of vehicles, bins and equipment for waste collection, which will be owned by the landfill management company and rented out to municipal and/or private companies providing the waste collection services. The regional sanitary landfill will be established on land owned by Hrazdan municipality on territory of former clay quarry next to existing major dumpsite with upgrading of the existing access road and relevant connections to infrastructure.

No	Type of component according to the EBRD PR1	Components of area of influence for Kotayk Solid Waste Management Project
2	Supporting/enabling activities, assets and facilities owned or under the control of parties contracted for the operation of the clients business or for the completion of the project (such as contractors).	Assets and facilities of contractors involved in implementation of the Project; Assets of the Landfill Operating Company (to be established during the Project implementation)
3	Associated facilities or businesses that are not funded by the EBRD as part of the project and may be separate legal entities yet whose viability and existence depend exclusively on the project and whose goods and services are essential for the successful operation of the project.	The assets of waste collection companies owned by the municipalities; the dumpsites and promising landfill sites owned by the communities.
4	Facilities, operations, and services owned or managed by the client, which are part of the security package committed to the EBRD as collateral.	N/A
5	Areas and communities potentially impacted by: cumulative impacts from further planned development of the project or other sources of similar impacts in the geographical area, any existing project or condition, and other project-related developments that can realistically be expected at the time due diligence is undertaken.	Communities of urban and rural settlements in Kotayk Region and community of Sevan town of Gegharkunik Region
6	Areas and communities potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location. The area of influence does not include potential impacts that would occur without the project or independently of the project.	The areas and communities located to the East of Sevan town, which will not be used for disposal of waste from Sevan town after establishment of the regional landfill in Kotayk Region

It can also be expected that the area of the Project's influence will include all other regions of Armenia, because the Project will have a demonstration effect and will be part of the national plan of the waste management sector modernisation.

The Project will have a positive impact on the catchment areas of the Hrazdan River and the Lake Sevan. The water basins of Armenia are presented in Figure 10.



Source: [www.wikimedia.org](http://www.wikimedia.org)

*Figure 10 River basins in Armenia*

Improvement of municipal waste management in Kotayk Region and prevention of waste dumping in catchments of rivers in Kotayk Region will have positive impact on Hrazdan River which is a tributary of the Arax River trans-boundary for Armenia with Georgia, Turkey, Iran and Azerbaijan.

The proposed Project will also have a positive indirect trans-boundary impact as an example for improvement of waste management systems in other countries of the region.

## 5 Description of the Existing Environment

This chapter includes a description of relevant aspects of the physical and natural environment in the Project's area of influence which serve as the baseline for impact assessment during preparation of the ESIA..

Kotayk Marz is situated in the centre of the Republic of Armenia. In the south-west it borders with capital Yerevan, in the west – with Aragatsotn Marz, in the north – with Lori Marz, in the north-east – with Tavush Marz, in the east – with Gegharkunik Marz and in the south– with Ararat Marz. Kotayk is the only Marz that does not border any foreign countries. The Map and key data on Kotayk Marz are provided in Figure 11:



Area:	2089 sq. km
Territory share of the Marz in the territory of the Republic of Armenia:	7%
Number of communities:	67 (7 urban, 60 rural)
Population number as of 1 Jan 2010:	280600
including urban:	157400
rural:	123200
Share of Marz population in the country's population, 2009:	8.6%
Share of urban population size:	56.1%
Agricultural land:	161667 ha
including arable land:	38057 ha
Administrative centre:	Hrazdan town
Cities:	Hrazdan, Abovyan, Charentsavan, Byureghavan, Tsaghkadzor, Yeghvard, Nor-Hachn

Figure 11 Map and key geographical data for Kotayk Region

Kotayk Marz includes 3 administrative districts. The district names correspond to their centres: Hrazdan District, Abovyan District, Nairi District.

- **Hrazdan District** is situated in the upper and middle parts of the Hrazdan river basin. The majority of the area is located at altitudes of 1500-2400 m. The highest elevation mark - 3101m - is at the top of the Tezh Mountain. In the north the slopes of the Pambak mountainous range fragmented by tributaries of Marmarik River are located, while in the east branches of Geghama Range and lava flows are observed. Volcanic cones of Gutanasar and Menaksar are in the south-east. The industrial towns of Charentsavan and Hrazdan as well as recreational and health resort Tsakhkadzor are located in the Hrazdan region.
- **Abovyan District** is located in the Kotayk plateau between the rivers Azat and Hrazdan. In the north-east part of the region the mountain Azhdahak (3597m) of the Geghama mountainous range as well as Voghjaberd range are positioned. The extinct volcanoes of Hatis (2528m) and Gutanasar (2299m) are located in the northern part, while Hrazdan Canyon is situated on the east and Nork heights are located on the south. The lake Akna is located at an elevation of 3030m. There are two urban communities in the Abovyan region: Abovyan and Byureghavan.
- **Nairi District** is located in the Yeghvard volcanic plateau between the rivers Kassakh and Hrazdan. The highest point of the region is the top of Arai Mountain, where elevation is 2575 m. The urban areas of Nairi region are the towns Yeghvard and Nor Hachn.

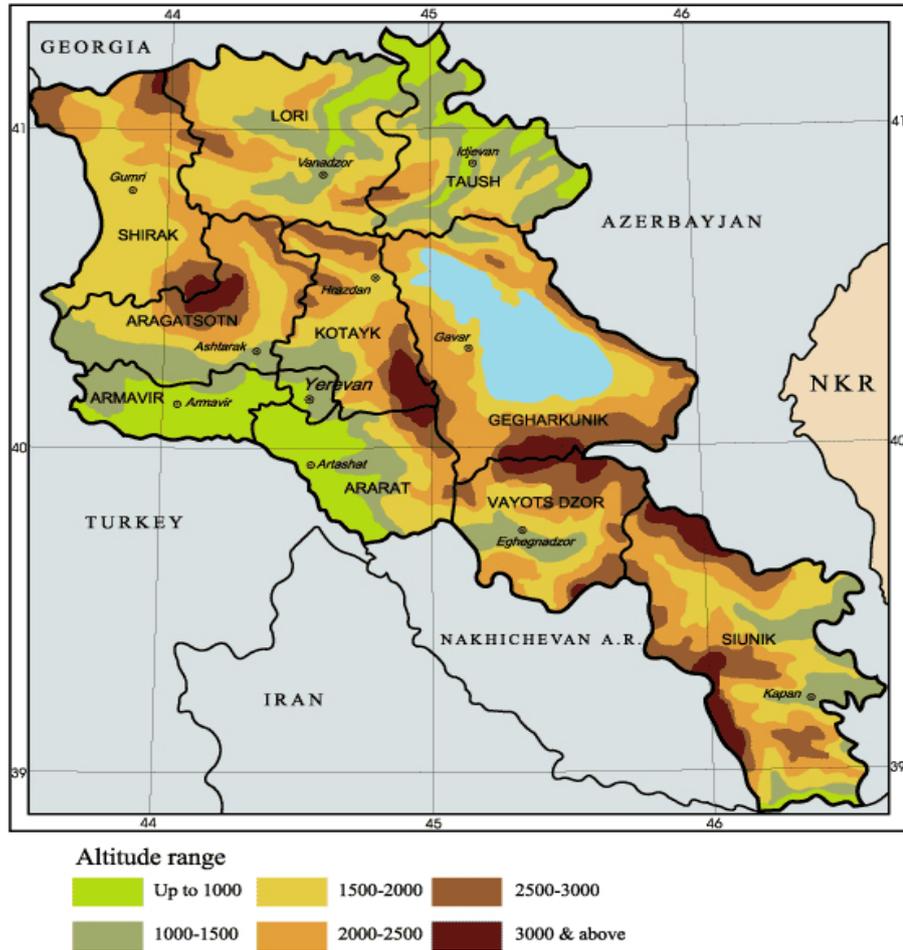
Sevan town is located on the coast of the Lake Sevan to the north from Kotayk Marz and within 15 km distance from Hrazdan.

## 5.1 Geomorphology and Geology

Natural conditions of Kotayk Marz and Sevan town are to a considerable degree determined by the terrain altitudes. A schematic map of altitude variations in Armenia is presented in Figure 12.

Kotayk Marz with its total area of 2,089 sq. km is located in the central part of Armenia at an altitudes of approximately from 1,200 m to 3,500 m (top of the mountain Ajdahak) above sea level. The territory of the Marz covers the upper and middle flows of Hrazdan River basin, and the basin of Marmarik River completely. Gutanasar marks the border of the Marz in the north, while in the north-east the Marz borders with Hatis mountainous range. South-western part of the territory gradually decreases and joins the Ararat valley. Kotayk plateau is located in the eastern part of the Hrazdan River basin between the river valley and the eastern slopes of Geghama Mountains.

**ALTITUDE VARIATIONS WITHIN ARMENIA**  
*( measured in meters above sea level )*



Source: [http://www.cac-biodiversity.org/arm/arm\\_biodiversity.htm](http://www.cac-biodiversity.org/arm/arm_biodiversity.htm)

*Figure 12 Map of terrain altitudes in Armenia, meters above sea level*

The geomorphology features of the area reflect a volcanic origin. The landscape is formed by masses of effusive and pyroclastic rocks. Slopes of the Geghama Mountains, Tsaghkunyants mountain chain, Hatis and Arai mountains are located within the Marz territory. The following major geomorphologic elements are located in this Marz: Yeghvard valley located at an altitude of 1200-1300m above the sea level, and Hrazdan plateau located at altitude of 1700-1800 m above the sea level.

**5.2 Climatic Conditions**

Climatic conditions in the regions of Armenia are mainly determined by altitudes of the terrain. A map of climatic zones is presented in Figure 13.

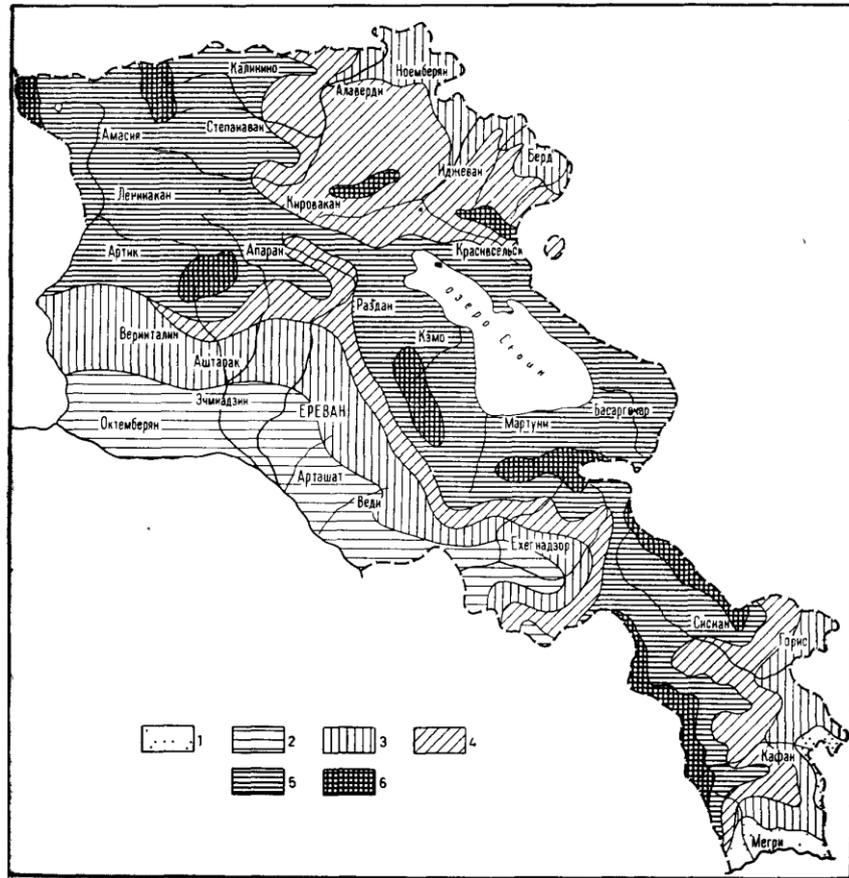


Рис. 10. Карта вертикальных климатических поясов  
(по А. Б. Багдасаряну)

1 — сухой субтропический климат; 2 — сухой континентальный климат; 3 — умеренно-теплый сухой климат; 4 — умеренно-холодный лесной климат; 5 — холодный горный климат; 6 — климат нагорных тундр

*Figure 13 Map of vertical climatic zones of Armenia:  
1 - dry subtropical climate, 2 - dry continental climate, 3 - moderately warm dry climate, 4 - moderately cold forest climate, 5 - cold mountainous climate, 6 - climate of alpine tundra*

Source: Hydrogeology of USSR, Volume XI, Armenia, Moscow, Nedra Publishing House, 1968

The climate of Kotayk is mainly dry continental, in the highlands- mild alpine. In the lowlands the summers are hot, in the mountains- cool. Winters are cold and snowy. In spring weather is quite changeable. In the first half of autumn the weather is relatively warm, sunny and windless, while in the second half of the season the cyclones causing cloudy and rainy weather are often observed.

The annual average temperature in locations within Kotayk is from 8 to 10 °C. The average air temperature in July varies between +21 and +25 °C. The highest temperature in summer is +39 °C. The average air temperature in January is within the range of -4 - -6 °C. The coldest temperature varies between -30- -34 °C. The annual precipitation varies from 400 to 800 mm. The maximal water content in snow is 120 mm. The snow cover forms in the first half of November and melts till mid-April. The number of snow days is 120. The height of snow cover, including the 5% of reserved capacity, is about 101 cm. The maximum

soil freezing depth is 96 cm. The humidity is 67%. Throughout the year the winds mainly blow from north-west, and in winter – from south-west. The average annual wind speed is 2.0m/sec.

Studies based on meteorological observation data show that Armenian climate has been changing towards higher temperatures during last decades. Variety of hazardous weather and climate events are expected to affect the socio-economic sectors and sustainable development in the country. Among the natural hazards, Armenia is mostly affected by droughts, early spring frosts, heat/cold waves, hailstorms, mudflows, landslides, storms, fogs and forest fires. Assessment of vulnerability of Kotayk Marz to the hydro-meteorological hazards is presented in the table Table 5.1 below:

*Table 5.1 Vulnerability of Kotayk Region with regard to extreme climate conditions (0 – low, 5 – high)*

Marz	Dry conditions	Drought	Seasonal flooding	Hailstorm	Early frosts
Kotayk	2	4	1	3	3

### 5.3 Land Use and Settlement Patterns

The area of Kotayk Marz is located within the three soil zones: forest, desert and dry desert. As to agricultural land cadastral evaluation zones, the Marz is included in Urts-Kotayk-Shamiram, Kotayk-Talin and Aparan-Hrazdan evaluation zones. The vast majority of communities are included in the dry desert zone typified by brown soils that are formed at altitudes of 1100-1950 m above sea level. Forest brown soils were formed under the forest cover with moderate warm and non-stable humid climate. These soils are characterized by a clear separation of genetic horizons, average and sufficient humus content of 4-10%. In lime-free soils the neutral and slight saline reaction - pH varies between 6.4-7.4, while in typical and carbonate soils the slight saline and saline reactions - pH concentration varies between 7.4 and 8.3. These soils are characterized by considerable water-physical properties. Soil thickness in humus horizon varies between 1.0-1.3 g/cm<sup>3</sup>, in low horizons - 1.45-1.5 g/cm<sup>3</sup>. General porosity is 50-56% and 43-50%. The water absorption velocity in the first hour is 340 mm. These soils are poor in nitrogen and phosphorus and contain moderate and high potassium.

Steppes are present in Armenia within altitude range 1200 to 2000 m (sometimes as high as 2500m) above sea level. Mountain steppes cover 37% of territory of Armenia and form the dominant landscape for most of the country, particularly at altitudes above 1500m and up to 2000m in the northern regions of Armenia, and 2400-2500m in the southern regions.

Typical flora includes the following distinctive species of higher plants: *Stipa lessingiana*, *S. pulcherrima*, *S. capillata*, *Festuca sulcata*, *F. ovina*, *Bothriocloa*

*ischaemum, Agropyrum cristatum, Astragalus microcephalus, A. laguris, Onobrychis cornuta, Bromopsis variegatum, Phleum phleoides, Koeleris cristata.*

Plants cultivated in steppes include vegetables, frost-tolerant fruit trees (in lower altitudes) and fodder plants (in highland areas).

Land use pattern in Kotayk Region and Sevan municipality includes residential and industrial zones with 8 urban municipalities and residential and agricultural areas (arable fields, gardens and pastures) within 60 rural municipalities mainly located within the intermountain river valleys and plateaus at lower altitudes of the terrain. Higher altitudes correspond to mountain slopes not convenient for construction and agriculture. Irrigation networks are established for the agricultural areas, but many of the arable plots are abandoned. Currently operated and abandoned quarries occupy considerable part of the territory along the main road Yerevan-Sevan within Kotayk Region. One of the largest clay quarries is located to the east from this main road in the southern outskirts of Hrazdan city. Peculiar land use features of Kotayk Region include a canyon-like valley of the Hrazdan River with a cascade of hydropower plants in the central part of the region. A mountain forest resort zone of Tsagkadzor is located in the northern part of the region.

## 5.4 Water Resources

### 5.4.1 Surface water

Kotayk Marz is almost fully located in the Sevan-Hrazdan water basin, which includes the rivers Hrazdan, Marmarik, Kassakh and Amberd. A very small part of the territory of Kotayk Marz is located in the Ararat water basin. The map of Sevan-Hrazdan water basin with its section relevant to Kotayk Marz presented in Figure 14.

**Hrazdan River** originates from Lake Sevan nearby the Sevan town. The basin of the river in its upper flow is limited by Pambak mountainous range in the north, by Tsaghkunyats mountainous range in the west, and Geghama mountainous range in the east. Overall, the river flows through a narrow gorge. After passing the Yerevan city the river flows through Ararat valley and discharges into the river Araks. The length of the river is 141 km and inclination is about 1,000 m. The area of catchment basin (without the lake Sevan) is 2560 sq. km.

From hydrogeological perspective the river catchment basin is divided into two significantly different from each other parts: on the right bank hydrophobic layers dominate, while the left bank, in the contrary, is formed by cracked non-waterproof rocks. This is why the river has tributaries mostly on the right bank (Marmarik, Dalar, Arai).

The river is mostly recharged from the sources located on the left bank (Akunk, Argelt, Arzni, etc.), which in turn are recharged from Geghama mountainous range. The Marmarik River is the largest tributary of the Hrazdan River. The

length of the Marmarik River is 37km and the area of catchment basin is 427 sq. km. The river originates from the springs flowing from Pambak and Tsakhkunyats mountainous ranges and discharges into the river Hrazdan 116 km from its estuary.

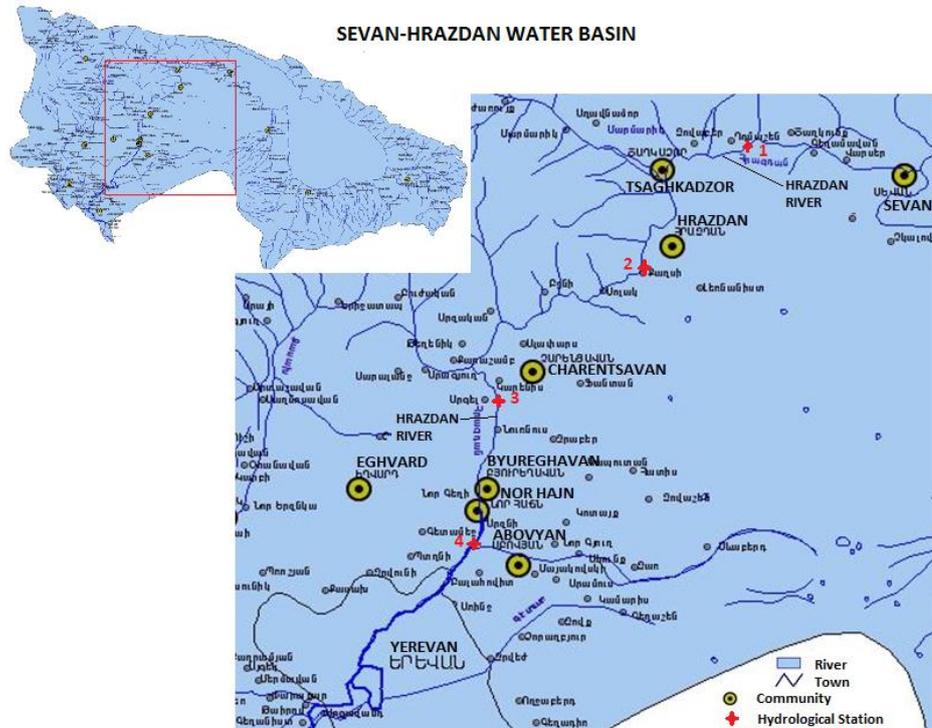


Figure 14 Map of Sevan-Hrazdan Water Basin

Overall, there are 8 hydrological stations located on the river, out of which 4 are situated in the Kotayk Marz. The information on location of the hydrological stations is presented in Table 5.2 below and on the map of Sevan-Hrazdan water basin.

Table 5.2 Location of hydrological stations in Kotayk Marz

N	Location of Hydrological Station
1	13 km upstream from Hrazdan town
2	0.5 km downstream from Qaghsi community
3	0.5 km downstream from Argel community
4	0.5 km downstream from Arzni Hydropower plant

Due to the fact that the Hrazdan River originates from the Lake Sevan, has a significant inclination, flows through Ararat valley and central regions as well as the capital, it is considered as the major river of the county. The river is used for irrigation water supply, power generation, recreation, fish-farming and other purposes.

**Azat River** originates at eastern volcanic slopes of Geghama Mountains, which explains why the river is mostly fed from underground sources. The river is formed by Goght and Yotnakunk mountainous streams. The length of the river

is 40 km, catchment basin area is 572 sq. km. It discharges into Araks River 21 km downstream from Hrazdan river estuary. Only a very small upper section of the river is flowing through Kotayk Marz. In the upper part the river flows through a narrow gorge, and has significant inclination. Downstream the Garni village river flows become quiet and downstream the Lanjazat village it passes through Ararat valley. The only hydrological station is located in Garni (Kotayk Marz), while the only water quality station is positioned nearby the Azat river estuary (4 km upstream the estuary, Ararat Marz), thus the data is not representative for Kotayk Marz, where only a minor upstream part of the river is located. The water from river is mainly used for water supply, irrigation and fish-farming purposes. In its lower part, the river is regulated by Azat reservoir.

In the samples taken from Hrazdan, Marmarik, Getar Rivers the concentrations of ammonia, nitrite, and sulphate ions, BOD<sub>5</sub>, Aluminium, Vanadium, Chrome, Bromine, Selenium, Manganese and Copper exceeded Maximum Allowable Limits for drinking water. In the upper and middle section of Hrazdan River (located below the Argel community and down to the estuary) the significant pollution with Vanadium has been registered; the average annual concentrations exceeded MAL by 11-20 times.

In the samples taken from Hrazdan river the annual average concentrations of Aluminium exceeded Maximum Acceptable Limits by 2.4-5.3 times; concentrations of Chrome by 2.0-7.0 times; concentration of Copper by 2.0-4.0 times; BOD<sub>5</sub> by 1.1-1.5 times; concentration of Manganese by 2.1-4.6 times. In the lower parts of Hrazdan river (downstream the Argel HPP) and in estuary of Getar river average annual concentrations of nitrite ion exceeded the maximum allowable limits by 2.0-8.3 times. In the Hrazdan river nearby the lake Sevan, downstream the Arzni HPP and nearby the estuary average annual concentrations of Bromine exceeds MAL by 2.2-3.1 times; Selenium – 2.0-3.0 times. The concentrations of other substances were within allowable limits.

#### 5.4.2 Groundwater

Data on groundwater resources of Kotayk Marz and main components of groundwater flow are presented in Table 5.3:

Table 5.3 Groundwater resources in Kotayk Marz

River basin	Groundwater natural resources, cub. m/sec			
	Total	Including		
		Springs	Drainage	Outflow
Hrazdan	14.75	8.46	4.19	2.10
Azat	6.33	4.28	1.86	0.19

### 5.4.3 Water use

Data on breakdown of water use by the purpose of its use for the period of 2007-2009 in Kotayk Marz are summarized in Table 5.4 below.

Table 5.4 *Water use in Kotayk Marz in 2007-2009*

Year	Total use, M cub. m	Use for various purposes, M cub. m			
		Domestic and drinking	Industrial	Agriculture, fish-farming and forestry	Other
2007	135.2	5.3	8.5	120.2	1.2
2008	113.8	8.4	13.2	91.2	1.0
2009	96.5	4.1	8.7	81.9	1.8

## 5.5 Biological and Ecological Resources

### 5.5.1 Key Flora and Fauna

#### Flora

Flora of Kotayk is quite diverse, having dry steppes, forests and alpine meadows. Geghard Gorge is particularly unique, with *Linaria armeniaca*, *Acantholimon bracteatum*, *Illium akana*, *Tulipa julia*, *Corydalis augustifolius*, *Ornithogalum montanum*, *O. gussonei*, *Campanula choziatorskyi*, *Bellevalia longystila*, *Muscari neglecta*, *Lotus goebelia*, *Astragalus strictifolius*, *Serratula serratuloides*, *Tomanthea aucheri*, *Malus orientalis*, *Prunus divaricata*, *Sorbus graeca*, *S. persica*, *S. aucuparia*, *Crataegus orientalis*, *C. laciniata*.

The semi-arid zone is specified by wormwood and ephemeral plant cover: *Artemisia fragrans* Willd.; *Kochia prostrata* (L.), Schrad.; *Capparis spinosa* Willd.; *Ceratooides papposa* Botsch. et Ikonn.; *Atropaxis spinosa* L.; *Rhamnus pallasii* Fisch. et Mey.; *Tanacetum argyrophyllum* (C. Koch) Tzvel.; *Poa bulbosa* L. *Bromus*; *Aegilops*; *Eremopyrum*; *Alyssum*; *Aeluropus littoralis* (Gouan) Parl.

The part of the landscape was transformed into the agricultural landscape of heat-loving crops. This type of vegetation often is called “vegetation of skeleton mountains” and it feels the impact of Iranian deserts. The most common plant variety of semi-arid area is the fragrant sagebrush (*Artemisia fragrans*) or similar species in some places (e.g. *Artemisia araxina*). The area is covered by ephemeral vegetation in spring (*Ceratocephala falcata*, *Anisantha tectorum* and others).

Among plant species of semi-desert zone it is worth to note the capers (*Caparis spinosa*), bean caper (*Zygophyllum fabago*) and others.

The following species of useful wild growing flora also occur within the area: Armenian everlasting (*Helichrysum armenium*); water pepper (*Polygonum hydropiper*); red hawthorn and other species of hawthorn (*Crataegus astrosanguinea*); macrosepalous primrose (*Primula macrocalyx*); heart-like motherwort (*Leonorus cardiaca*); red snakeweed (*Polygonum cameum*).

Among plants registered in the Armenian Red Book the following species are met in this area: setwall (*Linaria pyramidata*), Tigran elder (*Sambucus tigranii*).

## Fauna

Each vertical vegetation zone including the semi-arid zone has its specific fauna. Meanwhile some animal species are met almost in all landscape zones due to their ecological plasticity.

The amphibians and the reptiles are represented by toads, tree frogs, frogs, fresh-water turtle, typical tortoise, geckos, agamas, lizards, blind snakes, boas, grass snakes. The most common species among birds are the fowl-like birds, cranes, pigeon birds, perching birds. The most common species among mammals are hedgehogs, shrews, horseshoe bats, porcupines, nutrias, typical squirrels, rabbits, mice, martens, hyenas, canines, cats, pigs.

The animals prevailing in semi-arid zone are specific mainly to vertebrates of Iranian Highland and partially of Middle Asia. Among other mammals its worth to mention field mouse (*Microtus arvalis*), martens (*Martes martes*), foxes (*Vulpes vulpes*), Erinaceus auritus, brown bats (*Nyctalus noctula*), *Vesperilio ognevi*, *Plecotus auritus*, etc.

According to data of National Atlas of Armenia, the hare and lebetina viper are among the vertebrates that occur within the Kotayk Marz. The hare is the hunting animal of this region.

### 5.5.2 Protected, Listed or Endangered Species

Armenia has over 3,500 species of plants, more than half of the 6,000 that can be found in the entire Transcaucasus region, while Europe has around 20,000 species.

As a result of wild range of factors affecting biodiversity almost half the plant species presented in Armenia may face some threat of extinction. To date, 35 plant species of economic importance are known to have become extinct in Armenia. A further, 386 species (12% of the flora) are listed in the Armenian Red Data Book (produced in 1988). At a regional level, 61 plant species are listed in the Red Data Book of the former Soviet Union (produced in 1984).

Among plants registered in the Armenian Red Book the following species are met in Kotayk Region: setwall (*Linaria pyramidata*), Tigran elder (*Sambucus tigranii*).

The black gryphon (*Aegypius monachus* L.) and the Tetrao *mlakosiewiczzi* Taczan are of this area are included into the Armenian Red Book.

Armenian bio-geographical zones are well linked, and the lack of isolation results in relatively few endemic species. Overall, 106 species of endemic plants are recorded (representing 3% of the total Armenian flora, and 1.5% of flora found across the Caucasus).

In addition, Armenia contains a number of regional endemics which are also found at a limited number of sites in neighbouring countries. For example, *Campanula massalskyi* 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 is of relatively recent origin (dating from the Quaternary or Holocene), with no ancient endemic species recorded. This reflects the relatively recent diversification of flora in the region, which has resulted in the current botanical richness of Armenia. The distribution of endemics corresponds closely with climate, and most are found in the southern and central arid zones of the country. In particular the regions of Vayots Dzor Region and Yerevan show high numbers of endemics (with 38 and 36 species, respectively).

Threatened plant species have been recorded from all regions. Many of the rare and threatened plants in Armenia are associated with wetlands; water-marsh systems 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. Around 20,000 ha of wetland sites have been drained across the country, resulting in inevitable damage to these ecosystems and associated flora and fauna.

### 5.5.3 Specially protected nature areas

A network of specially protected areas was first established in Armenia in 1958 to protect ecosystems, habitats and rare, endemic and threatened species. There are currently five State Reserves, 22 State Reservations and one national park registered, which together cover around 311,000 ha, or 10% of the surface of the country. Around 60% of Armenian species are represented within the protected area network; however, there is a bias towards forest habitats, and a need to expand the system to include better representation of other ecosystems.

State Reserves are established to provide high levels of protection for important habitats and species. The human use within reserves is restricted to scientific research, and the reserves are under overall responsibility of the Ministry of Nature Protection. State Reserves represent strict nature reserves, with respect to IUCN criteria. In the Republic of Armenia the specially protected natural areas based on their importance are identified as national parks, state reserves and reservations. According to the National Statistical Service of Armenia, there specially protected areas cover a territory of 310,000 ha that comprises

about 10 percent of the country's surface area. The information regarding state reserves and reservation located in Kotayk Marz is presented below. Map of protected areas of Armenia including the areas located in Kotayk Marz is presented in Figure 15.

### **The Erebuni Reserve**

It was established in the 1981 and is situated in the border of Kotayk and Ararat Marzes, near Yerevan on tertiary red clay soil. This precious and ancient collection of wild cereals has existed here for millions of years. Approximately 300 sorts of *plants* grow here on the area of 90 hectares. These collections consist generally of year-old wild cereals - Araratian, Urartu, and Beotiân (*Tricum araraticum*, *T.urartu*, *T.boeiticum*) wheats, numerous sorts of *Aegilops* and *Secale vavilovii*. The most dense, pure and fluffy cereals 70-75cm tall found in the reserve give the impression of a densely sowed wheat field. Here one can see rich material for scientific, practical and selection activity - over 100 kinds of wheat. Some interesting endemic kinds such as *Amblyopyrum muticum*, *Actinolema macrolema*, *Szovitsia callicarpa* and *Cichorium glandulosum* can be found only here. Some of them - unique umbellate *Hohenackeria excapa* and small (1-2cm tall) *Rhizocephalus orientalis* - are disappearing kinds and are included in the Red Book of Armenia and the former Soviet Union.

There are also plant associations with *Iris reticulata* and *Iris elegantissima* that grows on the southern slopes of the Erebuni Reserve.

The *avifauna* is quite diverse and is represented by Quail, Chukar, Grey Partridge, Turtle Dove, Common Kestrel, Little Owl, Nightjar, European Rollers and others. The common species of *mammals* in the reserve are fox, vair and field mouse. Sometimes one can see marten, wolf, badger and Persian and Vinogradov's launces. Near the reserve live many rare species of *beetles*, *reptiles* as well as 9 species of snakes and lizards such as marsh frog, green toad, hyla, mountain and slender racers, Gluss-lizard and five-streaked lizard, Pleskes and Strauch's racerunners, golden grass skink and others.

### **Khosrov reserve**

The reserve is located close to the southern border of Kotayk Region. It has been known as a unique area as far back as in the 4-th century when the Armenian king Khosrov II Kotack declared the southern slopes of the Gueghama Mountains a restricted area. He "planted a forest" and made it a hunting-ground for the palace. Over the centuries the Khosrov Reserve has been mentioned in the history of Armenia as a hunting-ground for the nobility and animals were brought and bred in the Reserve from various regions, especially Persia. In 1958 the Khosrov forest, consisting of 8 separate lots, was officially declared a reserve and its borders were widened to create a single parcel of land (in 1992). The Khosrov Forest Reserve is situated south-east of Yerevan, at the foot of the Gueghama volcanic mountain, in the basins of the Azat and Vedi rivers. The Reserve is situated 1,400-2,250 meters above sea-level, and extends over an area of 29,196 hectares, about 9,000 hectares of which are covered with forests. The importance of the Khosrov Forest extends beyond the local margins and

plays a significant role in the entire ecology of the region. It is the only Caucasian reserve with such diversity of climatic areas and plant types.

Khosrov Reserve has very complicated relief with amazing landscapes. As everywhere in Armenia the results of tectonic activities - fractures, steeps, etc. - can be seen. Atmogenic processes, hot climate and water create numerous fantastic monuments - figures, pyramids, towers, quaint cliffs etc.

The reserve is famous for its rich flora. Within its borders grow more than 1800 kinds of plants (more than half of species growing in Armenia), 156 of which are considered rare, endangered and disappearing. Numerous rare and disappearing species are mentioned in the Red Book and grow only here. It is the only Caucasian Reserve of mountain xerophytes, where semi-deserts, various phryganoid formations, different types of arid thin forests, tragacanthys steppes and others.

Fauna of the reserve is also rich. Invertebrate animals and in particular insects are presented by unique diversity of specific composition. There are amphibians, 7 types of fish, and over 30 reptiles living there such as the Levantine viper, the Montpellier snake, the dotted dwarf and the collared dwarf snakes, the Pleskes racerunner, the five-streaked and the three-lined lizards, the golden grass and the Snaider's skinks, the eastern spadefoot and others.

In the Khosrov Reserve there are 40 kinds of mammals, 18 of which are registered in the Armenian Red Book, including the Primary-Asian leopard, the Bezoarian goat, wild sheep (the Armenian mouflon), the Transcaucasian gray bear, the lynx, and more.

Among 67 kinds of birds registered in the Armenian Red Book, in the territory of the Reserve there are 16 nesting birds of prey, including Egyptian, Black and Griffon Vultures, Lammergeier, Golden and Lesser Spotted Eagles and Northern Goshawk.

The Khosrov Reserve includes numerous natural attractions: picturesque rock with a system of vertical fragments reminding a music instrument organ ("rock organ"), mysterious caves, shady canyons and alpine meadows, ancient oaks and unique flowers. Numerous historical monuments, cave dwellings, early medieval monasteries, khachkars (cross-stones), churches and fortresses have been preserved. The pearl of medieval architecture - the cave monastery of Geghard (Spearhead in Armenian) is also situated here. The acoustics of the church hall, where the Spearhead of Golgotha was kept for centuries, will impress even the most demanding audience and is perfect for classical music recordings.

### **Sevan National Park**

Lake Sevan is the second highest lake in the world, situated at an altitude of 1900 meters in a hollow of the picturesque Geghama Mounts. The surrounding highland steppes fade to alpine meadows and groves, crowned with snow-capped peaks. Add fresh mountain air, the rich blue sky, elusively changing shades of the Lake and you'll understand why Sevan is a beloved place for rest

and travel. Simply, it is a source of endless surprise and discovery: Amateur geologists can observe rainbow-colored fields of cracked magma and huge basalt cliffs while they gather rich collections of stones and minerals.

Botanists are particularly interested in the endemic species with ancestors dating back to the post - mounts formation era. Ornithologists find a fascinating diversity of resident and migratory birds.

Archaeologists are amazed by the hundreds of historical monuments, numerous excavations and pieces of Bronze Age crafts and fine art.

The beauty of Lake Sevan and its surroundings is difficult to express in words. It must be seen. One who has seen the dawn with golden ribbons on the turquoise water and colonies of pelicans and flamingos will remember Sevan forever. Lake Sevan provides 80% of Armenia's water resources (1585 billion cubic m.), and plays an important role in regulating the country's water balance. From 1933 to 1981, the lake was used to support agricultural, industrial and energy sectors and its level dropped dramatically. The lake system and its ecological balance were greatly disturbed by this use.

The only National Park in Armenia was established in 1978 to protect Lake Sevan and the surrounding areas. Overall, including buffer zones, 150,100 ha are protected, including 24,800 ha of dry land. Sevan National Park falls under the jurisdiction of the Ministry of Nature Protection, and is managed as a research centre, which monitors the ecosystems, and undertakes various conservation measures (including regulation of use and tourism, and protection of historical and cultural monuments). Licensed fishing on the lake is also regulated. Three main zoning areas exist: the core (reserve) zone, a recreation zone and a zone for economic use. The core protection zone includes the watershed for the lake, as well as a park which incorporates a number of smaller reserves and reservations.

Protection is aimed at the rare and endemic species of the lake and surrounding habitats. The diversity of habitats and conditions in the area supports a wide range of plants and animals, including:

- Plants - *Acantholimon gabriljanae*, *Astragalus goktschaicus*, *Isatis sevanensis*, *Sorbusjunstanjca*, *S. hajastaria*, and *Adonis wolgensis*.
- Fish - Nine species, including whitefish, Sevan trout, barbel, 'kogak' and carp.
- Amphibians - Six species, including the green toad (*Bufo viridis*) and frog (*Rana ridibunda*).
- Reptiles - Seventeen species, including rock lizards (*Lacerta unisexualis*, *L. narensis*, *L. rostombekovi*, *L. armeniaca*) and snakes (*Natrix natrix*, *Coronella austriaca*, *Vipera erivanensis*).

- Birds - 267 species, including Greylag Goose, Red-crested Pochard, Pochard, White-headed Duck, Coot, Mallard, Whopper Swan, Shelduck, Armenian Gull, Great and Pigmy Cormorants, Glossy Ibis, Black-winged Stilt and others.
- Mammals - 34 species, including marbled polecat, otter, manul, leopard, wild goat, wolf, fox and beech marten.

The decline in the water level of Lake Sevan (by 19m since the 1950s) has severely affected aquatic, coastal swamp and marshland habitats of the park. In addition, a further 10,000 ha of marshland was drained for agricultural use. In particular, the birds using Lake Sevan were affected by these habitat changes, and a number of species no longer breed on the lake. Between 1922 and 1996, the areas used by nesting waterfowl on the lake nearly halved, and the number of Armenian gulls on the lake has also declined dramatically.

#### Natural monuments

Natural monuments have been established to protect unique and typical natural sites of academic, historic or cultural importance (following a law on specially protected areas adopted in 1991). Such sites are protected from disturbance, to avoid loss of small areas of high international importance or of aesthetic value. Each site is considered independently and an appropriate agency is specified for protection. However, natural monuments are not under full legal protection, and inventory and identification procedures are underdeveloped. These sites are considered to be the most threatened within the protected areas system. As a result of human impacts (including mining, tree-felling and constructions) many natural monuments are being degraded and destroyed.

The following nature monuments (described on [http://www.cac-biodiversity.org/arm/arm\\_natreserves.htm](http://www.cac-biodiversity.org/arm/arm_natreserves.htm)) are located in Kotayk Marz or close to its borders:

- ***Pine of Banx State Reservation*** was established in 1959 to protect the unique arboretum park of pine of Banx located in the northern slopes of the Tsaghkuniats Ridge and in the Marmarik. The state reservation occupies 4 ha. The main object of preservation is American jack pine (*Pinus banksia*). Jack pine is a North American pine with its native range in Canada.
- ***Arzakan/Meghradzor State Reservation*** was founded in 1971 with aim to protect goats, deer, grey bears, wild boars and Caucasian Grouses in the basins of the Marmarik and Dalarik Rivers, at altitudes of 1600-2100m in the Kotayk Province.
- ***Hankavan State Reservation*** was established in 1981 to protect mineral water springs at the upper watershed of the Marmarik River in the Kotayk Province. The main objects of preservation are the springs of Hankavan mineral water. Hankavan mineral waters are believed to cure diseases of liver, gall-bladder, pancreas and ailments of the nervous system. The alkaline waters contain potassium, calcium, iodine and other minerals. The

pools and baths are naturally filled by mineral waters at temperatures of 37-42C.

- ***Rose Bay Rhododendron State Reservation*** was founded in 1959 to conserve the Caucasian rosebay at altitudes of 1900-2200m in the Pambak and Tskaghkuniats Ridges (in the Kotayk, Lori and Tavush Provinces).

#### **Conservation outside protected areas**

A number of ecosystems and species are not well represented in protected areas, and their survival will rely on conservation efforts outside the protected areas network. Environmental activities are currently only regulated by outdated laws which relate to control of activities in river valleys, environmentally sensitive areas and collection of particular species. In addition the Ministry of Nature Protection operates three mechanisms which serve to limit damage to biodiversity: a system of hunting licenses; provision of special licenses for the collection of medicinal plants; and environmental impact assessment for business development.

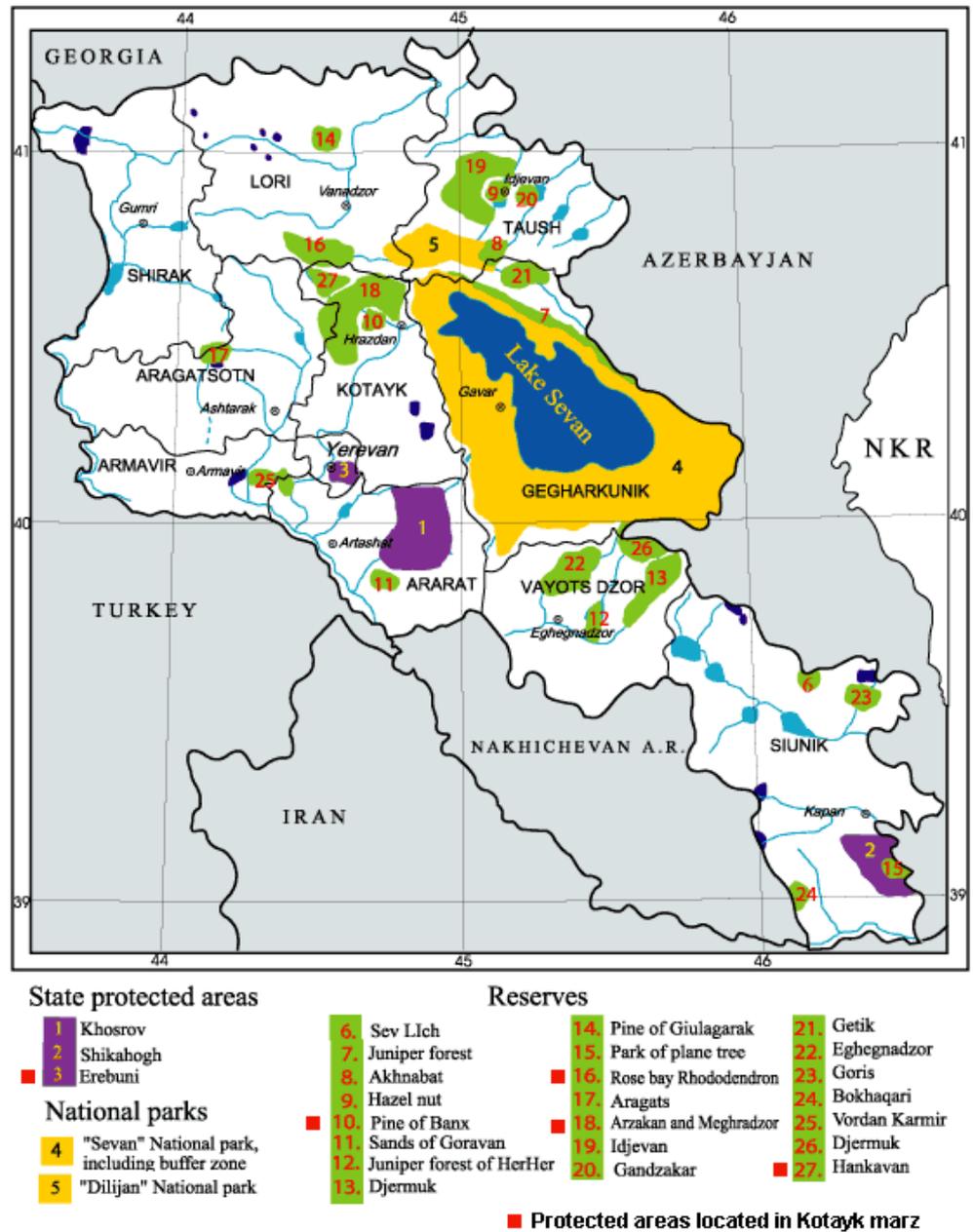


Figure 15 Location of specially protected areas in Armenia and in Kotayk Region

However, given the current rate of social, economic and political change, a new series of measures is needed to address conservation and land use outside protected areas. These might include legislation, education and improved administration, supported by independent ecological assessments and monitoring of all industrial and other activities.

The Consultant has reviewed information on Important Bird Areas (IBA) available from the Armenian Society for the Protection of Birds within the initiative of BirdLife International ([www.aspbirds.org](http://www.aspbirds.org)). No detailed information on biodiversity monitoring, biotope mapping or counts of migratory birds or other terrestrial fauna in areas close to the site in Hrazdan recommended for construction of regional landfill was available during preparation of the ESIA. This in-

formation should be collected prior to start of any construction works for the Project.

#### 5.5.4 Habitats

Lake Sevan is the largest inland water body in the Transcaucasus and is one of the largest high-mountain freshwater lakes in the world. Its wetland ecosystem plays a significant role for migratory birds. In conjunction with many small lakes in the country, the lake stores snowmelt and other runoff from mountains, which makes river water available in both wet and dry seasons. In addition to its key role in the natural complex, Lake Sevan possesses strategic economic, social, and historical importance along with cultural, recreational, and spiritual values.

Indeed, it is recognized as a national treasure. The declining water level (after establishment of hydropower plants on the Hrazdan River and irrigation systems recharged by water from Lake Sevan) increased nitrogen content and algae growth, decreased biomass of high-grade water plants, and destabilized the ecological balance of the lake. Adverse impacts on the ecosystem include the disappearance of the native lake trout (*Ishkhan*), as a result of the lowered water levels, which dried out the breeding habitats, and increased poaching. The situation was worsened by discharge of untreated wastewater, surface runoff contaminated with pesticides from farmlands, deforestation and illegal establishment of vacation houses. Changes in the physical-chemical characteristics of the lake water severely affected not only the fish community but also the waterfowl habitats. During the Soviet era the wetlands were drained to eliminate the threat of malaria and to create new croplands, which had a critical impact on the survival of migratory birds and other wildlife.

#### 5.5.5 Landscape and Visual Issues

The mountainous nature of Armenia results in a series of highly diverse landscapes, with variations in geological substrate, terrain, climate, soils, and water resources. These landscapes support a great variety of habitats, which support distinctive flora and fauna, and different human use. These landscapes are generally associated with particular altitude zones. Each landscape represents a different ecosystem, with a distinctive group of associated plants and animals. However, there are also some species that are found in different ecosystems. For example plants such as fescue (*Festuca sulcata*) are common in both steppe and meadow systems.

Seven distinct landscape zones are described in Armenia: deserts, semi-deserts, dry steppes, steppes, woodlands, sub-alpine and alpine lands. Their description is available at [http://www.cac-biodiversity.org/arm/arm\\_landscapes.htm](http://www.cac-biodiversity.org/arm/arm_landscapes.htm).

Armenia is a party to the European Landscape Convention. The Convention The Convention came into force in 1 March 2004. It is aimed at:

- the protection, management and planning of all landscapes

- raising awareness of the value of a living landscape

The Convention provides an important contribution to the implementation of the Council of Europe's objectives, namely to promote democracy, human rights and the rule of law and to seek common solutions to the main problems facing European society today. By developing a new territorial culture, the Council of Europe seeks to promote populations' quality of life and well-being.

The European Landscape Convention introduced a Europe-wide concept centring on the quality of landscape protection, management and planning and covering the entire territory, not just outstanding landscapes.

In rural areas, the damage caused by unplanned mineral extraction was one of the early reasons for a public demand for landscape planning. The principles of landscape planning should be incorporated in various types of legislation and policy documents.

The negative visual impacts in Kotayk Region and Sevan municipality are posed by waste (municipal solid waste, construction and demolition waste, industrial waste) dumped along roads and on slopes of hills, smoke from waste burning, clouds of smoke and dust from Hrazdan cement plant, as well as views of abandoned quarries and dust emissions from operated quarries located along the main road Yerevan-Sevan.

## **5.6 Air Quality and Existing Emissions Load**

Atmospheric emissions of pollutants from stationary sources in tons per year for the whole country and for Kotayk Marz for the period of 2005-2009 are presented in Table 5.5.

*Table 5.5 Air pollutant emissions from stationary sources in Armenia and Kotayk Marz in 2005-2009 (1000 tons/year)*

Country/Marz	2005	2006	2007	2008	2009
Republic of Armenia, total, including	51.1	43.3	34.2	34.3	74.7
sulphur anhydride	24.8	27.3	25.6	22.4	22.9
nitric oxides	1.7	1.6	1.7	1.7	1.4
carbon monoxide	20.4	10.3	2.7	2.7	2.2
volatile organic compounds	0.1	0.1	0.1	0.2	0.5
Kotayk Marz, total	3.1	3.4	2.9	3.2	1.7

Atmospheric emissions calculated per capita, per sq.km and per one organization for the period from 2006 to 2009 are presented in Table 5.6.

*Table 5.6 Unit rates of air pollutant emissions in Armenia and in Kotayk Region*

	per 1 person, kg				per 1 sq. km, kg				per 1 organization generating the emissions, t			
	2006	2007	2008	2009	2006	2007	2008	2009	2006	2007	2008	2009
Armenia	13.4	10.6	10.6	23.0	1520.3	1202.1	1206.2	2621.5	50.2	40.8	23.3	62.0
Kotayk Region	12.5	10.5	11.6	61.6	1650.8	1390.2	1549.5	8247.4	33.5	27.1	17.9	120.5

The numbers of stationary sources of air pollutant emissions for the whole country and for Kotayk Marz for the period of 2005-2009 are summarized in Table 5.7.

Table 5.7 Number of air pollutant emission sources in Armenia and Kotayk Region

	Total number of emission sources					Number of sources with approved MAL				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Armenia	2043	2592	2750	2935	3191	1657	2305	2412	2599	2735
Kotayk Region	226	286	297	367	439	206	275	276	355	411

A schematic map presented in Figure 16 shows per capita quantities of contaminant emissions to air in all marzes of Armenia. According to this map Kotayk Region in 2009 had relatively high per capita pollutant emission rate, in comparison with other regions of Armenia.

Data on amount of dust emissions to the atmosphere (in tons) for the whole country and for Kotayk Marz for the period of 2005-2009 are presented in Table 5.8.

Table 5.8 Dust emissions to air in Armenia and Kotayk Marz, t/year

Country/ Marz	Total					Including									
						organic					Inorganic				
	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009	2005	2006	2007	2008	2009
Republic of Armenia	2844.6	2944.6	2916.5	3059.6	2774.9	462.6	146.5	220.1	150.6	207.8	2382.0	2798.1	2696.4	2909.0	2567.1
Kotayk Marz	879.3	1074.0	808.9	726.7	518.0	7.8	9.6	9.1	7.5	21.8	871.5	1064.4	799.8	719.2	496.2

A schematic map based on statistical assessment of per capita quantity of hazardous substances emitted into air by stationary sources located in various Marzes of Armenia is presented in Figure 16.

Արտանետման անչարժ արդյուրներից մթնոլորտ արտանետված վնասակար նյութերի քանակը մարզի մեկ բնակչի հաշվով, 2009թ.  
 Quantity of hazardous substances emitted into atmosphere from stationary sources per capita of marz, 2009  
 Количество вредных веществ, выброшенных в атмосферу стационарными источниками на душу населения марза, 2009г.

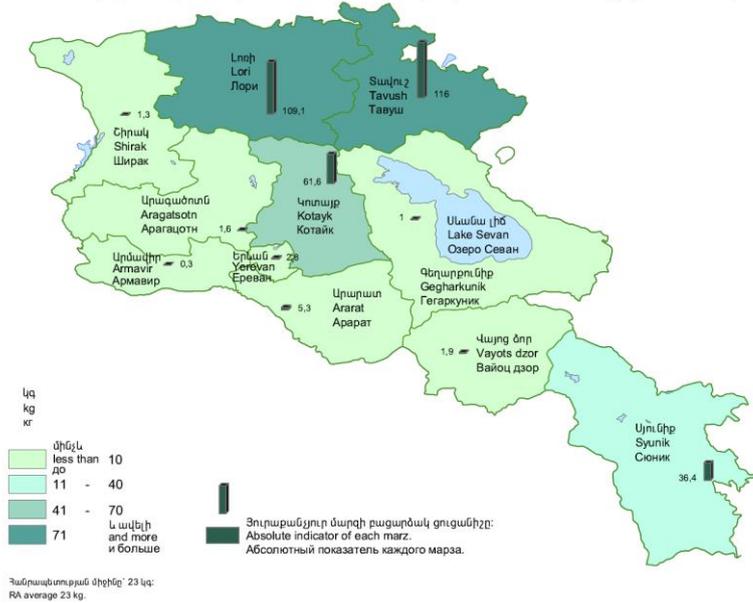


Figure 16 Per capita quantities of pollutants emitted to air in marzes of Armenia in 2009

More details on air quality and emissions are available from data of assessments made for Hrazdan and Tsaghkadzor towns. They are discussed below and compared with the maximum allowable limits (MAL) also known as maximum allowable concentrations of air pollutants based on the Armenian standard Maximum Permissible Concentration (MAC) for Ambient Air in residential Areas included in Table 5.9.

Table 5.9 Maximum Allowable Concentration (MAC) in ambient air for residential areas of Armenia

MAC (mg/m3)	Parameters measured at receptor (mg/m3)	
	SO2	NO2
Single event	0.50	0.085
Daily average	0.05	0.040

Source: RA government decision N160-N, 02.02.2006.

Air quality in Hrazdan In 2010 overall 891 air samples were taken from one permanent observation station located in the Hrazdan town in order to study content of cement dust in the air. The average annual concentration of dust exceeded maximum allowable limit (0.1 mg/sq. m) by 3.4 times, while the concentration of dust in a single sample (MAL 0.3 mg/sq. m) taken from 48% of total samples exceeded MALs up to 5.6 times. Location of air quality observation station is presented in the scheme of the town (Figure 17).



Figure 17 Map of location of the air quality observation station in Hrazdan

Data on the observed dust concentration in air are presented in Figure 18.

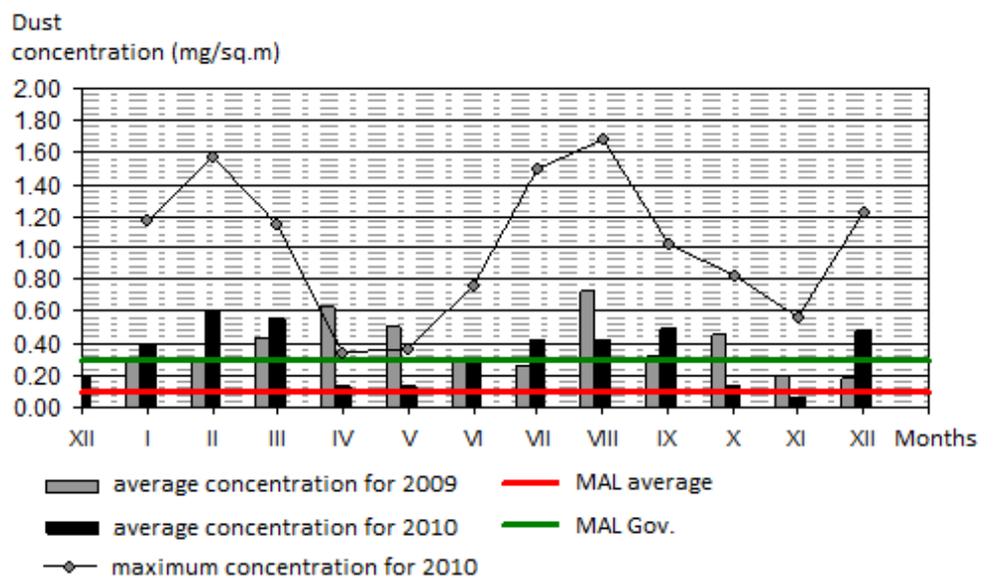


Figure 18 Chart for dust concentration in Hrazdan according to air quality observations

In comparison with 2009 the average annual concentration of dust decreased by 1.1 times. In 12 observation points in the town the air samples were taken to determine concentrations of sulphur dioxide and nitrogen dioxide. Overall, 948 air samples were taken, and annual average concentrations of sulphur dioxide and nitrogen dioxide were within the allowable limits.

Air quality in Tsaghkadzor

14 observation stations are installed in the town to monitor concentrations of sulphur dioxide and nitrogen dioxide in the air. In 2010 1098 air samples were taken from these stations. Average annual concentrations of sulphur dioxide and nitrogen dioxide were registered within allowable limits. Data on average monthly concentrations in air samples collected in Tsaghkadzor of sulphur dioxide and nitrogen dioxide are presented in Figure 19 and Figure 20, respectively.

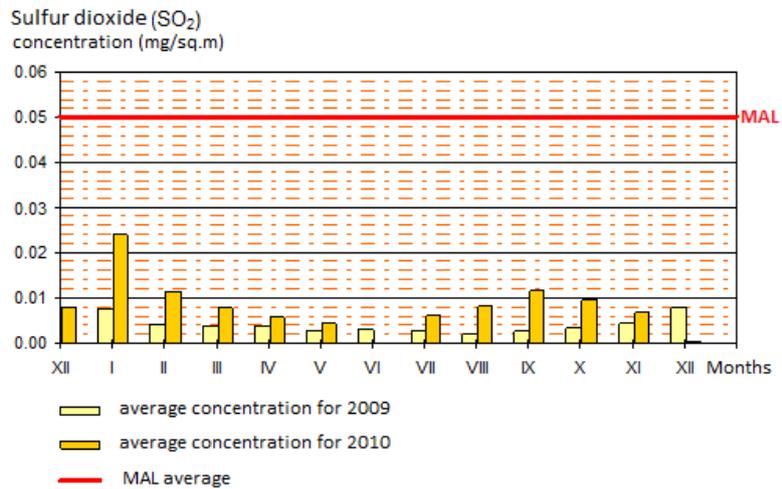


Figure 19 Monthly average concentrations of SO<sub>2</sub> in Tsaghkadzor

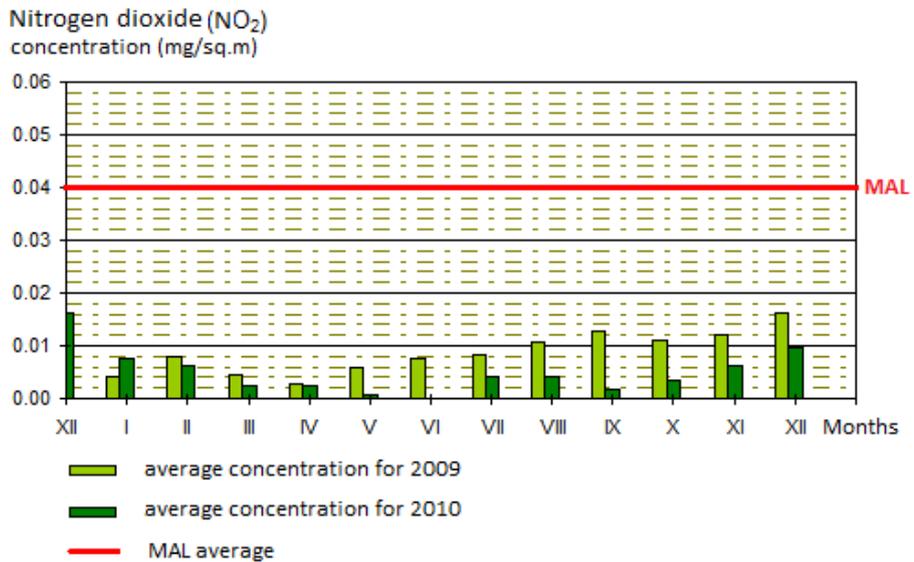


Figure 20 Monthly average concentrations of NO<sub>2</sub> in Tsaghkadzor

Data on odour measurements are not available due to lack of suitable equipment in Armenia.

## 5.7 Noise and Vibration

Maximum allowable noise levels defined by the RA Ministry of Health for areas adjacent to residential and public buildings are presented in Table 5.10. The allowable noise levels are regulated by Sanitary Norms N2-III-11.3 "Noise at workplaces, residential and public buildings, and urban areas" adopted by the RA Ministry of Health (Order 139 No 138 of 6 March 2002). No regulation regarding vibration was identified during preparation of the ESIA.

Table 5.10 Maximum allowable noise levels in Armenia

Receptor	Hours of a day	Maximum allowable noise levels	
		dBL <sub>Aeq</sub> 15 min	dBL <sub>Amax</sub> 15 min
Near residential dwellings and public buildings	06:00-22:00	55	70
	22:00-06:00	45	60

No data on noise and vibration measurements in residential areas of Kotayk Region and Sevan town were available during preparation of the present ESIA.

## 5.8 Existing Sources of Pollution and Extent of Contamination

Transport operations, industrial activities and dumping of various types of waste are the key existing sources of pollution in Kotayk Region and Sevan city.

In 2005-2010 over 160 permits for emissions were issued for companies operating in Kotayk Region.

An overview of payments collected in Kotayk and other regions of Armenia is presented in Figure 21.

Բնապահպանական և բնօգտագործման վճարները մարզի մեկ բնակչի հաշվով, 2009թ.  
 Payments for environment protection and environmental resources use per capita of marz, 2009  
 Платежи по охране окружающей среды и природопользованию на душу населения марза, 2009г.

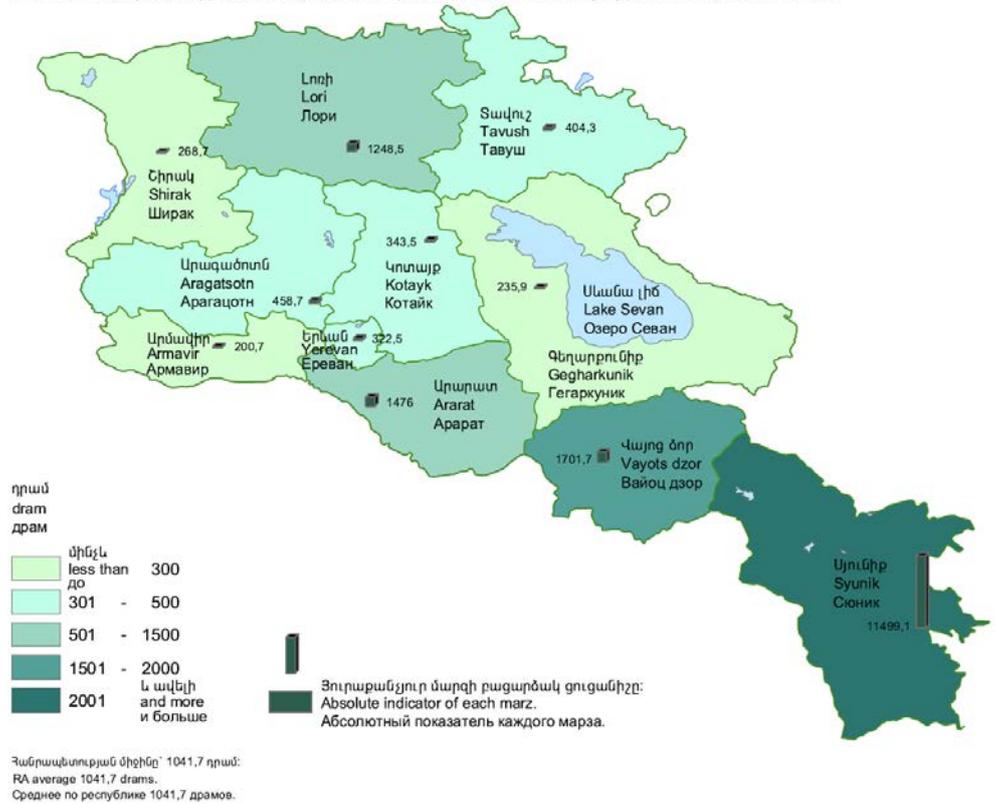


Figure 21 Payments for environmental protection and use of natural resources calculated per capita in Marzes of Armenia

Data on identified violations of environmental protection legislation in Marzes of Armenia are presented on schematic map included in Figure 22.

Բնապահպանության օրենսդրության հայտնաբերված խախտումների քանակը մարզի 100 հազար բնակչի հաշվով, 2009  
 Number of disclosed violations of environmental protection legislation per 100 thousand population of marz, 2009  
 Число выявленных нарушений законодательства охраны окружающей среды на 100 тыс. человек населения марза,

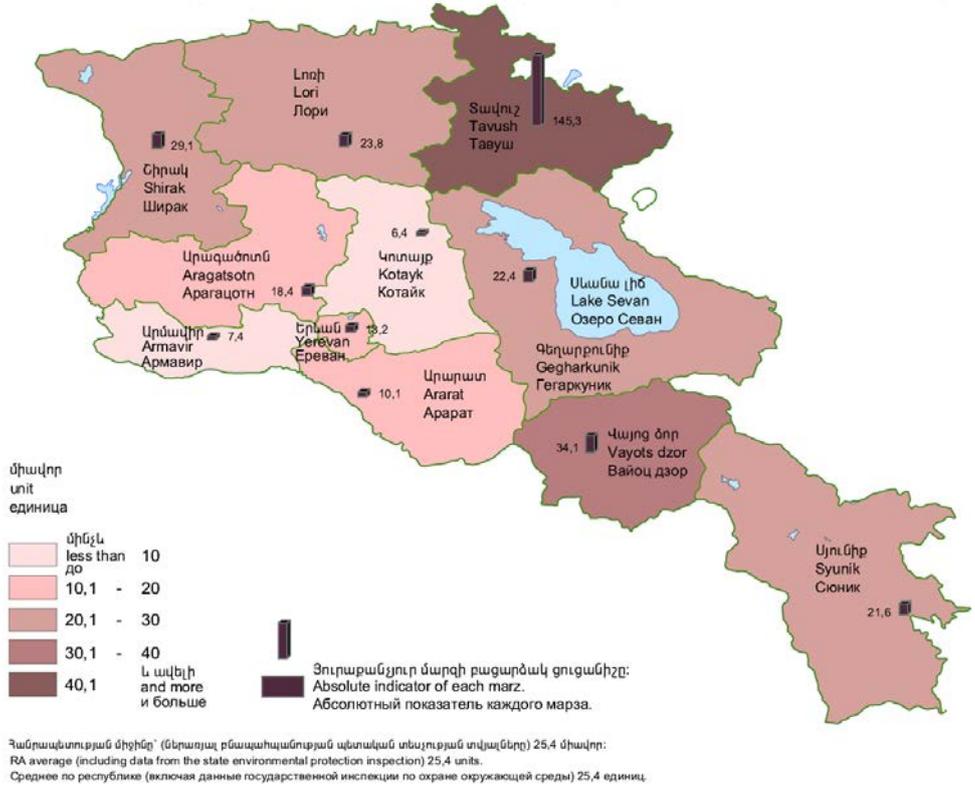


Figure 22 Number of identified violations of environmental protection legislations in Marzes of Armenia (per 100 thousand population of Marz)

There are no available data on soil contamination in Kotayk Region and Sevan town.

5.8.1 Existing Environmental Pressures in Armenia

The rapid growth of some sectors of the economy during the last decade and lack of attention to their impacts have created serious environmental challenges. These developments, combined with problems inherited from the Soviet period, have imposed a strain on the environmental conditions in Armenia. Environmental protection should constitute a key element of Armenia’s developmental strategy if the country is to reach sustainability in its development.

Armenia has ratified many international conventions that address issues such as biodiversity, climate change, desertification, and the preservation of cultural and natural heritage. In addition, Armenia’s Constitution explicitly addresses nature protection, damage to the environment, and the rights of people to lead healthy lives. However, these concepts have been neglected or only implemented selectively, and until recently the voice of Armenia’s civil society was largely ignored. Moreover, lack of independence from the executive branch as well as institutional and human capacity bottlenecks prevent the legal system in Armenia from adequately handling environmental issues. Improving environmental governance requires effective implementation and enforcement of exist-

ing environmental laws, as well as increased transparency and public participation in key policy decisions.

Waste dumping	Dumping and burning of waste is a major source of pollution in Kotayk Region, Sevan city and many other urban and rural areas of Armenia. During the transition period from the centralised to the decentralised provision of housing services, non-payment for services became common. Coupled with insufficient enforcement to collect user fees, the culture of non-payment has limited the volume and reduced the quality of services provided to the population, creating a vicious cycle. Thus, solid waste management has become one of the problem services that chronically suffers from lack of funding and has remained of low quality in Armenia since the early 1990s.
Waste burning	Burning of industrial and household waste which can cause releases of hazardous gases and odour nuisance for residential areas is defined as violation of RA legislation on air protection, but the phenomenon can be observed in many places all over the country.
Deforestation	<p>Deforestation, which had begun on a lesser scale in the Soviet era, has now escalated to an unprecedented level. It continues to be an important environmental issue even though the energy crisis of the 1990s is long over. It is a particularly dire concern for Armenia because only about 7-8 percent of the country is covered with forest (down from 35 percent two centuries ago), and much of this forest is degraded.</p> <p>Overall, the leading drivers of deforestation in Armenia are the use of fire wood because of a lack of alternative fuel supplies, illegal logging, and the export of wood.</p>
Impacts on protected areas	<p>Established nature preserves are not well protected, they are open to environmental and socio-economic impacts. The examples are known of negative impacts on the Khosrov Preserve and the Lake Sevan National Park.</p> <p>Despite the existing regime of protection of Lake Sevan National Park and constraints for economic activities on the shores of the Lake, hundreds of construction permits have been unlawfully issued and illegal buildings constructed without proper reaction from the relevant authorities.</p>
Agriculture contamination	Pesticides left over from the Soviet era, including DDT, are still used in agriculture along with many other products, which are sold with very little or no instruction about how to use them and are applied with little regard for their danger. These pesticides are flushed into the drainage water during the irrigation process and contaminate the receiving rivers and shallow ground water. Stocks of obsolete pesticides present in Armenia pose risks for the environment and public health.
Overgrazing	It poses yet another agriculture-related problem. Increasing numbers of bands of domestic sheep, goats, cattle, and horses are consuming the steppe and mountain grasslands and shrub vegetation in Armenia. Loss of vegetation from riparian watershed areas and the consequent erosion of topsoil could become

one of the most serious problems for Armenian farmers and herders in the decades to come. Such an outcome may also have implications for Armenia's economy, which relies heavily on agriculture.

- Removal of fertile soil** Excavation of fertile soil in Kotayk Region and its transportation to private gardens in Yerevan and other regions of Armenia are known as a phenomenon posing risks of soil erosion and degradation.
- Mining** Mining is considered to be the most profitable sector in Armenia. Unfortunately, environmental restrictions are not enforced for most of the major mining operations, which results in damages to the ecosystem of the surrounding areas. Often corruption originates at the stage of issuance of licenses and acquisition of permits.
- Lack of wastewater treatment** Municipal wastewater treatment facilities are missing in the settlements in Kotayk Marz and in Sevan town. Untreated wastewater discharge and dumping of waste close to or directly into rivers, lakes and irrigation canals are the critical sources of water pollution. Major sources of pollutant emissions into air are the Hrazdan TPP and the Hrazdan Cement Plant. Opening of iron ore mine on the territory of Hrazdan town is expected to have negative impacts on the environmental conditions and has caused the social tensions.
- Weak EIA and monitoring procedures** According to the PFA Environmental Report<sup>1</sup> the Environmental Analysis Department of the Ministry of Nature Protection is currently considered the lead agency for evaluating proposals and providing project approvals. EIAs prepared in Armenia for major projects are often just a formality with minimal information to show that the project under review complies with applicable law. Even poor quality EIAs not covering all the issues of concern for Projects stamped with endorsement from the highest levels of the government receive approval from various agencies with no major comments or objections. The enforcement of EIA procedures, monitoring plans and regulations are essential to improvement of the EIA process in Armenia.
- The improvement of the EIA process necessarily requires competent environmental specialists trained in the field of environment.
- Regulatory structure is another serious issue in the evaluation of possible environmental impacts and the enforcement of the implementation of mitigation measures. Currently, there are no clear guidelines about the process of evaluating and enforcing the required mitigation measures. The adequacy of environmental inspections is currently one of the major shortcomings in the Ministry of Nature Protection. One of the main issues is pressure from influential developers, who corrupt the inspection process.
- Climate change** According to forecast presented in a study completed by the Stockholm Environment Institute a decreased availability of water can be expected in Armenia under a business as usual scenario for climate projections developed by

<sup>1</sup> ([http://www.pf-armenia.org/fileadmin/pfa\\_uploads/PFA\\_Environmental\\_Report.pdf](http://www.pf-armenia.org/fileadmin/pfa_uploads/PFA_Environmental_Report.pdf))

the Intergovernmental Panel on Climate Change. Under this scenario (which is likely unless there is a global agreement on climate change) worldwide emissions of greenhouse gases will follow the trends of the past 200 years and grow larger over time leading to higher average annual temperatures. The study, which was initiated by the United Nations Development Program and relied on officially reported data, indicates that average annual precipitation is expected to decrease by 10- 27 percent. The biggest reductions are predicted for Yerevan and the Ararat Valley, which can expect 30 percent less precipitation by 2100. Higher temperatures will lead to more evaporation which means less soil moisture and reductions of up to 24 percent in river flows, which will reduce the availability of water for agriculture and power generation.

## GMO

Armenia is a country of rich biodiversity and is a centre of origin for wild ancestors of crops and livestock. There are more than 3,500 high plants, 4,000 fungi, and around 17,500 invertebrate and vertebrate species recorded in the territory of Armenia. Indeed, Armenia falls within one of the five centres of diversity and origin of the world's major food crops described by Vavilov, the creator of the world's largest collections of plant germplasm. Hence, it is critically important for Armenia to strengthen its capacity to pursue biosafety policies based on well balanced decisions on the introduction of biotechnological innovations. The country should be responsible for providing a safe and healthy environment and conserving its genetic diversity for present and future generations. Armenia, as a country in transition, ranks high in vulnerability to the consequences of importation, production, and usage of GMOs due to such factors as dependency on agriculture, high necessity for crop improvements, deficiency in GMO regulating legislation, and imperfect institutional capacity. Officially, GMOs are neither imported nor commercially produced in Armenia. However, according to some experts, NGO representatives, and officials there are apprehensions that many products imported to Armenia contain GM ingredients; in particular, GM soy, which was introduced initially as humanitarian aid and then on a commercial basis. This is partly because the genetic origin of imported seeds, plants, and animals is not registered at national border crossings due to lack of GMO testing laboratory.

### 5.8.2 Environmental pressures in Hrazdan

According to GEO Hrazdan report on assessment of environmental conditions of Hrazdan in 2005-2008 prepared by Armenian NGO Association for Sustainable Human Development with support from UNEP and ENVSEC (Yerevan, 2009), the main environmental pressures in Hrazdan are as follows:

- Air contaminated with dust and other emissions
- Poor condition of water supply networks
- Pollution of the Hrazdan River and the Akhpara water reservoir (located in the city centre) with discharged untreated wastewater

- Waste dumping by individuals and companies, littering
- Decrease of forest areas, removal and export of fertile soil
- Increasing risks of mudflow, flood, landslides;
- Environmental and health risks posed by open mining activities planned within the forest areas and close to the city centre.

### **5.8.3 Environmental pressures in Sevan municipality**

The following environmental pressures in Sevan municipalities have been identified:

- Illegal felling of trees on the Sevan Peninsula
- Need for removal of trees in coastal areas covered with water due to raising water level in the Lake Sevan (174 ha were cleaned in 2010, cleaning of 283 ha is planned for 2011), particularly in the areas of public beaches.
- Need for compensatory reforestation in the elevated parts of the Lake Sevan coastal zone, where about 3500 ha of forest areas are expected to be cut down during cleaning of beaches.
- Dumping of waste, littering by residents and tourists.

## **5.9 Availability of Solid Waste Management Facilities**

Current status of waste management is presented in a separate Baseline Report prepared by COWI within the Feasibility Study of the Kotayk Solid Waste Management Project. Presence of numerous dumpsites is a typical feature of Kotayk Marz as well as of many other regions in Armenia.

Dumpsite elimination and waste disposal allocation works have been implemented in Yeghvard, Kanakeravan, Kamaris, Jrvej, Dzoraghbyur, Arinj, Akunk, Qasakh, Arzakan, Meghradzor, Hrazdan, Karenis, Bjni communities.

In more than 20 communities, including Byureghavan, Verin Ptghni, Ptghni, Nor Hachn, Nor Geghi, Zovuni allocation of areas for authorized landfills faces serious problems. Several rural communities (e.g. Garni, Bjni, Arzakan) have no waste collection systems.

## **5.10 Baseline conditions of Hrazdan site recommended for establishment of regional landfill**

The Project proposed for improvement of municipal solid waste management system for Kotayk Region and Sevan town with the EBRD financing assumes establishment of regional sanitary landfill.

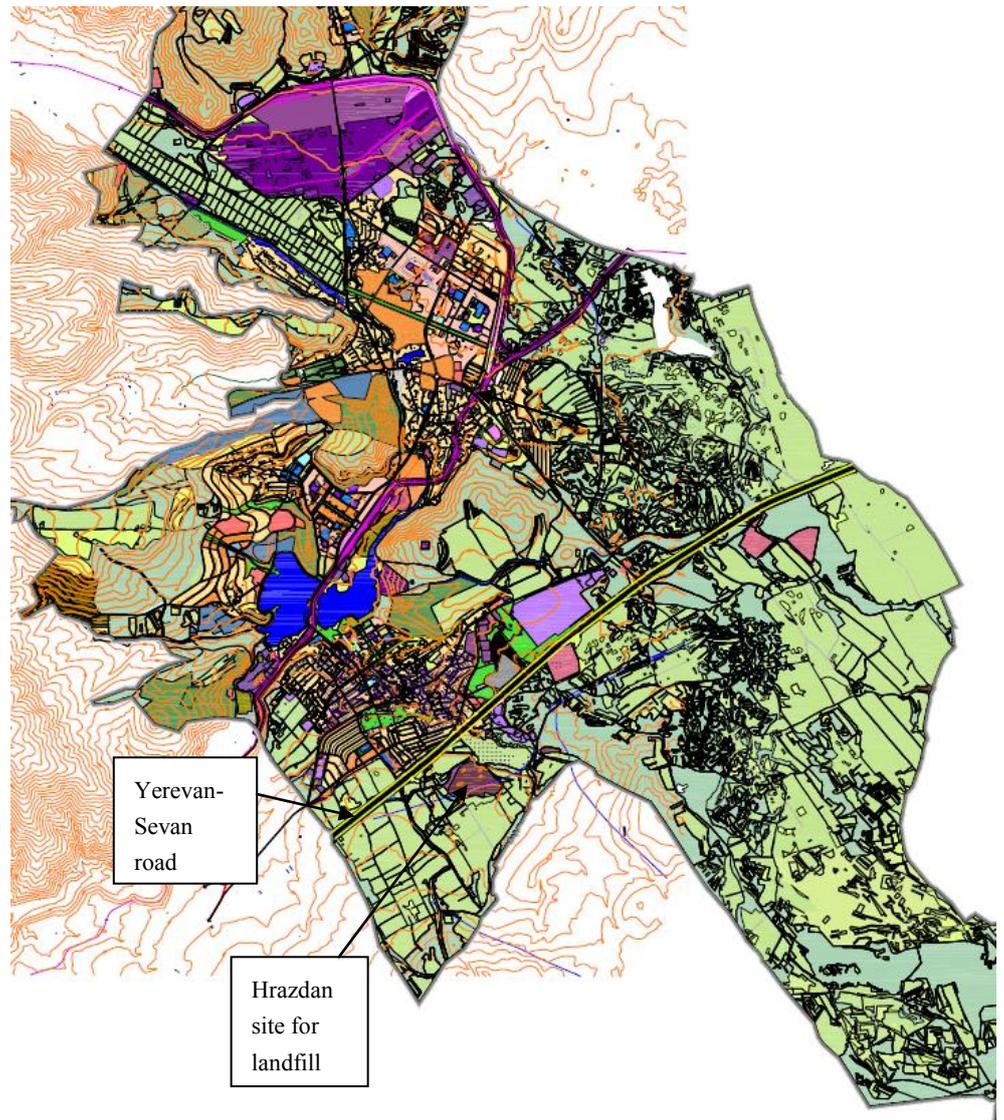
Selection of site suitable for establishment of regional sanitary landfill included the following activities carried out during the Feasibility Study in August 2010 - March 2011:

- Elaboration of landfill site selection criteria, presentation of the criteria to the Armenian counterparts and subconsultants;
- Visits to all the largest existing dumpsites in Kotayk Region;
- Topographic surveys of the existing dumpsites;
- Consultations with the MUD on the Master Plans available for Kotayk Region;
- Consultations with Kotayk Regional Administration regarding criteria for landfill site selection;
- Visits to all sites potentially meeting the site selection criteria available in Kotayk Region identified by Department for Land Use and Real Estate of the Kotayk Regional Administration;
- Screening of the visited sites according to the site selection criteria and detailed assessment of most promising sites;
- Planning and completion of geotechnical and hydrogeological investigations at Hrazdan site and the most promising of all the sites considered;
- Preparation of site selection report and its presentation at a stakeholder meeting in MUD in March 2011.

#### **5.10.1 Location of the site**

The site is located within about 4 km distance to the South-South-East from Hrazdan city centre, at a distance of about 500 m from residential areas and about 400 m from the main road Yerevan-Sevan. The distance between the site and the Hrazdan River and Akhpara water reservoir exceeds 2 km. The distance between the site and the nearest nature protected areas is more than 10 km. The distance between the site and the nearest cultural heritage monuments and recreational areas are more than 10 km.

The site is located just next to the eastern edge of the existing dumpsite of Hrazdan town within a quarry remaining after about 30 years of excavation of clay material for the local cement plant. In the Master Plan developed in 2007 for the Ministry of Urban Development of Armenia the site is defined as suitable for disposal of waste. On a fragment of the Master Plan map included in Figure 23 the site is shown as a triangular-round plot to the south from the main road Yerevan-Sevan (straight line from South-West to North-East) and marked in violet-gray colour with a lighter stripe-like section in the western part corresponding to the existing dumpsite of Hrazdan.



*Figure 23 Master Plan of Hrazdan and area next to the existing dumpsite of Hrazdan city to the south from the main road Yerevan-Sevan*

The visible thickness of excavated material is about 10-20 m. General view of the site is presented in Figure 24.

Most of the excavated material was removed from the area, however some portions of the excavated material remain as small heaps visible on the relatively flat bottom of the quarry area. The site has an access road from the main road Yerevan-Sevan and has a dirt road within the site. The dirt road was constructed over a dam of demolition waste and mixture of various crushed stones and stone blocks.



Figure 24 Hrazdan dumpsite and adjacent abandoned clay borrow area

### 5.10.2 Climate and Hydrology

According to the Construction Reference Book on Climate II-7.01-96 (IV II-05.2-99) the area belongs to the third cold climatic zone with cool summer and severe winter. The annual precipitation is 688 mm. The mean parameters of climate conditions according to the meteorological station of Hrazdan town are presented in Table 5.11.

Table 5.11 Climate characteristics typical for Hrazdan site (climate zone III)

Month	Mean air temperature, °C	Air humidity, %	Wind speed, m/sec
July	+16	45 - 60	3 - 6
January	-5 to -12	70	5 - 7

The annual mean air temperature is +5.2°C. The absolute minimum is -31°C, the absolute maximum is +33°C. The maximum observed thickness of snow cover accumulated within 10 days is 106 cm. The frost zone in soil has the depth of 96 cm.

The atmospheric precipitation on the site is accumulated in 3 closed pools (temporary lakes, playas). One pool is located in the zone of the deepest excavation in the central part of the site. This zone has an established grass and reed

cover. Compared to the other areas of the site this zone looks like a "wetland". The pool area has a soft clay bottom about 10 m in diameter and is surrounded by trees and bushes. The two other pools are water bodies on clay without a grass cover. The smallest pool is located in the western part of the site. The largest is located in the eastern part. Visible animal tracks show that all the three pools are visited by cattle. Water was observed in the three pools during the site visit in August 2010. However, during September 2010 the largest pool located in the eastern part of the site was the only water body on the site. The water table diameter was about 7 m. The water is accumulated in the pools due to low permeability of clayey material in the bottom. A schematic map showing the site landscape and location of the pools (blue colour) is included in Figure 25.

Within about 1 km to the west from the site the access road connecting the site with the main road Yerevan-Sevan crosses the Hrazdan-Solak open irrigation canal in a prefabricated concrete bed. The canal during summer months feeds irrigation systems of Hrazdan, Qaghsi and Solak communities. The flow rate in the canal is reportedly 1,000 litres per second.

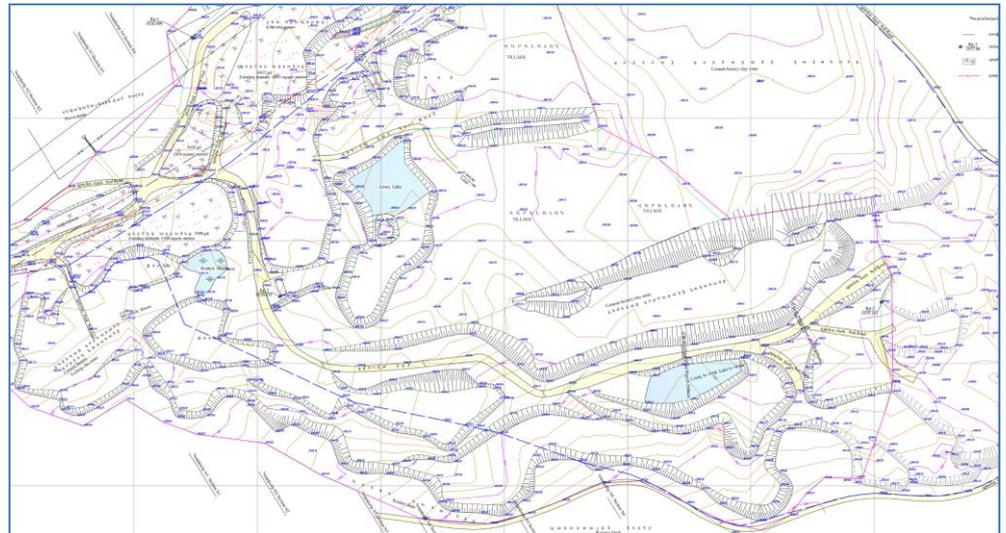


Figure 25 Landscape map and location of water pools in the abandoned clay quarry near Hrazdan dumpsite

An irrigation canal is located at a distance of about 300 m to the west from the site border, between the site and the Yerevan-Sevan highway. The access road to the site is crossing the canal. The canal is constructed as an open gutter made of prefabricated concrete and is used during summer time as an element of irrigation network delivering water from the Lake Sevan to the arable areas.

### 5.10.3 Geology

No information on geological conditions of the site was available from the operator of the clay quarry. Geological and geotechnical conditions of the site were studied in September-October 2010 during the Feasibility Study by observations at existing slopes and excavations remaining on the site after operation

the former clay quarry, soil investigations in 13 points by excavation and drilling (depth 3 to 15 m). The investigations revealed that part of the site is covered with a visible waste dump, but there is also an area of the former dumpsite, where the waste is covered with grass and topsoil and is not visible. It was encountered in excavations made on the site. The layers below the waste include a layer of brown loess-like loam (visible thickness in outcrops is about 15m), a layer of fine pumice stone gravel and sand of granular perlite (visible thickness in outcrops and boreholes is 3-15 m), a layer of eluvial/residual deposits of basalt blocks mixed with sand and loam (visible thickness of about 1.5 m)

#### **5.10.4 Hydrogeology**

The groundwater table was encountered in October 2010 in 3 boreholes drilled to the depths of 12-15m at depths of 5.1m, 7.0 m and 11 m below the terrain. The terrain elevation marks within the site vary from 1819 m in the zone of deepest excavation in the western part of the site to 1860 m at the edge of undisturbed clay plateau along the southern border of the excavation. Major part of the site area has the elevation marks about 1830 m. The groundwater table was encountered at the elevation mark of about 1814 m in a layer of loam containing thin layers of sandy loam. According to the information on regional hydrogeological conditions, no aquifers of interest for water intake are present in the area. No groundwater abstraction facilities have been identified in the area adjacent to the site. Water supply of Hrazdan and other towns is based on intake of water from springs captured in areas not affected by the site. Groundwater is not used for water supply or irrigation in areas adjacent to the site.

#### **5.10.5 Biotopes**

The site is located within the administrative borders of Hrazdan city, which is developing as an agglomerate of urban centre and 7 villages. As a result, there are urban and semi-natural biotopes present within the city territory.

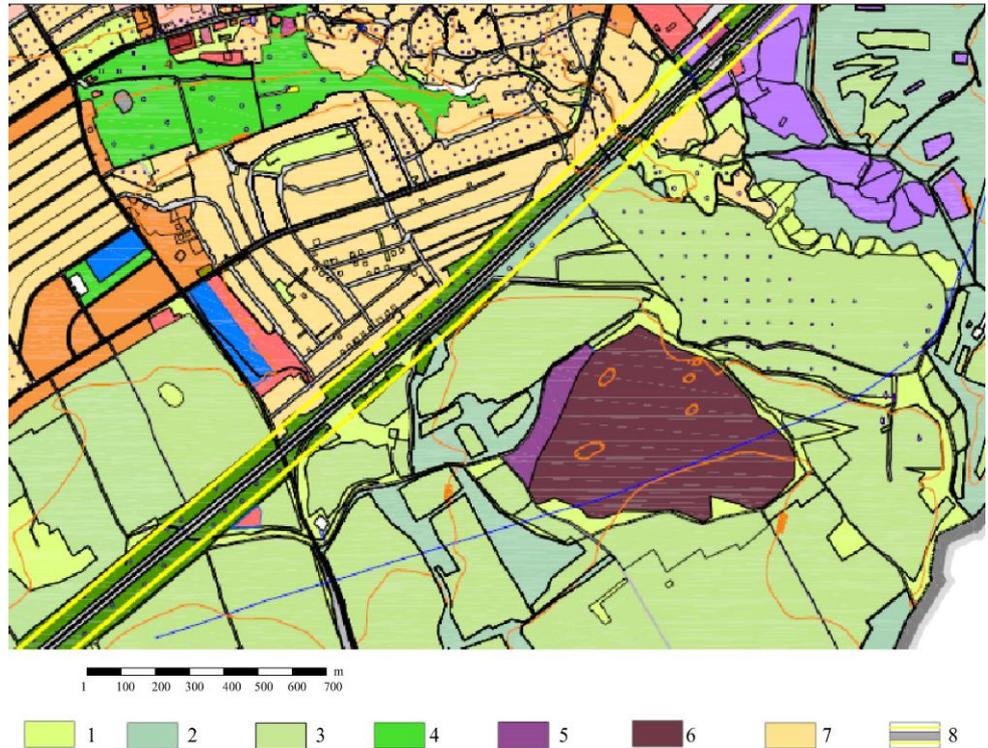
Urban biotopes present in the central part of the city include densely populated residential areas (multi-storey buildings), low-density residential areas (individual houses), industrial areas (including dumpsites), various public institutions, health and educational institutions, parks and playgrounds, cemeteries and road areas.

Semi-natural biotopes in Hrazdan city are typical for arable land, meadows and pastures, plantations of trees, bushes and rural residential areas.

The area along main road Yerevan-Sevan has a semi-natural biotope of green belt. The road and the green belt separate the city territory and in its southern part form a border between the urban biotopes of the city to the west from the road and the semi-natural biotopes on the territory of arable land to the east from the road, around the Hrazdan dumpsite and the bottom of the clay quarry located next to the dumpsite. Major part of the quarry is abandoned for more than 10 years, is partially covered by waste deposited earlier or spread from the

adjacent dumpsite, but it has got a cover of wild grass typical for vacant lands in Armenia.

Land use pattern on the territory adjacent to the recommended landfill site is presented in Figure 26.



*Figure 26 Land use pattern near Hrazdan dumpsite in south-eastern part of Hrazdan city territory (according to Master Plan of Hrazdan):*  
 1- arable land in use; 2 - pastures; 3 - land not in use; 4 -green belt of Yerevan-Sevan motor road; 5 - existing dumpsite of Hrazdan; 6 - former clay quarry of Hrazdan Cement Plant (site recommended for establishment of regional landfill); 7 - residential areas, 8 - border of Hrazdan city

The site location and its area size allow to establish the landfill cells at a distance over 500 m from the nearest residential buildings.

#### **5.10.6 Environmental and social risks**

The site is located close to the area of ongoing excavation of clay for the needs of the cement plant and close to the arable land plots. No groundwater interests have been identified. The surface water interests requiring attention are the water pools within the former clay borrow area and the irrigation canal to the west of the site.

### **5.10.7 Construction requirements**

The site has an access road and seemingly has available a clayey material for the landfill bottom liner and loose soil material for other construction elements of the landfill.

### **5.10.8 Costs**

Landfill construction costs are expected to be relatively low, due to availability of clayey material for liner construction and other soil materials for construction of embankments etc. During operation of the site, there will be sufficient access to soil for waste covering etc., which will also contribute to keeping operation costs relatively low, when compared with other possible sites.

Construction and operation of sanitary landfill at Hrazdan site can be carried out without any disruptions in utility services provided to adjacent residential areas. Detailed assessment of impacts related to connections to engineering infrastructure will be carried out as part of the supplementary environmental and social studies to be completed prior to the start of construction works for the Project.

## **6 Existing Social and Socio-Economic Issues**

This chapter includes a description of existing social and socio-economic issues relevant for Armenia and the Project's area of influence which serve as the baseline for impact assessment during preparation of the ESIA.

### **6.1 Socio-economic context of Armenia**

Armenia, as other UN member states which joined the UN Millennium Declaration in September 2000, express its commitment to achievement of universally recognized Millennium Development Goals (MDGs) by 2015.

The MDG targets and indicators were nationalized to correspond to the country-specific priorities of poverty reduction and human development reflected in the main development policies and strategies of Armenia. The Republic of Armenia Government's Poverty Reduction Strategy (PRSP) was adopted in 2003 and became the first policy document where the achievement of MDGs was formally reflected.

In 2008, a comprehensive strategic program on the country's long-term development - Sustainable Development Program (SDP) - was adopted and the achievement of the MDGs is at the core of this strategic document.

The main trends and the current state of progress towards achieving the MDGs should be assessed taking into consideration the impact of the global economic and financial crisis resulted in the economic downturn registered in Armenia since the fourth quarter of 2008. It is now evident that, due to the crisis and its rather serious impact on the Armenian economy, the country has to adjust the initial estimates towards achievement of nationalized MDGs. An encouraging factor is that it was decided to scale-up the initiative at the national level and include localized MDGs, their targets and indicators in Regional Development Programs (RDPs). Engagement of local and territorial administration bodies in the process of MDG implementation is a key factor in achieving the MDGs at national and local level. The RDP for Kotayk Region is available.

## 6.2 Demography

This section contains information mainly related to Kotayk Region. The information includes information available from Kotayk Regional Administration and summaries of statistical data (available from [www.armstat.am](http://www.armstat.am)) based on the census of 2001. The section could be updated based on the information available from the next census, which is according to RA government decision 301-N, March 26, 2009 is scheduled for 12-21 October, 2011.

### 6.2.1 Information about Sevan

Sevan city started as village Yelenovka was established in 1830 and got the status of city in 1961. Total area is 13.8 km<sup>2</sup>. Population is 26,806 people, including

- Permanent residents - 23,806 (13,429 of them are female)
- Households – 8650
- Recipients of subsidies – 1353
- Children 0-6 years old – 2696
- Pensioners – 2998
- Refugees – 300
- Disabled – 436
- Unemployed – 1880

The city is located 1925 m above sea level and in South-Western part of the Lake Sevan coast on the crossroads of major roads.

The public institutions include 5 kindergartens, 1 music school, 1 art school, 1 sports school, 1 children's creative center, 1 culture house, 1 centralized system of libraries. The educational institutions: 7 secondary schools, 1 college, 1 medical college, 1 handicrafts school.

There used to be about 19 industrial enterprises in Sevan municipality, but at present they do not function. Since 1996 the local administration considers the development of tourism as the most promising prospect for the city.

Environmental issues requiring urgent actions:

- waste management,
- management of coastal zone of the Lake Sevan.

Due to lack of local jobs the capable workforce is daily commuting to Hrazdan and Yerevan or leaves the municipality for jobs in other regions of RA and other countries.

Hotels and catering during summer months provide jobs for 1,200-1,500 people.

According to the mayor office of Sevan there are 5 non-governmental organisations acting in the municipality.

Additional data on vulnerable groups in Sevan city should be collected and presented as part of the supplementary environmental and social studies to be completed prior to the start of construction works for the Project.

### 6.2.2 Kotayk Marz

#### Communities

The total area is 2,089 km<sup>2</sup> includes 7 towns and 60 rural communities. Hrazdan town (52,800 residents) is the administrative centre of the Region.

Main indicators of population natural growth in Armenia and in Kotayk Region are included in Table 6.1.

Table 6.1 *Natural dynamics of population in Armenia and Kotayk Region*

	RA			RA Kotayk		
	2008	2009	2010	2008	2009	2010
Number of population in the beginning of the year, thousand people	3230.1	3238.0	3249.5	277.8	278.8	280.6
Number of births	40105	41185	44413	3778	3702	4108
Number of deaths	26830	27412	27560	2197	2232	2245
Natural growth, person	13275	13773	16853	1581	1470	1863
Number of deaths of children under 1	433	442	454	51	31	43

The indicators of population natural growth per thousand of residents are summarized in Table 6.2.

Table 6.2 *Indicators of population national growth for Kotayk Region per thousand of residents*

Indicators	2005	2006	2007	2008	2009
Births	12.1	12.4	13.6	13.3	14.7
Deaths	7.3	7.5	7.9	8.0	8.0
Natural growth	4.8	4.9	5.7	5.3	6.7

Available statistical data on population migration are presented in Table 6.3.

Table 6.3 Data on population migration in Armenia and in Kotayk Region

	Those who come			Those who leave			Migration balance (+.-)		
	2007	2008	2009	2007	2008	2009	2007	2008	2009
RA	9795	10399	7961	15935	15871	12374	-6140	-5472	-4413
RA Ko-tayk	1328	1308	1254	1338	1245	1228	-10	65	26

The 3 administrative districts of Kotayk Region are as follows:

Hrazdan District (38.2% of population, 3 urban and 14 rural communities), Abovyan District (40.4% of population, 2 urban and 30 rural communities) and Nairi District (21.8% of population, 2 urban and 16 rural communities).

Population of the city of Sevan according to the latest available data is about 22,000. During summer months the population increase for about 200,000 people can be observed due to inflow of tourists from Yerevan and other regions of Armenia and other countries. Many of the tourists overnight at hotels, vacation houses and in private houses, but most of the tourists come to the Lake Sevan coast in the morning and leave the area in the evening.

## Demography

Data on population of Kotayk Region available for the 3 recent years are presented in Table 6.4.

Table 6.4 Population of Kotayk Region (as by 1 January of the year)

	Total		including			
	Number of residents	% of RA total	In the towns	% of RA total	In the villages	% of RA total
2008	27,222	7.0	6,841	5.2	20,381	7.9
2009	27,525	7.0	6,990	5.2	20,535	7.9
2010	27,433	6.8	7,044	5.0	20,389	7.8

Urban population is 55%. About 48.8% of population are men, 51.2% are women. The latest available data on population of 7 cities of Kotayk Marz and of Sevan municipality are included in Table 6.5. The age of about 37% of population is below 18 years, about 43% of population (105,000) are persons 18 to 45 years old, age of about 19% of population is above 45 years.

## Households

There are 56,332 households in Kotayk Region, including 38,900 households in the rural areas. Average household size is 4.2 persons.

*Table 6.5 Population of urban municipalities of Kotayk Region and municipality of Sevan (as per 1 January of the year)*

Municipality	City status year	The distance from Yerevan, km	Resident population, thousand people				
			2006	2007	2008	2009	2010
Abovyan	1963	18	45.0	45.4	45.7	46.0	46.5
Byureghavan	1995	24	8.3	8.3	8.3	8.4	8.5
Eghvard	1995	18	12.0	12.1	12.2	12.2	12.3
Tsaghkadzor	1984	55	1.6	1.6	1.6	1.6	1.6
Nor Hachn	1991	30	10.2	10.2	10.3	10.3	10.3
Hrazdan	1959	50	52.8	52.8	52.9	52.9	53.2
Charentsavan	1983	36	24.6	24.7	24.8	24.8	25.0
Sevan	1961	66	21.6	21.6	21.6	21.7	21.7

## Education

In 2010 the public education system in Kotayk Region included 104 educational institutions, 59 of which are secondary schools, 31 primary schools, 1 special school, 2 prior professional/vocational schools, 11 higher schools. In addition to them there are private educational institutions including 2 education centres, 2 private secondary schools, 6 colleges, and 1 higher school.

The public schools had 1577 classes with 32 589 pupils. There were 3,455 children in the first-year class in 2010, which gave 100 children more than in 2009. The education program is scheduled for 11 years. There are 51 public preschool institutions.

The public educational institutions employ about 3400 teachers, with 86% of them having the higher pedagogical education. About 1100 teachers work in educational institutions located in the mountainous and high mountainous areas.

Pedagogical staff vacancies are replenished on the competitive basis. Presently there are no vacancies for the pedagogical staff at schools.

All the secondary schools in Kotayk Region have computers and Internet connections. Repairs of heating systems and buildings are scheduled in some of the

schools according to the Program of Socio-Economic Development for 2011-2014.

### 6.3 Social Composition

#### Ethnic profile

About 97.6% of population are Armenians. The ethnic minorities are Yezidis, Assyrians, Russians and Kurds.

Ethnic profile of Kotayk Region according to census of 2001 is presented in Table 6.6.

Table 6.6 Ethnic minorities present in Kotayk Region

Nationality	Total	Urban	Rural
Assyrians	865	91	774
Yezidys	3,496	412	3,084
Russians	661	482	179
Kurds	204	85	119
Other	465	321	144

No clan/tribal structure has been identified in Kotayk Region and Sevan municipality during preparation of the ESIA.

#### Residents and tourists

Residents of Kotayk Region and Sevan municipality have close links to Yerevan and are not isolated from population of other regions. During summer months the region, and particularly the Lake Sevan coast, is visited by numerous tourists from all over Armenia. During winter months thousands of tourists visit the ski resorts of Tsaghkadzor.

#### Combination of urban and rural behaviour

Urban and rural life styles are present in all parts of Kotayk Region. Being composed of the urban core and 7 villages the municipality of the Regions administrative centre Hrazdan is remarkable for a unique combination of urban and rural population and the city's large area stretched within about 23 km.

### 6.4 Power Relationships and Governance Issues

Strengthening of democratic structures, in particular of the rule of law and good governance are key priorities for the Armenian government. Continued public administration reform and improved public finance management are among crucial issues in Armenia aiming to improve the institutional capacity, transparency and public accountability of all government structures. They are essential for ensuring the effectiveness of the fight against crime and corruption. Meas-

ures in these fields should be accompanied by further promotion of citizens' rights and citizens' participation in the political, economic and social spheres - leading to stronger participation of citizens in public life and more efficient control of institutional bodies, law enforcement agencies and services, including at local level. This should also involve action to further promote and secure freedom of expression and freedom of the media. A regulatory framework for civil society is another important feature in this context.

According to Anti-Corruption Snapshot<sup>2</sup> Armenia's economy is in transition, with construction and services as the two main engines of its economic growth. The country's annual GDP has grown by an average of 12% for the past several years, providing an attractive market for foreign investors despite a 10% inflation rate and a growing trade deficit. According to the World Economic Forum Global Competitiveness Report 2009-2010, Armenia has already transitioned from an economy described as 'factor-driven' to one driven by efficiency. Over the past several years, Armenia has been implementing an ambitious programme of reforms, improving tax and customs regulations, restructuring the banking sector, and liberalising its economy. However, widespread and systemic corruption in government bureaucracy coupled with inconsistent implementation of laws, weaken state institutions and hinder their efficiency.

Positive developments in relation to corruption and investment include the following:

- Armenia's anti-corruption strategy has led to the exposure of a number of high-ranking officials, who have been dismissed on charges of bribery and corruption.
- Foreign investors in Armenia are given several investment incentives, such as tax holidays and the ability to carry losses forward indefinitely.
- Armenia has initiated a process of enhancing transparency and accountability in governance. In order to reduce bureaucracy and decrease the opportunities for corruption, one-stop shops have been established for companies to deal with public officials, and several governmental internet portals have been launched to make the regulatory processes more transparent.

Risks of corruption are mostly related to the following spheres:

- SMEs primarily encounter two types of corruption in Armenia: high level corruption through the abuse of political authority and administrative corruption exercised through middle and lower-level public officials.
- The selective and non-transparent application of tax, customs and regulatory rules, as well as weak enforcement of court decisions fuel opportunities for corruption to occur.

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<sup>2</sup> <http://www.business-anti-corruption.com/country-profiles/europe-central-asia/armenia/snapshot/>

Armenia makes efforts for improvement of corporate governance and municipal governance.

Governance profile of Hrazdan municipality is remarkable for active participation of civil society involvement in public consultations related to environmental and social aspects of investment projects. The municipality is known as the most advanced in Armenia in terms of public participation and NGO activities for raising environmental awareness and engaging the public in sustainable development initiatives.

Environmental NGOs The NGOs (“Civil Academy”, "For Development of Hrazdan", "Forests for the Future", Hrazdan Branch of "Association of Women with University Education", "Regional NGO", "Children Assistance Fund") operating in Hrazdan town has experience of several environmental projects. For regional administration and municipality workers together with NGO "For Sustainable Human Development" have hold seminars for environmental education and campaigns for awareness-raising. The environmental seminars have been organized in Institute of Humanities in Hrazdan, at colleges, schools, NGO offices. A seminar for teachers was organized in school N13 of Hrazdan. Teachers were given a large number of educational material, posters, brochures, video “Love your planet” for their environmental lessons at schools. The NGOs have carried out town waste removal campaigns, tree plantings and clean-up works of the Lake Hrazdan coast.

Environmental Information (Aarhus) Centre supported by OSCE operates in Hrazdan starting from 2007.

## 6.5 Waste Pickers

Waste pickers in Kotayk Region and Sevan town are known as persons being from time to time or regularly involved in "screening" of mixed household waste in containers at collection points, e.g. looking for food, recyclables or other valuables (the number of them is not know, no seasonal trends have been noticed) and persons involved in collection of some waste fractions at the existing dumpsites (there are 6 men and 1 women at Hrazdan dumpsite reportedly staying overnights close to the dumpsite during summer months, and up to 10 men in total on other existing dumpsites) . According to the interviews and observations carried out during the site visits, the waste pickers do not live at the dumpsites, do not stay there overnight and come there not every day, but on a rather regular basis. They typically also have other sources of income and do not entirely depend on waste picking. No children have been seen picking the waste. Children and their parents expressed their concern about waste visible here and there in many places in the cities and along the roads.

The site visits in Kotayk Region and Sevan municipality revealed that many residents pick up metal waste and use it for construction of fences around their gardens and vegetable plantations.

It has also been noticed during the site visits that not all the dumpsites are visited by the waste pickers. For example, the dumpsite of Yegvard (located in a deep quarry far from the city) seems to be not attractive for the waste pickers. Farmers leaving close to the dumpsite expressed their support to the idea of the dumpsite closure. The dumpsite of Abovyan is also not much visited by waste pickers, probably because of its location on a steep slope and non-stop fires.

Pickers of waste from collection points quite often turn the containers over, take the waste out of the containers, look it through, pick up the items of interest and then just leave the waste spread over the area of collection point, which irritates the general public, and particularly the residents of areas adjacent to collection points and the staff of waste collection companies.

Interviews with some of the waste pickers showed that waste pickers are involved in informal collection and recycling schemes for certain waste fractions. Some of the waste pickers are reportedly looking for food discarded by households, shops and catering companies.

During preparation of the ESIA the Consultant has identified 7 persons participating in waste picking activities at the existing Hrazdan dumpsite. It was not possible to receive information on the earnings and proportion of their livelihood obtained from waste picking. However, it has been found out that the identified 7 waste pickers are residents of Hrazdan and have their households in the municipality.

Identification of waste pickers, consultations with them (regarding possible economic displacement resulting from changes in the waste collection containers and disposal system, closure of existing dumpsites, establishment of regional landfill with restricted access to the waste disposal area) should be carried out by municipalities during preparations for closure of existing dumpsites. Opportunities for alternative livelihoods and need for social assistance should be explored as part of the supplementary environmental and social studies to be completed prior to the start of construction works for the Project, when it might be determined that the development of Livelihood Restoration Framework for the Project is required.

## **6.6 Land Use**

### **6.6.1 Ownership, tenure, squatting and relocation**

Land ownership and tenure including the issues of squatting and relocation are regulated by the RA Land Code. The country faces serious challenges in enforcement of the code and development of the secondary legislation.

Uncontrolled extension of Abovyan dumpsite is an example of infringement of land legislation, in fact squatting.

Establishment of landfill Hrazdan is planned on public land owned by the community of Hrazdan city. The land plot was used by the Hrazdan cement plant as a quarry. The quarry operations will be completed in 2011. No land acquisition is required for the landfill and access road. Land use interests in areas adjacent to the site and access road will be considered as part of the supplementary environmental and social studies to be completed prior to the start of construction works for the Project.

### 6.6.2 Housing demand and supply

According to official statistics the average population density in Armenia is 109 persons/km<sup>2</sup>, and in Kotayk Regions the density is 134 persons/km<sup>2</sup>.

Data on housing areas available per capita in Armenia and Kotayk Region are included in Table 6.7.

Table 6.7 *The total housing area per capita in the communities of Armenia and of Kotayk Region*

	Urban					Rural				
	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
RA	20.7	21.0	21.5	21.6	22.0	27.4	28.3	34.6	34.6	34.9
Kotayk	21.5	20.2	20.8	20.9	21.5	24.8	25.0	24.9	25.7	26.6

### 6.7 Economic Activities (formal and informal sector)

Kotayk Marz has comparatively developed and multi-sector economy. The main branch of economy is industry. Marz has an exclusive role, particularly, in the energy field, as here are two large organizations of electricity production.

In 2009 the share of economy of main branches of Kotayk Marz in total volume of correspondent branches of Armenia comprised 12.2% in industry, 7.2 % in agriculture, 5.6% in construction, 3.4 in retail trade, 2.4 in service sector.

One of the features in marz's economic pattern is presence of manufacture enterprises well established in the following sectors:

- food and beverages production (meat and meat products processing and canning, fruits and vegetables processing and canning, milk products, flour, beverages production),
- non-metal mineral production (glass and glass products, cement, other construction materials),

- metallurgy and metal production ( steel and iron casting),
- furniture industry, production jewellery.

The main branch of agriculture is poultry farming. There are three large battery farms in the territory of the Marz. Yerevan-Hrazdan-Sevan motor-road and Yerevan-Hrazdan-Ijevan railway that are of great importance for the country pass through the central part of the Marz territory. In 2010 there were 66 licences for mineral resources mining activities possessed by 54 companies in 17 communities on the territory of Kotayk Region. Mining activities were carried out according to 33 licences. The rest were preparing the paperwork.

The number of shops and other trade places in Kotayk Region are included in Table 6.8.

*Table 6.8 Number of retail trade units in Kotayk Region*

	Total number of units	Breakdown according to types				
		Shops	Markets of goods other than food	Markets of agricultural products	Kiosks	Other units of trade
2006	1253	353	7	4	844	45
2007	1345	436	7	4	845	53
2008	1448	535	7	3	852	51
2009	1618	711	5	3	848	51

## **6.8 Distribution of Income, Goods and Services**

Officially, services account for 40% of the GDP, industry for 25%, the agricultural sector for 20% and construction for 15%.

Despite good macroeconomic performance and some achievements in fighting poverty within the framework of the PRSP, about 32% of the population of Armenia are reportedly still living below the poverty line. In terms of poverty profile rural and less educated groups remain particularly vulnerable.

Poverty reduction is therefore one of the key goals of the Armenian government. Assistance of many international organisations focuses on support in further reducing poverty levels and social inequality. They contribute to and assist in further reforms and upgrades of the education system, including through exchange programmes, with a view to convergence with EU standards and prac-

tices. An improved educational system will also be essential to strengthen democratic development, social stability and economic competitiveness.

Armenia has 522 835 pensioners with average pension of 24 500 AMD. By the end of 2009, there were 123 293 families receiving the subsidies of 23 560 AMD per family per month on average.

Many socio-economic indicators available for Armenia in general are relevant for Kotayk Region.

Data on increase of consumer price index in Kotayk Region are included in Table 6.9.

*Table 6.9 Average monthly increase of consumer price index in Kotayk Region (from December to December)*

Year	Average increase of consumer prices index per month
2005	99.95
2006	100.4
2007	100.4
2008	100.3
2009	100.4

According to the official statistics, the dynamics of consumer prices in Kotayk Region in 2005-2009 followed the general trend in changes of consumer prices in Armenia. Statistical data show that average prices for main food items in Armenia and Kotayk are quite similar.

According to the survey conducted by the Armenian National Health Information Analytic Center ([www.niharm.am](http://www.niharm.am)) in 2010, the per capita income in families of 68% of the interviewed persons was below 30,000 AMD (83.5 USD), which is minimal salary level in Armenia. Official assessment of prices in Armenia in 2010 was 28,064 AMD (77 USD) for a minimum set of consumer goods and 37,000 AMD (103 USD) for the minimum set of goods and services. This means that the average estimated monthly per capita income of 28,038 AMD (78 USD) for the survey participants was 24.2% below the minimum. Families with per capita income of 76,500 AMD (211 USD) the respondents defined as reach. Families of only 8% of the respondents reportedly had per capita monthly income of 100,000 AMD and above.

About 92% of the respondents stated that expenses related to medical care for their families are about 30,000 AMD per month. According to the survey as-

assessments, about 68 % of population could hardly allocate money for medicine and medical care. The medical care services were reportedly used 3 and more times a year by 16% of respondents, 2 times a year by 24% of respondents, once a year by 48% of respondents, and 12% of respondents did not use medical care, even when there was a need for it. No data are available on affordability of medical services in Kotayk region, but it can be assumed that the situation is not much different from the findings of the above survey.

The income of Armenian families and their access to goods and services during the recent years are affected by the dramatic inflation. The economic assessments for 2010 show that an average family in Armenia spends 70-80% of its income for food, while in the EU countries the families spent only up to 15% even during the financial crisis. Increase of food prices in Armenia has significant social impact. According to the National Statistical Service (NSS) of Armenia, the food prices in January 2011 were 17,1% higher than in January 2010. And the general inflation rate was 10,6%. According the NSS, the average inflation in 27 EU countries from December 2009 to December 2010 was 2.6% with the highest rate being observed in Romania at the level of 7.9%.

## Employment

The unemployment level is high and estimated to be at the level of 24-25% of the active population. 7964 persons (about 7.8% of active population) are in 2010 registered as unemployed with the official employment centres. Many industries went bankrupts, agriculture is not profitable. Many residents of Kotayk region are commuting to and from work places in Yerevan. Data on workforce available in Kotayk Region are included in Table 6.10.

*Table 6.10 Workforce available in Kotayk Region (in thousand people)*

Year	Total population	Economically active population			Economically not active population
		Total	Occupied	Unemployed	
2006	168.6	83.1	78.4	4.7	85.5
2007	172.7	81.7	76.3	5.3	91.0
2008	175.0	82.6	76.2	6.4	92.4
2009	177.8	83.4	75.8	7.6	94.4

Employment data with breakdown according to spheres of economy are presented in Table 6.11

*Table 6.11 Number of middle aged residents of Kotayk occupied in various spheres of economy, thousand people*

	Total	Industry	Agriculture, hunting and forest economy	Construction	Services
2007	76.3	20.2	31.6	1.5	23.0
2008	76.2	16.0	28.0	8.6	23.7
2009	75.8	14.7	27.6	7.6	25.8

Information about residents of Kotayk Region looking for job are included in Table 6.12.

Table 6.12 Job offer in Kotayk Region

	Number of residents looking for job		among them unemployed			
	Total, thousand people	Compared with previous year, %	Total, thousand people	women	compared with previous year, %	
					total	women
2007	6.4	116.4	5.7	4.3	121.3	119.4
2008	7.2	112.5	6.5	4.9	114.0	114.0
2009	8.8	122.2	7.9	5.5	121.5	112.2

**Workforce migration** Many men from Kotayk Region and other regions of Armenia work abroad during most months of a year. Unprecedented migration patterns in Armenia in the past two decades have affected the country's public life and development.

An estimated 700,000-1,300,000 people have emigrated from Armenia since 1991. Migration has been driven by socio-economic causes, with little attention paid to its overall effect on Armenia's development. Emigration from Armenia over the last 20 years has included a significant number of highly-trained professionals, thus draining the country's social and cultural capital.

Migrants left the country for a variety of reasons including, lack of jobs, obstacles to doing business and insufficient opportunities for the future. More positively, Armenia did benefit from an inflow of income by those who had moved abroad, known as remittances, boosting living standards, education rates and health care in some parts of Armenia. But the recent global financial crisis has offset some of those gains and Armenians working abroad have seen a decline

in the amount of income they can send home. This uneven approach necessitates more comprehensive planning, policies and regulation

#### Immigrant workers

About 300 of Chinese migrant workers are located in Hrazdan. More immigrant workers are expected, if the open mining of iron ore is started.

### 6.8.1 Services

Services available or population of Kotay Region and Sevan municipality include power supply, water supply, wastewater collection, waste collection, other housing services, irrigation, telecommunication, medical care, etc. Not all population is covered by the services. Public transport services (minibus) are provided by individuals or private companies. The most active service improvements and the highest customer satisfaction and demand growth during the last years are observed for services provided by mobile telephone operators and private minibuses, where the revenue collection is arranged in a way not allowing access to services without the timely payment. Collection rates of tariffs for the waste collection services are reportedly about 50%.

## 6.9 Population Health Profile

Health profile of Armenia is available on WHO website. The health profile in brief is presented below.

**Demographic situation:** The general mortality rate per 1000 increased from 5.7 in 1986 to 8.2 in 2005, and the natural growth rate of the population declined from 18.3 to 3.5 per 1000.

**Main causes of mortality:** Eighty-three per cent of deaths in Armenia are attributed to non-communicable diseases followed by external causes (3%), communicable diseases (1%), and ill-defined conditions (4%). The leading causes of premature death (under 65) in Armenia are, in order of magnitude, diseases of the circulatory system, cancer, external injuries and poisoning.

**Maternal and child health has improved in recent years:** Although there is a discrepancy between the nationally-reported data, WHO estimated data, and data from various surveys, all sources testify to the declining trend in infant, child, and maternal mortality. In spite of positive immunization results (e.g. achievement of the status of a polio-free region), the coverage rate of fully-immunized children, valid by recommended age, dropped to 42.3% in 2006 despite adequate vaccine supplies.

**Lifestyle-associated health problems:** Tobacco consumption is rising rapidly, varying between 64.2% and 69.4% among men in the 24–65 years age group. The prevalence of smoking among women is also on the rise, comprising 2.2%. Alcohol is not a big problem in Armenia so far; however, it is becoming more popular among those in the youngest age group (16–24). Unhealthy diet, obesity and low physical activity are common.

**Tuberculosis (TB) has become an important public health problem**

with an estimated total incidence of 77 new TB cases and 35 new pulmonary smear-positive TB cases per 100 000. The prevalence of multi-drug-resistant TB is estimated to be 12% and 57% in new and previously-treated patients respectively. The DOTS (Directly Observed Treatment, short course) is currently being implemented nationwide, including the penitentiary system. However, not all TB patients are properly registered and the case detection and treatment success rates are low. The prevalence of HIV/AIDS in the adult population was about 0.1% in 2005.

**Sixty-one percent of health funding is paid out of pocket at the point of service:**

This imposes a large barrier to health care access and a financial risk for many Armenians. Apart from foreign sources, the general tax revenue is the only pre-paid source of health funding. However, the large share of unofficial out-of-pocket payments (OOPs) and the low priority given to health by the Government limit the available public resources (1.64% of GDP, 2006)<sup>i</sup>. The Ministry of Health manages the health budget and the State Health Agency is responsible for purchasing a defined Basic Benefits Package (BBP) for the population. In 2006, there was a 21% increase in the Government budget for the health sector, most of which was spent on primary health care. BBP covers not only primary care but also inpatient services for certain socially vulnerable groups and treatment of certain diseases and medical conditions for the whole population (TB, oncology, urgent care, etc).

- The Government has committed itself to continuing the health reform with emphasis on prevention, family care and community participation, and on reducing problems of financial protection and the barriers to health care access associated with this high share of OOPs.
- In the last decade, Armenia has experienced strong economic growth and reduced poverty rates with potential positive effects on health and equity. Poor use is made of the health information system for decision-making
- The BBP is not based on real costs of health care services and thus contributes to unofficial payments.
- The essential drug list is not in active use. There is a wide practice of prescribing expensive brands that a large part of the population cannot afford.
- There is a lack of modern technology and equipment.
- TB and HIV services are too vertical and not well integrated in the overall health system
- There are skill imbalances, mal-distribution of health professionals, lack of incentives to attract health workers to remote rural areas and lack of infrastructures for continuous professional development.

Annual health data reports for Kotayk Region are available in Armenian on website of Armenian Committee for Statistics [www.armstat.am](http://www.armstat.am).

Health profile data for Sevan town were not available by time of this report preparation and require collection of additional information.

#### Health care in Kotayk Region

The healthcare institutions are operated by 40 companies, 35 of which have 100% of shares owned by the state including 4 medical centers (Hrazdan, Abovyan, Charentsavan, Nairi), 1 maternity clinic (Abovyan), 1 town clinic (Nor Hachn), 1 regional Blood Bank (Hrazdan), 2 health centers (Garni, Argel), 26 primary health institutions. Shares of 5 companies belong to communities.

The healthcare system includes 250 places at hospitals, of which therapeutic 75, surgical 58, infectious 22, obstetric-gynecological 95.

The number of staff employed in the healthcare system is about 1800, among them 420 doctors.

During 2010 there were 3131 children born in the maternity clinics of the Region, which is 14% of the total number of children born in Armenia. No cases of maternity mortality was recorded.

An overview of the population health profile is not available due to the limited access of population to the health care and medical services, which are the paid services in Armenia.

### 6.10 Gender Issues

#### Gender equality

The Armenian culture assumes great respect to women, to motherhood, education skills and wisdom of women. Admirable roles were historically played by women in battles, in religion, literature, art, establishment of hospitals, water supply systems and construction of bridges. Women charity foundations operated in Armenia since the 19th century. Armenian women got the right to vote during elections according to the Constitution of 1918-1920. During the Soviet Union time women in Armenia were among the political leaders and governmental officials at the national, regional and local administrative levels. Number of women corresponds to 52.8% of Armenian population; however, 60% of all residents with higher education are women.

Number of women among in top management of various sectors in Kotayk Region is presented in Table 6.13.

Table 6.13 Women among top managers in Kotayk Region

Position in organisation	Total number	Women
School directors	107	75
Directors of health care institutions	40	24
Judges	9	2
Bank managers	5	2
Governor's staff departments heads	7	2
Governor's staff divisions chiefs	12	3
Mayors of urban communities	7	0
Mayors of rural communities	60	1
Town Council Members	54	27
Staff Secretaries of Communities	67	34
Servants of rural communities	322	148
Servants of municipalities	269	100

Gender aspects of the labour market in Armenia at present include the high level of female unemployment and low mobility of female workforce. This can be explained by the fact that many men from Armenia (reportedly up to 50% of men from rural areas) travel for jobs outside Armenia, mainly in construction and other industries, while women take care of the households.

Based on experience of public consultations in Armenia the local consulting company JINJ Ltd (on ADB, WB and EBRD funded water supply and sanitation improvement projects in various regions of Armenia, including Kotayk), and NGO Civil Academy (during discussions and actions related to industrial development projects in Hrazdan) have noticed that women are typically active in putting questions about the future development, but are not so active during the decision-making. However, in many families, where men are working abroad, women get used to make all the day-to-day household management decisions. This should be addressed during the public consultation and communication of information on improvements in the waste collection and disposal routines. Women should also be provided opportunities of employment in the reorganised waste management sector. Equal employment and remuneration

opportunities will be provided for men and women with the Landfill Management Company during implementation of the proposed Project.

#### Waste management habits

The Armenian tradition is to keep clean the own household area, but not necessarily the public/common areas. Women are typically active in motivating the children and other family members for introduction of better hygienic habits and highly appreciate any improvements in municipal services, including waste management, and that is why they are particularly interested in having containers for waste collection close to their homes and emptied regularly. No difference in attitude of men and women to the present level of waste collection services and to selection of disposal opportunities was identified during the ESIA preparation. Women showed more active interest to planning and organisation of the waste collection and pointed out that the proposed closure of chutes in multi-storey residential buildings will have pros and cons. Men were mostly concerned about arrangements (enforcement, incentives, practical control measures) for delivery of all waste to the regional landfill and closure of existing dumpsites. Men were particularly concerned about the discipline of drivers taking waste by trucks to the landfill, so that they are not dumping the waste before reaching the landfill.

### 6.11 Vulnerable groups

Project preparation, construction and operation phases require special attention to vulnerable groups in Kotayk Region and Sevan town.

**Vulnerable groups** are households and/or individuals that will suffer **disproportionately** more, economically and socially, from project activities. These groups can include: (i) female-headed households; (ii) informal settlers, displaced people; (iii) disabled household heads and/or providers; (iv) households below the RA poverty line; and (iv) aged-heads of households with no household member in the active labour force. It may also include people who work in the informal economy such as waste pickers.

The list of categories can be grouped into different types of vulnerability like in the following checklist of the EBRD:

Categories	Key features/Indicators
<b>Group A</b> <ul style="list-style-type: none"> <li>• Elderly</li> <li>• Youth</li> <li>• Physically Handicapped</li> <li>• Mentally Handicapped</li> <li>• HIV/AIDS</li> <li>• Other debilitating illnesses</li> </ul>	Human physical characteristics related
<b>Group B</b> <ul style="list-style-type: none"> <li>• Informal settlers</li> <li>• Common property land users</li> <li>• Nomadic/transhumant communities</li> <li>• Artesian fisher folk</li> </ul>	Economic and occupation

Categories	Key features/Indicators
<ul style="list-style-type: none"> <li>• Artesian miners</li> <li>• People below the poverty line</li> <li>• Sex Workers</li> </ul>	
<b>Group C</b> <ul style="list-style-type: none"> <li>• Refugees</li> <li>• Internally displaced people</li> <li>• Recent entrants into a community</li> <li>• Irregular migrants</li> </ul>	Migratory
<b>Group D</b> <ul style="list-style-type: none"> <li>• Indigenous peoples</li> <li>• Ethnic group</li> <li>• Caste or Religion based</li> </ul>	Social group related
<b>Group E</b> <ul style="list-style-type: none"> <li>• Women</li> </ul>	Gender
<b>Group F</b> <ul style="list-style-type: none"> <li>• Geographically remote locations</li> <li>• Areas prone to natural disasters</li> <li>• Politically unstable areas</li> <li>• Locations with limited infrastructure</li> </ul>	Location/area

Statistical data on vulnerable groups of population available for Armenia and for Kotayk Marz are presented in the following 5 tables (Table 6.14 to Table 6.18).

Table 6.14 Number of pensioners in Armenia and in Kotayk Region

	Number of pensioners							
	2006		2007		2008		2009	
	total	per 1000 people	total	per 1000 people	total	per 1000 people	total	per 1000 people
RA	527496	163.8	522662	162.0	523839	162.0	522835	161.2
Koyatk	39538	143.5	39041	140.9	38941	139.8	39036	139.5

Table 6.15 Number of pensioners in Armenia and in Kotayk Region and average size of pensions

	Total number of pensioners	Breakdown of the total number				Number of pensioners per 1000 residents	Average pension, AMD/month
		insurance	social	military	Receiving second pension		
RA, 2008	523,839	469747	48632	10425	4965	162.0	21370.0
Kotayk, 2009	38,941	34754	3751	841	405	139.8	20053.7
RA, 2009	522,835	467555	50470	9176	4366	161.2	24520
Kotayk, 2009	39,036	34677	3982	734	357	139.5	23079

Table 6.16 Number of families receiving subsidies in Armenia and in Kotayk Region

	Number of subsidised families			
	2006	2007	2008	2009
RA	139670	136917	129414	123293
RA Kotayk	9573	9889	10267	10215

Table 6.17 Registered disabled persons in Armenia and in Kotayk Region by the end of 2009

	Number of disabled persons		Groups of disability							
			I		II		III		Disabled children	
	total	women	total	women	total	women	total	women	total	girls
RA	179,257	80,169	14,839	5,987	96,178	41,711	59,882	29,890	8,358	2,581
Kotayk	11,177	4,840	671	265	5,292	2,146	4,568	2,242	646	187

Table 6.18 Residents of Kotayk Region affected by industrial accidents

	Persons injured during industrial accidents		Number of deaths of workplace accidents	
	total	women	total	women
2006	6	1	-	-
2007	7	-	-	-
2008	4	-	1	-
2009	5	2	1	-

Detailed mapping of vulnerable groups during the ESIA was carried out based on data available from the Armenian Statistical Service, the social department of Kotayk Regional Administration, mayors of cities and NGOs including Sevan municipality. The collected information was reviewed from the viewpoint of provided services and tariff levels during development of the business plan for the regional waste management company, during comparison of Project alternatives and waste collection technology in specific residential areas.

Collecting both quantitative data and qualitative data allows for an understanding of the socio-economic characteristics of the vulnerable categories represented in the area of influence and their relationship with the rest of the community.

The vulnerable groups identified in Kotayk Region during preparation of the ESIA include the following persons:

- 11,514 disabled persons including about 700 persons with limited mobility;
- elderly people with own households (the number is to be clarified, however the elderly people in Armenia typically live in households including two or three generations);
- 11,800 refugees displaced from Azerbaijan and provided housing in 6 towns and 2 villages;
- about 50-60 persons picking up some fractions of waste (e.g. food waste) at collection points;
- 7 waste pickers (including 1 women) collecting various components of waste at the Hrazdan dumpsite - they live in their houses in Hrazdan city, but spend most of the daytime at the dumpsite, particularly during summer months;

- owners of arable land plots adjacent to Hrazdan landfill area and access road, to existing dumpsites (the number to be clarified);

- owners of cattle grazing next to Hrazdan dumpsite and drinking from water pools within the area of former clay quarry (the number to be clarified).

The impacts of the proposed Project on all households and particularly on low-income families will be related to increase of tariffs. The impact on elderly and disabled people will be related to changes in waste collection system (e.g. in case of closure of chutes in multi-storey buildings). Construction of landfill and its operation could result in certain impact on arable land plots adjacent to the landfill site and possible loss of their value.

No negative impact is expected for health care and education institutions.

The proposed Project includes the ordinary waste collection system with collection points placed in optimal locations and equipped with sufficient number of convenient containers for mixed waste and clearly marked containers for collection of recyclable materials, so that the waste collection services could address specific waste management habits and demand of the following population groups:

- about 300 Chinese migrant workers of Hrazdan TPP Block 5 (the number is expected to increase in 2012-2013),

- about 25-35,000 tourists staying in Kotayk Region (the assessment is for daily average number in summer months),

- about 200,000 tourists staying in Sevan town and adjacent areas (the assessment made by Mayor office of Sevan town is for daily average during weekends in summer months),

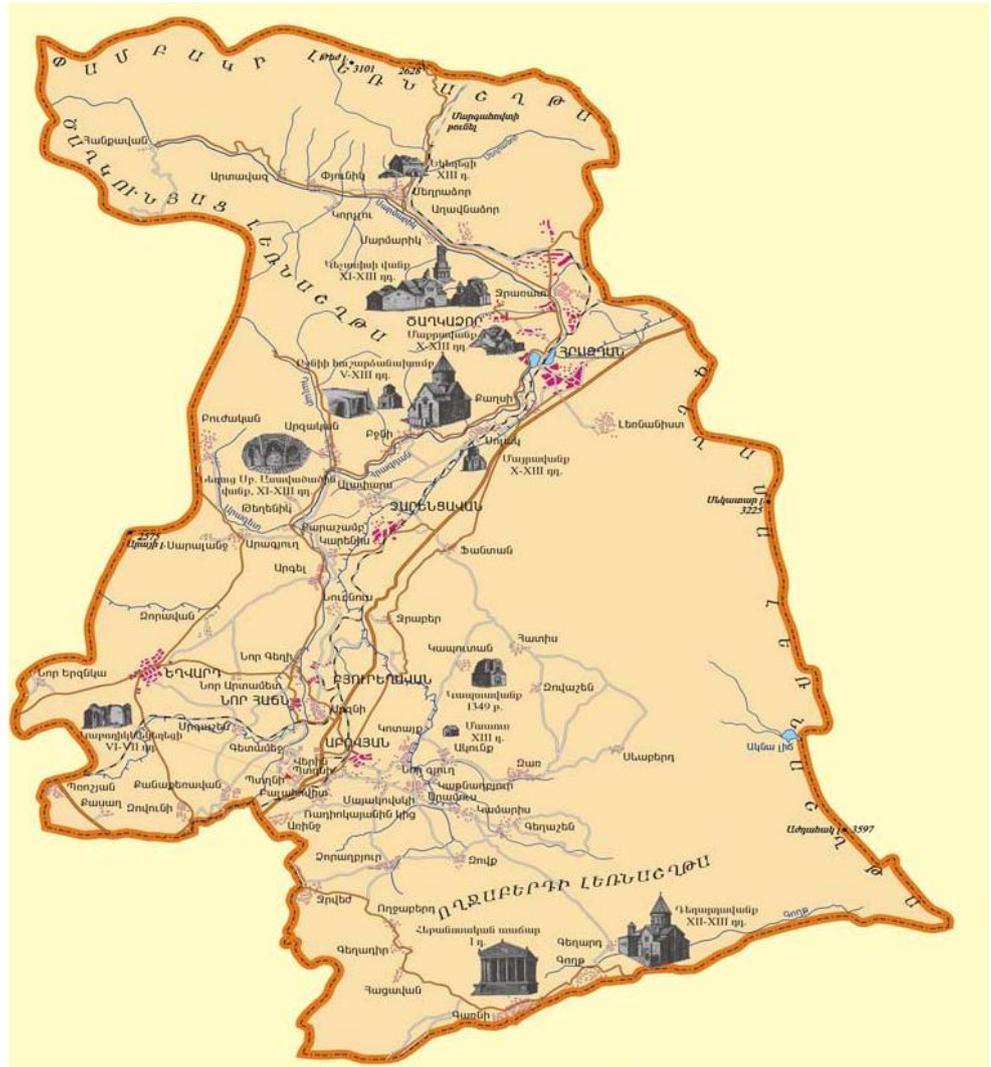
- cattle owners living in relatively urban areas of towns and villages, e.g. in former villages now included in Hrazdan town, having a demand for disposal of manure.

The regional landfill company and municipal waste collection companies should be attentive to the comments/grievances and daily practices of the above mentioned and other groups to achieve the improvement of waste collection services and its appreciation by the customers.

The proposed Project should address the respective roles and attitudes of men and women with respect to solid waste management, especially as it is women who often have the responsibility for waste management at the household level in Armenia, and it is men who predominate as the waste pickers. The attitudes and preferences of women and men should be studied prior to start of any construction works for the Project.. The public consultation procedure within ESIA will provide equal opportunities for participation of men and women in discussions related to the Project proposal and equal opportunities for benefits.

### 6.12 Cultural Heritage

Currently, more than 3200 historic-cultural treasures and monuments are registered in Kotayk Marz, including Garni temple, Geghard, Kecharis, basilicas and beautiful Christian temples of the late period in Vokhjaberd, Eghvard, Aramus, Ptghni, Tsakhkadzor, Bjni, Meghradzor, etc. Many tombs, fortresses, Cyclop fortresses and habitations found there suggest that Kotayk was densely inhabited already in the 3rd-2nd millennia B.C.



Hrazdan is the region's most developed industrial centre, yet is nevertheless rich with archaeological and medieval monuments. Northwest of Hrazdan, perched on a mountainside of the Pambak range, the Kecharis monastery (11-13 cc.) can be admired. This pearl of Armenian architecture was a renowned religious and educational centre and underwent development in the 11th century under the supervision of Grigor Magistros Pahlavouni, the famous Armenian politician, military commander, diplomat and scientist. He founded the Monastery of Kecharis, built the churches of St. Grigor the Illuminator and of Surb Nishan.

The village of Garni is situated on the edge of the Azat canyon 35 km south of Yerevan. Although the village is most well known for the 3rd century BC temple of the same name, the area is rich in Christian monuments as well, including numerous cross-stones, tombstones, and the frescoed churches of Sourp Astvatsatsin or Mashtots Hairapet, Saint Sargis (17c.). Of architectural significance is the 10th-12th century bridge spanning the Azat river, connecting the Armenian highland with the Ararat valley.

Nearby Geghard may very well be the most astonishing architectural wonder in Armenia. Hewn from the solid rock of a mountainside one can freely walk into a large church dating back nearly 9 centuries. The name Geghard dates back to Biblical times, and is named after the legendary lance said to be the one used to pierce the body of Christ. The lance itself was long kept at the church prior to it being moved to the museum of the Cathedral at Echmiadzin.

South of the town of Abovyan along the Hrazdan River lies the town of Yeghvard, famous for its unique assemblage of 4th century stone-crosses (khachkars), a two-story church-mausoleum dating back to 1301 and a great number of settlements that stretch up to the village of Aragiugh. The Tegheniats Monastery (initial construction in the 6th century) and the churches and fortress of Dovri the Zoravor Monastery (7th century) are further examples of architectural wonders shrouded away in the dense forests of Kotayk.

Kotayk Marz has always been and remains a famous recreation and tourism zone not only in Armenia but all over the CIS region. The famous sites are Hankavan, Tsakhkadzor, Arzakan, Arzni, Buzhakan, and Garni.

## 7 Project implementation phases

### 7.1 Pre-construction phase

Pre-construction phase will include all the necessary preparations for introduction of a new regional collection system for municipal solid waste in Kotayk Region and Sevan municipality and for construction of the regional landfill.

Before the construction of proposed regional sanitary landfill for Kotayk Region and Sevan municipality can be started, the following activities should be carried out during the pre-construction phase of the Project:

- Signing of loan agreement between EBRD and 8 municipalities;
- Establishment of PIU;
- Establishment of Regional Landfill Management Company (Company), employment and training of the staff;
- Procurement of consultancy services for EIA, support to PIU and Company;
- Completion of Environmental Impact Assessment procedure with public consultations according to the Armenian legislation and regulations and meeting the EBRD requirements (including a disclosure period for ESIA of at least 120 days);
- Possible adjustment of design according to recommendations of the ESIA
- Obtaining permits for and completion of design for connections to engineering infrastructure (water supply, power supply, telecommunication networks), obtaining of approvals from the Environmental Expertise and from the Inter-ministerial ("Construction") Expertise;
- Procurement planning and tendering of contractor services for construction works and tendering of supply of waste collection equipment and waste transportation vehicles.
- Establishment of Project monitoring and reporting procedures.

## **7.2 Landfill construction**

Once all necessary approvals have been obtained and a contractor has been hired for the construction of the landfill, construction works can commence. This is expected to happen in the second half of year 2012, as shown in the attached landfill construction time schedule included in Appendix 4. The time schedule shows that within about 20 years of the Project duration a lot of activities are planned for the initial 2 years of the Project, when the first sections of the landfill and all the necessary buildings for normal operation of landfill should be constructed. The constructed landfill is presented as an artist image in Appendix 5.

### **7.2.1 Upgrading of access road**

A new access road from the main road to the landfill will be constructed in order to ensure proper access to the landfill during construction and during the landfill operation.

Upgrading of the existing road to Hrazdan dumpsite will be started with clean-up of areas along the road. The heaps of waste have accumulated due to dumping on both sides of the existing road within most of the road length. The waste will be moved to the existing dumpsite area, which will be later covered with soil and vegetation layer.

A 750 meter long and 7 meter wide paved road between the Yerevan-Sevan main road and the landfill site next to the existing Hrazdan dumpsite will be constructed (by upgrading of existing road) at the early stage of the Project implementation. The access road will follow the routing of existing access road to the existing Hrazdan dumpsite and clay quarry. No land acquisition is required. The land is currently used for the existing road to Hrazdan dumpsite and clay quarry. The land is partially covered by waste dumped along the road. The upgraded road is designed for heavy traffic in two directions. The road will be provided with shoulders and drain ditches along both sides of the road.

### **7.2.2 Fencing and planting of green belt**

Construction activities on the landfill site will be started from construction of a fence along the entire perimeter of the landfill area, for example a 2 meter high steel mesh fence with concrete posts or a fence made of prefabricated concrete plates can be established. An 8 meter wide steel bar gate will be constructed at the main landfill entrance.

20,000 m<sup>2</sup> plantation with trees, bushes and grass will be establish along the entire landfill perimeter in order to limit the visual impact from the landfill to the surroundings.

### **7.2.3 Construction of internal roads**

The internal roads will be constructed for receiving, tipping of waste, construction and filling of landfill cells, etc.

#### 7.2.4 Establishment of reception area

A reception area will be established next to the entrance to the landfill. The building for office, staff-facilities, garage, workshop, an electronic weighbridge for incoming waste, a wheel-washing facility and parking areas for visitors.

The reception area occupies a total area of 15,000 m<sup>2</sup>, of which approximately 4,500 m<sup>2</sup> will be paved with asphalt. Main water and power supply facilities will be situated at the reception area and connected to relevant buildings and installations. Lightening poles will be installed for the paved sections of the reception area. Example of reception area facilities is presented in Figure 27.



Figure 27 Reception area with weighbridge, buildings and leachate pond.

#### 7.2.5 Construction of landfill cells

The total waste disposal area at the landfill is 147,000 m<sup>2</sup> and has a total disposal capacity of 1,600,000 m<sup>3</sup>. This capacity will last for at least a period of 23 years.

For many reasons, the entire waste disposal area shall not be constructed from the beginning. The main reasons are:

- Investments in waste disposal area should only be made when there is a need for additional capacity. Otherwise, the investment will not be cost-effective.
- The elements of a waste disposal cell (liner, leachate collection system etc.) are vulnerable and are likely to be damaged/destroyed, if they are not covered by waste within approximately one year after construction.
- As little as possible of the waste disposal area should be kept open at the same time in order to reduce leachate generation.
- To the extent possible, landfill cells should be filled up and closed before new cells are constructed and taken into operation. This will limit nuisances from the landfill (incl. odours, rodents, birds, escape of windborne

waste etc.). Furthermore, the visual impact from the landfill to the surroundings will be limited this way.

A total of eight disposal cells shall be constructed within the entire lifetime of the landfill. Three cells will be constructed initially, however only one will be used for waste disposal at the time.

First, the land surface will be prepared with the correct shape and slope in order to ensure an even surface with a well defined surface water runoff direction towards collection wells to be located at the deepest points.

The bottom and the inner slopes of the disposal cell will be provided with a minimum 1.0 meter thick layer of dense clayey material, which will be well compacted in order to provide a nearly watertight basis. Most of the clayey material will already be available at the Hrazdan site-this is one of the reasons why it has been selected for the regional landfill. In case the available clay is of too poor quality it will be replaced by clayey material from the surrounding areas (from within the total 20 ha landfill area).

The next step will mean that directly on top of the levelled and compacted clay surface, a 1.5 mm thick HDPE liner (High Density PolyEthylene) will be installed. The combination of the underlying clay liner and the upper HDPE-liner ensures a very tight bottom at the disposal cell and thereby minimizes the risk of leachate escaping to the surrounding environment.

Photo in Figure 28 shows example of clay layer construction and installation of HDPE liner for bottom of a landfill cell.



*Figure 28 Construction of clay liner and installation of HDPE-liner*

A geotextile will be installed on top of the HDPE-liner in order to protect it. Hereafter, a 0.5 meter thick layer of drainage gravel (see Figure 29) will be installed all over the bottom and inner slopes of the waste disposal cell.



*Figure 29 Installation of drainage layer on top of the HDPE-liner*

Leachate collection drains will be installed in the drainage layer and connected to leachate wells at the lowest part of the disposal cell (see Figure 30). From here, leachate will be taken by gravity through pipes to a leachate collection pond located next to the waste disposal area.



*Figure 30 Construction of waste disposal cell, with bottom clay layer, HDPE liner on bottom and slopes, and a leachate collection well at the lowest point of a landfill cell*

### **7.2.6 Construction of other landfill elements**

The waste disposal cells will be surrounded by embankments and by surface water ditches in order to keep the waste inside the disposal cell and to prevent surface water from the surroundings to enter the cell.

An access road will be constructed, passing the embankment and into the waste disposal cell in order to ensure access for trucks with waste and for landfill operation equipment, such as e.g. the waste compactor.

Internal service roads will be constructed along the perimeter of the waste disposal area.

### **7.2.7 Remediation of the existing Hrazdan dumpsite**

The bulk part of the existing Hrazdan dumpsite is located next to the area where the future reception area of the new landfill is going to be constructed. Thus, only a part of the main existing dumpsite is occupying land where the new landfill will be constructed. No information is available on contamination of groundwater at the existing dumpsite. On territory of the former clay quarry adjacent to the dumpsite the groundwater was encountered in low permeable loam layer. The risk of its contamination due to infiltration of leachate on the territory of the dumpsite is considered lower than the impact of surface runoff and spreading of waste from the dumpsite, which is located on a slope of the clay quarry.

Furthermore, significant waste amounts have been dumped all along and on both sides of the existing access road to the dumpsite.

The remediation of the existing dumpsite will take place in two phases:

- Phase 1: Excavation/removal of all waste on both sides of the existing access road and transport of the waste for disposal at the main existing dumpsite area - to the north of the area for construction of the new landfill.
- Phase 2: Excavation/removal of all waste within the area for construction of the new landfill and transport of the waste for disposal at the main existing dumpsite area - to the north of the area for construction of the new landfill.
- Phase 3: Levelling and compaction of the waste at the existing dumpsite area and covering of the waste surface with a one meter thick soil layer. Planting of bushes and grass. Collection of leachate and collection of landfill gas after closure of existing dumpsites are not considered feasible due to decomposition and burning of waste during many years.

Phase 1 must be executed at the early start of landfill construction in order to ensure access to the landfill area and to clear the access road area to allow for construction of a proper access road.

Phase 2 shall be executed in immediate continuation of Phase 1 in order to clear the landfill area and prepare it for landfill construction.

Phase 3 should wait until the landfill construction has been nearly finished, to allow for continued waste dumping at the existing site until the new landfill disposal cell can be taken into use.

### **7.2.8 Establishment of monitoring facilities**

Groundwater monitoring wells will be established both upstream and downstream the landfill for the regular monitoring of the groundwater quality in the area adjacent to the landfill. Hereby, the integrity of the landfill liner and possible spills of leachate can be monitored and mitigation measures taken.

Also surface monitoring points will be established in connection to surface runoff ditches etc., enabling regular monitoring of the surface water quality.

### **7.2.9 Construction of buildings**

The following buildings could be constructed in parallel with establishment of the first landfill cells:

- Administration building
- Garage and workshop
- Building for interim storage of hazardous waste

- Electronic weighbridge
- Wheel-washing facility
- Other facilities at the receiving area (a fuel tank and pump for filling land-fill vehicles, fire extinguishers and other protective gear).

Garage and workshop will be sufficient for keeping and maintenance of the following vehicles:

- A heavy landfill compactor for the crushing and placing of waste for final disposal
- An excavator or front-end loader for various maintenance works and for instalment of soil for covering the waste etc.
- A dumper for internal transport of soil etc.
- A tractor with various gear, incl. sweeping device etc.
- A truck with water tank for recirculation of leachate on top of the land.fill disposal cells.
- A fork lift loader for handling of drums and larger items at the receiving area

Example of weighbridge facility is presented in Figure 31.



Figure 31 *Electronic weighbridge for trucks delivering waste to the landfill*

### 7.2.10 Future facilities

In addition to waste disposal cells the landfill construction may in the future include establishment of the following facilities:

- A 20,000 m<sup>2</sup> composting plant for composting of organic waste, in order to prepare compost for the final covering of the landfill area.
- A 10,000 m<sup>2</sup> area for treatment of building and demolition waste.
- A landfill gas collection and flaring or utilization plant.

### **7.3 Establishment of new waste collection and transportation system**

New waste collection and transportation system will be introduced in Kotayk Region and Sevan municipality. It would be advisable to plan a gradual introduction of the system, so that the types of containers, their placing within the municipalities, the waste collection and transportation schedule and routing could be adjusted based on the experience. Particular attention should be focused at establishment of bring banks and at establishment of cooperation with recyclers of the waste fractions. It is assumed that collection of waste in urban municipalities will be planned and adjusted by the municipal waste management department/company. As for the rural communities, the planning and adjustment of the new waste collection and transportation system will be the responsibility of the regional landfill management company (the Company).

### **7.4 Operation and maintenance phase**

When the landfill construction is completed, the landfill will be the only available facility for sound disposal of mixed municipal solid waste generated in Kotayk Region and Sevan municipality.

Existing dumpsites will be closed according to the projects planned and prepared by municipalities. Measures for dumping prevention and enforcement of waste disposal at the regional landfill will be elaborated and implemented by the local authorities. It is important that all urban and rural municipalities join their efforts for implementation of the new regional waste management system.

Landfill gas emission from landfill activities can not be avoided. Short time after waste is disposed and compacted the anaerobic digestion processes begin and will result in methane emission through the waste at the tipping front or through other pathways. Collection of landfill gas will not be practical before a final top cover or a temporarily cover is in place. Flaring is in the initial phase of landfill operation the only option for handling and treatment of the collected landfill gas. Collection and flaring of landfill gas could be in place when the first cell is filled and covered which is estimated to be in 2016.

In 4-5 years after commence of the landfill utilisation of the landfill gas could be considered. It is assumed that utilisation of the landfill gas at earliest can be implemented in 2018. As no industry or other potential user of the landfill gas is present in the neighbourhood of Hrazdan landfill the only obvious option for utilisation of the landfill gas is production of electricity and maybe utilisation of the excess heat in a central heating system if installed in administration

building or it may be realistic to utilise excess heat in greenhouses to be established at the nearby farmland (to the East of the landfill). When production of electricity is economically feasible depends on amount of gas collection and in particular in the price for selling electricity. A landfill gas engine and generator unit could be proposed with a minimum size of 200 kW<sub>el</sub> (500 kW<sub>primary</sub>) which will require 750.000 m<sup>3</sup> of landfill gas per year assuming the methane content about 50%. It is expected that 750.000 m<sup>3</sup> of landfill gas per year can be collected starting from 2019. However, it would be advisable to carry out a separate feasibility study by that time for tailoring of the landfill gas utilisation system.

## 7.5 Closure

After the landfill has reached its planned capacity/height, a final cover will be installed. Elements of the landfill structure after establishment of the final cover are shown in Appendix 6. By that time a new waste disposal facility should be made available for the region. The options could include an extension of the landfill (e.g. by construction of additional cells) or construction of a landfill at a new site.

## 7.6 Aftercare

As described above, the landfill will be provided with a final cover layer. Depending of the actual and potential development of landfill gas, a system for the longer term management of the landfill gas will be designed and installed. The generation of leachate and landfill gas may continue during more than 50 years after the closure depending of the percentage and composition of organic waste and the rate of wash out from the landfilled materials. Proper control and monitoring procedures for the aftercare period should be developed. The landfill operator/management will take the decision whether and when it is feasible to install the active gas collection and treatment system.

Pumping and registration station, flare and gas utilisation plant are not included in the currently proposed Project budget, because it will certainly not be relevant for the first three years and might not be relevant at all.

Installation of gas wells (initial parts), transport pipes and area designated for the flare etc. is included in the budget.

The landfill can be finally closed when the emission of landfill gas and leachate has reached a level where the environmental impact is insignificant and acceptable with regard to maintaining air and groundwater quality.

The aftercare includes regular monitoring of landfill gas and leachate emissions as well as regular inspections and maintenance of the top layer including the vegetation cover. Excavation and construction activities in the landfill area should be restricted.

## **8 Impacts and Mitigation Measures during Pre-construction Activities**

In general pre-construction activities are those that are necessary for fixing locations of project components, completing engineering documents and collecting environmental data. They provide essential information for determining project feasibility and developing project description used during environmental studies.

Pre-construction activities for the Kotayk Solid Waste Management Project (Project) include:

- Feasibility Study
- Environmental and Social Due Diligence
- Signing of loan agreement between EBRD and 8 municipalities (the loan agreement includes ESAP as an annex)
- Establishment of regional Landfill Management Company (LMC or Company)
- Establishment of PIU
- Completion of Environmental Impact Assessment with public consultations according to the Armenian legislation and regulations and meeting the EBRD requirements (including a disclosure period for ESIA of at least 120 days);
- Possible adjustment of design according to recommendations of the ESIA;
- Obtaining permits for connection to engineering infrastructure networks (water supply, power supply, telecommunications), planning of back-up arrangements in case of disruptions and emergency situations;
- obtaining of approvals from the Environmental Expertise and from the Inter-ministerial ("Construction") Expertise;
- Procurement planning, tendering and contracting for construction works and for supply of waste collection equipment and waste transportation vehicles.

- Planning and preparation of mitigation measures for waste pickers.

The impacts which may appear during construction and operation stages of the proposed Project (e.g. traffic safety, soil erosion, air and water pollution, impacts on habitats, nuisance for communities, work with hazardous substances, identification of borrow sites for landfill development, etc.) shall be taken into consideration during design stage to ensure adequate mitigation of environmental and social adverse impacts.

It is expected that the proposed Project will not require any physical displacement. However, the ESIA during the pre-construction activities should reveal the issues related to possible economic displacement that can be full, partial, permanent, or temporary and be caused by restrictions imposed during the landfill construction and operation and resulting in loss of access to physical assets or natural resources irrespective of mechanism used for introduction of such restrictions (e.g. negotiations, expropriation, compulsory purchase, government regulation).

The measures for mitigation of the impacts identified at this stage shall be integrated into the design documentation and contractual clauses for contractor(s) to ensure their proper implementation.

The main issues to be considered at this stage of the landfill establishment project include the following:

- Optimal waste collection and disposal scheme, adequate capacity of landfill for the planned period, site suitable for landfill location, waste transportation scheme and access to the landfill.
- Identify existing borrow sites (quarries) that could be used for the landfill development, to the extent possible eliminate the need for opening the new borrow sites;
- On steep slopes and along river banks erosion protection with gabions, gravel or vegetation shall be included in design, if relevant;
- Storm-water facilities shall be included in the design taking into account the risk for pollution of surface and groundwater resources;
- Best management practices applied for similar projects shall be studied to ensure that the most relevant and adequate mitigation measures and practices are considered;
- All relevant permits shall be obtained prior to commencement of construction activities, including positive conclusion issued by the Environmental Expertise SNCO under the Ministry of Nature Protection.
- During preparation of the bidding documents for procurement of contractor for construction works careful consideration should be given to reflecting the EBRD Performance Requirements.

- Procurement of consultancy services should be arranged for adequate supervision of construction works.
- Project monitoring program should be agreed with the EBRD, the local authorities and possibly other parties (e.g. NGOs).

The main issues to be considered at the pre-construction stage would include the following:

- stakeholder engagement program focused on involvement of all urban and rural municipalities in implementation of the new municipal solid waste management system in Kotayk Region and Sevan town;
- consultations for establishment of waste tariffs for households and other clients, for establishment of waste registration system and tipping fee - it is expected that the doubling of household tariff would be required even for the proposed establishment of ordinary waste collection system by the year of 2014, when the new waste management system is to be operational;
- planning for smooth introduction of the new system elements with regard to technical and social aspects;
- preparations for coordination of activities planned in urban municipalities, exchange of experience (lessons learned);
- planning and allocation of funds for closure of existing dumpsites;
- elaboration of joint enforcement measures for prevention of waste dumping;
- planning of public awareness-raising campaign for prevention of waste dumping;
- training of the staff;
- elaboration of reporting format for the EBRD and the local stakeholders.

Many of the above listed activities will be continued during later phases of the Project. The following chapters describe the environmental and social impacts of Project activities during landfill construction, its operation, closure and aftercare. The summary matrix including potential impacts, magnitude of impacts, mitigation measures, and magnitude of residual impacts after implementing mitigation measures is included after description of the impacts.

## 8.1 Methodology of impact assessment

The baseline study provides information on receptors potentially affected by the Project activities. The potential impacts should be described and the needed mitigation measures should be proposed for including in the Project. The impact management strategy and effectiveness of mitigation measures could be discussed in terms of residual impacts.

### 8.1.1 Receptors

Biophysical resources sensitive to impacts of the proposed Project include soil, landscape, air, surface water and groundwater, urban and natural habitats, protected nature areas and species of flora and fauna, ambient noise, and areas of cultural heritage.

Social receptors sensitive to impacts of the proposed Project include residents of Kotayk Region and Sevan municipality and persons visiting the area regularly and often (working in the area) or for a short time (tourists). Employees of contractors involved in construction of the landfill and the staff of the landfill management company should also be considered as a sensitive receptor.

### 8.1.2 Significance of impacts

The identified potential impacts of the proposed Project include positive and negative impacts of higher or lower significance. Impact significance aspects considered during assessment of the impacts can be listed as follows:

- Magnitude of impact - the level or intensity of changes caused by the project activities with regard to baseline conditions. An impact of high magnitude would mean major changes for large amount of biophysical resources and/or people.
- Area of impact - the area where the changes occur.
- Duration of recovery - estimated time required for returning to pre-impact conditions after the impact is stopped.

From the viewpoint of significance the impacts can be of negligible, minor, moderate or major level. Definitions for these levels are presented in Table 8.1 below:

Table 8.1 *Impact significance levels*

Level	Impact on biophysical resources	Impact on socio-economic conditions
Negligible	Almost no changes in the environment, the effects can be recovered within a few days	Almost no changes in socio-economic conditions or commercial activities, the effects can be recovered within a few days

Minor	Isolated change in local biophysical conditions within a limited area (radius of 100 m or so) , the recovery takes a few months, no residual effects observed	Isolated change in local socio-economic conditions and/or commercial activities lasting for a few days to a few months with no residual effects
Moderate	Observable change in biophysical environment lasting from a few months to a few years before recovery. Considerable affected area is within a radius of 0.5 km or a lesser impact over a larger area.	Considerable change in socio-economic conditions and/or commercial activities of up to 10% of persons present in Kotayk Region and Sevan municipality or lesser change for 50% of persons
Major	Changes in biophysical conditions observable within a radius beyond 0,5 km or a considerable change in a smaller area not recoverable within a few years	Considerable changes in socio-economic conditions and/or commercial activities of more than 50% of persons present in Kotayk Region and Sevan municipality or noticeable changes for persons outside Kotayk Region and Sevan municipality

### 8.1.3 Residual impacts after mitigation

Implementation of mitigation measures proposed for potential negative environmental and social impacts at various stages of the proposed Project (pre-construction, landfill construction, operation, closure and aftercare) will result in considerable reduction of the negative impacts. The residual impacts after mitigation in most cases are supposed to be negligible.

## 9 Environmental Impacts and Mitigation Measures during Construction

The proposed Project includes the improved waste collection, transportation and disposal operations based on the establishment/construction of the regional landfill for Kotayk Marz. Impacts related to this phase of the Project scheduled for about 2 years will mostly have a relatively short duration.

The following impacts will not likely be significant:

- Loss of natural habitats, native species, introduction of alien species;
- Forest, fishery and mineral resources, handling of surplus soil;
- Surface run-off and coastal structures;
- Cultural heritage;
- Indigenous peoples;
- Thermal pollution and electromagnetic radiation;
- Transboundary impacts.

Environmental impacts and mitigation measures relevant for the construction phase of the Project are in detail discussed in the following sections.

### 9.1 Change in drainage pattern

No major changes in drainage pattern will be caused during procurement of new waste collection containers and waste collection vehicles during establishment of new waste management system in Kotayk Region and Sevan town. Measures for management of surface runoff should be included into design for upgrading/establishment of the waste collection points, preparations for closure of dumpsites with cleanup of areas adjacent to the dumpsites.

Changes in the local drainage pattern during establishment of the landfill will be related to construction of surface runoff management system and leachate management system. The existing area of a seasonal water pool located next to the existing dumpsite will be used for collection of surface runoff from the

landfill site. The runoff collection system for the landfill is designed with the objective to keep clean surface runoff separate from the contaminated runoff and leachate.

During construction phase the water will be mostly used during soil moving works for dust control and for compacting a layer of clayey material as an element of the bottom liner to achieve its lower permeability; when clearing vegetation and grading; for unpaved road traffic; for making concrete for foundations; and for consumptive use by the construction crew. Water will likely be trucked in from off-site by means of special vehicles. The quantity of water used for construction activities will be relatively small and will not cause any changes to existing drainage pattern.

Construction activities for the proposed development can have minor impact on hydrology and water quality of the area as the construction waste will not be leached into groundwater or any surface water body. The area designated as acceptable for location of the landfill facilities is relatively flat, and therefore minor changes in grade could alter the direction of surface water runoff. Grading associated with earthworks could cause runoff to be directed away from a landfill site. In addition, rain falling directly on the landfill area will flow under gravity to site gullies and may discharge into a surface water feature potentially affecting the water quality. Overall, the impacts on surface water resources are related to the project footprint (e.g., land disturbance, erosion, changes in runoff patterns, and hydrological alterations, etc.).

Site-specific drainage control is required to ensure that surface water runoff is properly managed. In particular, the following mitigation measures are recommended:

- Minimize the planned amount of land to be disturbed as much as possible. Use existing access roads and quarries, if possible;
- Locate access roads to minimize stream crossings;
- Construct drainage ditches where necessary, use appropriate structures at culvert outlets to prevent erosion;
- Clean and maintain drainage ditches and culverts regularly;
- Use special construction techniques in areas of steep slopes, erodible soils and stream crossings;
- Do not alter or restrict existing drainage systems, especially in sensitive areas such as erodible soils or steep slopes;
- Dispose of excess excavation materials in approved areas to control erosion and minimize runoff.

Taking into account the fact the proposed landfill site is located in the area of abandoned clay quarry it is not likely that surface runoff can penetrate into groundwater, that the impacts on groundwater are very limited.

## **9.2 Flooding potential**

There are no permanent natural water bodies located nearby the site proposed for establishment of the regional landfill. That is why it is considered that there is likely to be a low impact to the soil from flooding. Due to establishment of drainage ditches/culverts the rainfall water will be drained from the proposed landfill area and discharged into natural drainage flows.

## **9.3 Landscape impacts of excavation and construction**

The Project activities related to establishment of the regional landfill will be carried out within the areas affected by earlier road construction, soil works and dumping of waste. The proposed activities will include clean-up of areas adjacent to the access road to Hrazdan dumpsite, upgrading of the road, closure of existing dumpsite and establishment of soil cover having a form of a natural hill. Construction of landfill will be carried out in phases allowing to establish facilities with the limited area of excavation and construction activities at a time. The design of landfill is prepared based on minimum scope of soil works changing the existing landscape. This series of activities will have positive impact the on landscape of Hrazdan site.

## **9.4 Pollution of surface water and groundwater**

Pollution of water resources during construction phase usually happens as a result of improper storage of construction materials, construction waste and excavated materials, as well as spillage of fuel, oil and other substances during construction works.

To prevent pollution of surface water and groundwater resources the following mitigation measures shall be implemented during construction phase:

- To reduce the likelihood of contamination due to spillage of oil from construction equipment and wastewater from construction camps, the sites for these areas shall be carefully designated and proper technical condition of machinery and equipment shall be ensured. In addition, sand or fine gravel should be spread on the ground in the locations designated for parking and servicing construction machinery. In case of spillage the polluted layer should be removed and replaced with new layer of sand or fine gravel;
- Sections located very close to drainage ditches/culverts shall not be used for construction material storage and temporary accumulation of waste;

- Provide for covered zones of preliminary accumulation of construction materials and wastes in order to minimize formation of leachate as a result of rainfall;
- All vehicles must be regularly checked and their normal operational technical conditions shall be ensured. In case any leakage of oil or other liquid is observed, the vehicle must be moved to a paved impermeable area and be immediately fixed;
- Water samples shall be tested for oil products, in case the leakage is observed.

## 9.5 Air pollution

Air pollution occurs during construction works and includes release of dust from digging-loading works, earthworks, establishment of earth access roads, operation of heavy machinery and construction equipment, emission of harmful substances from combustion of diesel used by transportation means and machinery during the construction works, emissions from welding, concrete-mixing, asphalt-placing activities, as well as dust caused by improper storage of friable construction materials and non-timely disposal of friable construction waste. Dust and the bitumen smoke arising from construction activities may have negative impact on the ambient air quality. However, there are no receptors within 500 m of the landfill boundaries and hence the potential for nuisance impacts is limited. It should be noted that these impacts will occur during the construction works, but will only be short-term and affect different people at different times. No major air pollution is expected as long as proper construction and equipment functioning practices are applied.

To prevent or minimize the potential impacts on air, the following mitigation measures are recommended:

- Sprinkling of water on unpaved, non-vegetated surfaces to minimize airborne fugitive dust and during earthmoving activities, prior to clearing, and before excavating, backfilling, compacting, or grading;
- Post and enforce speed limits for vehicles to reduce airborne fugitive dust from vehicular traffic;
- Allow site access only to authorized vehicles;
- Keep soil moist while loading into dump trucks;
- Keep soil loads below the freeboard of the truck;
- Tighten gate seals on dump trucks;
- Trucks loaded with loose construction materials (such as gravel, sand, soil, etc.) shall be covered to minimize dust emissions during transportation;

- When feasible, shut down idling vehicles and equipment;
- Train workers to handle construction materials and debris during construction to reduce fugitive emissions;
- Where possible stockpiling of friable material should be avoided and in-time delivery should be practiced;
- Conduct dust-depressing measures aimed at prevention of air pollution through watering of access roads, construction site, construction camps;
- Develop a traffic management plan to ensure smooth traffic flow and safety both for workers and the passing traffic;
- All vehicles must be regularly checked and equipped with effective exhaust mufflers according to the requirements of relevant RA legislation.

## 9.6 Wastewater generation and disposal

During landfill construction stage the water will be used at construction camp for drinking, cooking, washing and bathing purposes, as well as at construction sites for construction activities (i.e, watering of the construction sites, washing the wheels, etc.). The facilities for daily accommodation of the workers shall be equipped with systems for water supply and sewerage collection. The wastewater from construction camp will be collected in a septic tank with 20m<sup>3</sup> capacity, which is made of impermeable material (the minimum volume of septic tank is specified in SNIP applied in the RA). The tank will be emptied every week by a special vehicle, which will transport wastewater to a centralized wastewater collector in accordance with prior agreement with the local authorities.

Improper operation of the sewerage system and wastewater collection tank may have minor negative impact on the site as a result of pollution of surface runoff accumulated in seasonal pools within the former clay quarry.. At the construction site, in order to minimize negative impacts from wastewater generation and discharge, the following measures are recommended for application:

- Avoid potential spills; washing of vehicles and equipment on the site to shall be restricted;
- Chemicals and other liquid and solid dangerous materials must be managed properly;
- Wastewater from the accommodation facilities shall be collected and adequately removed from the site.

## 9.7 Hazard vulnerability

Overall, the term "natural hazard" refers to all atmospheric, hydrological, geological (including seismic), and wildfire phenomena that, because of their location, severity, and frequency, have the potential to affect humans, their structures, or their activities adversely. The natural hazards relevant for the landfill site include drought, earthquake, flood and wildfire. The site is located in Armenia, where the risk of earthquakes is rather high, so all the landfill facilities should be constructed with respect to this fact. Drought and flood might affect the waste and soil humidity and runoff conditions during soil works.

Mitigation of disasters usually entails reducing the vulnerability of the elements at risk, modifying the hazard-proneness of the site. Mitigation measures to address such impacts usually include specific safety or vulnerability reduction measures incorporated in the design documents developed for construction of landfill facilities or building of protective devices (if relevant). To properly deal with hazards and ensure timely implementation of mitigation measures it is recommended that a Disaster Management Plan be developed for the landfill jointly with regional authorities. The Disaster Management Plan should include measures addressing the following issues:

- Natural hazard prediction;
- Emergency preparedness;
- Disaster rescue and relief;
- Post-disaster rehabilitation and reconstruction;
- Educational and training activities.

To reduce hazard vulnerability at the landfill site the following measures are recommended:

- Construction of cut-off drains;
- Establishment of buffer zone around landfill;
- Ensure preservation of safety rules by workers, while dealing with hazardous and toxic materials;
- Compliance with rules on storage and handling of construction materials, fuel, oil products, chemical substances, etc.;
- Regular inspection of landfill facilities to ensure their proper operation;
- Train workers on how to act in emergency situations;
- Establish reliable communication between landfill site and respective regional authorities, first-aid service, rescue service, police office, fire office, operators of electricity, gas and water supply utilities to ensure adequate response in case of emergency.

## 9.8 Noise

The primary source of noise during construction will be heavy equipment (e.g., bulldozers, graders, backhoes, excavators, dump trucks, etc) and vehicular traffic. The magnitude of construction noise impacts depend upon the construction activity, noise levels generated by construction equipment, duration of the activity is considered to be limited due to significant distance from noise-sensitive receptors (residential areas of Hrazdan city) and location of the landfill site in the abandoned quarry separated from the residential areas by Yerevan-Sevan road in the west and north-west and by areas of open land (arable, pastures, not used land) with hills and vegetation available within a distance over 500 m from the site. Raised noise levels at the construction site are inevitable, but they are temporary and might generate short time impact. Use of machinery and equipment during construction and operation of landfill will be planned to ensure that the estimated noise levels will not exceed the levels acceptable for the key receptors (residents of Hrazdan and the site workers). The allowable noise levels are regulated by Sanitary Norms N2-III-11.3 "Noise at workplaces, residential and public buildings, and urban areas" adopted by the RA Ministry of Health (Order 139 No 138 of 6 March 2002). Due to complicated landscape conditions the estimates can not be based on calculations or modelling, but should be verified by instrumental measurements of noise levels at the receptors.

The following mitigation measures are recommended to reduce noise impacts:

- Limit noisy activities to the least noise-sensitive times of day (weekdays only between 7 a.m. and 10 p.m.);
- All machinery and equipment should have sound-control devices no less effective than those provided on the original machinery/equipment. Motorized equipment should be adequately muffled and maintained;
- Whenever feasible, schedule different noisy activities (e.g. earthmoving, truck unloading, etc.) to occur at the same time, since additional sources of noise generally do not add a significant amount of noise. That is, less-frequent noisy activities would be less annoying than frequent less-noisy activities;
- To the extent feasible, route heavy-truck traffic away from residences and other sensitive receptors;
- Workers in the vicinity of sources of high noise shall wear necessary protection gear;
- Barriers (e.g. fences) or purpose-built acoustic screens should be used to reduce the noise reaching worker's camp, where practicable;
- Avoid use of percussive and impact tools wherever possible;

- Machinery in intermittent use should be shut down or throttled down to a minimum when not in use.

## **9.9 Odour**

Earthworks and civil works are not among the activities considered likely to produce odour emissions. It is considered unlikely that activities associated with the construction phase would result in the generation of odours other than odours from vehicles and construction machinery. It is therefore considered that the odour impact during landfill construction phase would be minor.

## **9.10 Spillage of hazardous or medical waste**

During construction of the landfill no spillage of hazardous or medical waste is expected. Relevant measures will be implemented during operation and maintenance of construction machinery and vehicles for preventing spills of fuel, waste oil and chemicals. These measures will include:

- Keeping vehicles and equipment in good working order to prevent oil and fuel leaks;
- Training of workers to promptly clean up any fuel or oil spill;
- Availability of portable spill containment and cleanup equipment in all vehicles.

## **9.11 Biodiversity**

The impacts from landfill construction to biodiversity would be proportional to the amount of disturbance and habitat fragmentation. It should be noted that the site is not a critical habitate of any plant or animal species and there are no protected natural resources nearby the landfill site. The likelihood and significance of impacts on biodiversity are low.

Site fencing will be developed during the landfill construction to prevent site access by cattle and wildlife species.

## **9.12 Sustainable natural resources management**

Taking into account location of the landfill site in the area of former clay quarry and absence of natural water bodies nearby, the impact on biota and water resources should be considered negligible. The construction activities are planned within the areas of existing access road, existing dumpsite and former quarry. The locally available construction materials will be used wherever applicable. Requirements for sustainability of supply chain for the materials (e.g. delivery of sand and gravel from authorised borrow sites, origin of materials not from areas of high ecological value, monitoring of origin) will be included in the contracts and checked during the construction supervision.

### 9.13 Greenhouse gas emissions

During construction phase, no landfill gas will be generated, and hence no significant emissions of greenhouse gases are expected. However, there could be limited emissions of greenhouse gases by construction machinery and equipment, transportation vehicles, welding works, etc.

The following measures will ensure minimization of contribution of construction activities in generation of greenhouse gases:

- Develop a traffic management plan to ensure smooth traffic flow;
- Regularly check technical condition of vehicles and machinery, and ensure that all the vehicles are equipped with effective exhaust mufflers;
- Turn off the construction machinery and equipment that is not in use.

### 9.14 Climate change and adaptation

The construction works will be mainly carried out during summer months. Probability of extremely hot temperatures should be considered during planning of the works. On the other hand, probability of severe winter frosts and heavy snow should be addressed during planning of equipment and construction site maintenance.

### 9.15 Assessment of environmental impacts during construction

Summary of identified environmental impacts related to the proposed landfill construction activities and measures recommended for mitigating the potential negative impacts is presented in Table 9.1.

Table 9.1 Assessment of environmental impacts during construction of landfill

Impacts	Assessment	Mitigation measures required
Change in drainage pattern	Negligible	-
Flooding potential	Negligible	-
Landscape impact of excavation and construction	Minor positive	-
Contamination of soil, surface water and groundwater	Minor negative	Installation of bottom liner in landfill cells and leachate pond, surface runoff management, spill control, leachate management
Air pollution (dust and emissions from ma-	Moderate negative	Maintenance of equipment, sprinkling of soil, covers during

chinery, dust during soil works)		soil transportation, low on-site vehicle speed
Noise from construction machinery and vehicles	Moderate negative	Construction during day hours, use of silencers, low on-site vehicle speed, PPE for workers
Odour	Minor negative	Maintenance of vehicles and machinery
Biodiversity	Negligible	-
Management of natural resources (land, water)	Negligible	Use local materials where applicable
Greenhouse gas emissions	Minor negative	Use efficient machinery and work schedule
Climate change and adaptation	Negligible	-

## **10 Social Impacts and Mitigation Measures during Construction**

Construction of the landfill and upgrading of access road to the site are planned on a public land. The site was in advance allocated as potentially fit for storage of waste and is located at a distance of about 500 m from the nearest residential buildings. Construction of the landfill on this area will not require any permanent or temporary acquisition of land. The landfill construction and upgrading of access road can be carried out with no disruptions in any public services.

Key adverse social impacts of landfill construction usually include the increased traffic, noise, aesthetic degradation, and property devaluation nearby landfill area. Impacts of these types will not be critical for the proposed Project, because the site selected for landfill is located on the territory of a former quarry far from residential areas and next to the existing major dumpsite.

It is expected that contractors of the infrastructure of regional landfill will bring their qualified staff but will also recruit local daily labourers for construction activities. Therefore the assessment is that construction of the regional landfill will have a positive impact on local employment.

Social impacts and mitigation measures relevant for the construction phase of the Project are in detail discussed in the following sections of this chapter.

### **10.1 Socio-economic and cultural impacts**

Doubling of waste collection tariffs in Kotayk Region and Sevan municipality required for proposed improvement of the waste collection services and establishment of the regional sanitary landfill will be the key socio-economic economic impact of the proposed Project. All households in the project region will be affected by increase of tariffs. The tariffs will be also increased for other users of the waste management system (institutions, shops, hotels, restaurants, etc.). To mitigate the major negative impact of the tariff change it is proposed to increase the tariffs already during the landfill construction and establishment of the new waste collection system. Increase of tariffs can bring essential improvements of waste management services only if collection rate of the tariffs is high. Otherwise, the households will not be encouraged to pay more for the services. Thus the waste tariff increase will have a direct socio-economic and an indirect cultural impact.

Direct socio-economic impacts will include creation of new jobs for construction workers and the associated income generated by the landfill construction. It is expected that the contractor will hire local drivers for transportation of construction materials. This employment opportunity will be available for about 2 years. Indirect impacts will occur as a result of the new economic development, and will include new jobs at businesses that support the expanded workforce or provide project materials. Meantime, taking into account that the landfill is constructed for the whole marz of Kotayk, the employment impacts on the local economy are likely to be negligible. The majority of the new employment associated with the landfill will be of temporary nature.

Land use impacts are also considered to be negligible, since the landfill and access road to it are located on the publicly owned land and no land acquisition is necessary to ensure land availability for landfill development. No impact is predicted upon the residential areas of nearby communities, as those are located at a sufficient distance from the landfill site. However, the impacts related to restricted access for residents of adjacent areas to the landfill site during its construction and operation will need to be established prior to construction works.

Direct impacts to cultural resources could occur from construction activities, and indirect impacts might be caused by soil erosion and increased accessibility to landfill site location. Given that the proposed landfill is located in the area of abandoned clay quarry, where clay extraction has been carried out for a period of time, the impacts to cultural resources are very unlikely. However, the following mitigation measures are proposed to prevent cultural resource impacts, if any occur:

- Use existing roads to the maximum extent feasible to avoid additional surface disturbance;
- Periodically monitor cultural resources in the vicinity of the landfill site (if any);
- An unexpected discovery of cultural resources during construction phase shall result in an immediate stoppage of civil works in the landfill site. The relevant information should be provided to the State Agency for Protection of Historical and Cultural Monuments of the Ministry of Culture, which after due consideration of the findings will recommend whether the works can be continued or the design must be revised;
- Educate workers and the public on the consequences of chance finds and unauthorized collection of cultural findings.

## **10.2 Labour and Working Conditions**

According to the Labour Code of the Republic of Armenia, employers - as part of construction process - need to assess potential risks to ensure the safety and health of workers (depending on the size of the construction company, such

assessment can either be performed by company's specialists or hired experts), as well as inform workers on safety practices and develop action plans to be followed in case of emergency. The construction company can establish a special committee dealing with worker's health and safety issues. The construction company shall ensure appropriate working conditions, so as the workers can implement their working duties. In particular, the construction company shall ensure:

- Proper working condition of vehicles, machinery, mechanisms, equipment and other devices;
- Timely provision of appropriate technical documentation;
- High quality and timely provision of materials and tools to be used by workers;
- Reliable and uninterrupted supply of electricity, gas and other sources of energy;
- Safe working conditions for employee's health (preservation of safety norms and rules, proper lighting, heating, ventilation, level of noise lower than the minimum norms accepted, dust, vibration, and other factors that may negatively impact the health of employee);
- Presence of emergency exits that are permanently accessible, free of physical obstacles. All workers should be made well aware of location of emergency exits;
- Availability of fire extinguishers in all the vehicles and construction sites;
- Availability of first-aid kit in all the vehicles and construction sites. All the workers shall be trained in delivering first aid and should be informed about the location of first-aid kit;
- Close monitoring of workers' physical condition; strictly prohibit the use of alcohol, psychotropic drugs and narcotics during the works.

In case the waste pickers get involved in arrangements for collection and sales of recyclables, their working conditions will be improved.

### **10.3 Occupational health and safety issues**

Potential impacts to workers and public health and safety from landfill construction would be similar to those expected for any construction project associated with earthmoving, use of heavy machinery and equipment, transportation of construction materials, and installation of industrial facilities. Most accidents in the construction industry result from overexertion, falls, or being struck by equipment. Construction-related illnesses could also result from exposure to chemical substances from spills. In addition, health

and safety issues include working in potential weather extremes and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects. All personnel involved with the construction would utilize appropriate safety equipment and would be properly trained in required occupational health and safety practices.

Measures to be carried out in order to mitigate occupational health and safety impacts include:

- Conduct a safety assessment to describe potential safety issues (site access, construction, work practices, security, transportation of heavy equipment, traffic management, emergency procedures, and fire control and management) and measures to mitigate them;
- Develop and implement a health and safety program for workers and the public, addressing all of the safety issues identified in the assessment and all applicable safety standards;
- Identify all applicable occupational safety standards and establish safe work practices;
- Ensure adequate provision of PPE, training on its use, timely cleaning and replacement of PPE;
- Closely monitor application of appropriate occupational health and safety practices at the construction sites, in particular while working with electrical equipment, welding equipment, heavy and lifting mechanisms, etc.;
- Consult with local planning authorities regarding traffic and traffic hazards. Address specific issues in a traffic management plan;
- Develop a fire management strategy to minimize the potential for a human-caused fire and establish fire safety evacuation procedures;
- Train workers in the early detection of fires;
- Fence and closely monitor the landfill construction site to prevent public access;
- Use appropriate procedures for storage and transportation of explosive materials, including appropriate signage indicating their location;
- Institute proper training protocols for employees working with dangerous materials.

## 10.4 Visual impacts, including view from the main road

Assessment of visual impacts, including view from the main road is largely based on professional judgment. During the construction phase, works will be confined to the proposed landfill site. The construction area will include installation of 2m high surrounding fence, establishment of paved access road, arrangement of offices and auxiliary facilities, and preparation of the first three cells for waste reception (for mixed household and commercial waste).

Visual impact during the construction period will result from the traffic and on-site operation of machinery. Taking into account that the Report on Landfill Site Selection mentions about low visibility of the site located within the abandoned quarry remaining after excavation of clay material, the visual impact generated by the project will be negligible. The fence will not be visible from any substantial distance. Visual impacts of the landfill facilities can be reduced by painting the buildings in a colour that merges with the surrounding natural background.

Soil excavated during construction of landfill cells will usually form 2-3 m high temporary earth bunds along the perimeter of the cell. The surrounding landscape for the most part of the year is of yellow-brown colour, the mounds will have only a marginal impact on the general view in terms of shape and colour.

The degree of change to the existing landscape during the construction stage will be low. Impact on visual receptors, as well as the duration and extent of the change in the landscape quality and value, taking into account that the landscape is currently of low sensitivity and can tolerate the change, will also be low.

The following mitigation measures are recommended for during construction phase:

- Design, construct, and paint conspicuous structures to blend with the character of the surrounding environment;
- Minimize the number of structures and co-locate facility components to the extent possible;
- Bury any power cables or lines on the site in a manner that minimizes additional surface disturbance, such as within areas that are already disturbed (e.g., access road shoulders);
- Use non-reflective paints and coatings to reduce reflection and glare. Avoid uncoated galvanized metallic surfaces;
- Use existing roads and disturbed areas to the maximum extent feasible to avoid additional surface disturbance;
- Lighting for facilities should not exceed the minimum required for safety and security.

## 10.5 Population movements

No resettlement, temporary or permanent acquisition of land, property and other assets is required for landfill construction.

The likelihood of population growth following the in-migration of the construction workers associated with landfill development and associated facilities in communities is very limited, taking into account the scale of the employment opportunities offered as a part of the project. Though a minor natural growth is observed, it is extremely unlikely that the trends will be impacted as a result of landfill development. In addition there is labour migration, particularly seasonal movements, from rural areas to urban ones and CIS countries, mostly Russia.

## 10.6 Economic impacts

The major economic impact during construction phase will be creation of employment opportunities for local population, as well as increase in production of materials to be used during construction process. Though these opportunities will be of temporary nature, they may still provide some possibilities for the local population to find work in the region, thus indirectly leading to reduction in seasonal workforce migration. Meantime, it should be also adopted that due to the scale and nature of the construction works, overall economic impact on the regional economy will be negligible, even in the communities located nearby the landfill site (e.g. nearby located Hrazdan town). The positive effect on employment, however slight, can be increased through procurement of local goods and services including contract services.

Traffic volumes on the roadways used to access the landfill will increase during the construction periods, in order to transport construction materials and workers. Increased traffic volume may cause air pollution (dust and emissions) and noise; however, these effects will be temporary and manageable with proper planning.

The impact on farming land is likely to be minimal, with assumption that the construction works are implemented with all the precautions and rules duly kept, in particular those regarding control of noise, dust, soil and water resources. But if there are disruptions and income is lost, this needs to be compensated.

Construction of the landfill is not expected to generate any significant additional demands on utility services (water, electricity, etc.). These services are required for the on-site facilities and workers.

Overall, the adverse impacts mentioned in this section can be sufficiently mitigated through the measures described above in this report.

## 10.7 Community Health, Safety and Security

During construction process the community health, safety and security may be impacted from dust and noise caused by vehicles and machinery movement to

the construction site and transportation of construction materials. It is envisaged that during the landfill construction the daily traffic on access road to the site will include 15-20 trucks and 10-20 smaller vehicles. The largest sole delivery will be 20,000 m<sup>3</sup> of drainage gravel transported by 2,000 trucks, which will stay for 50% of all incoming trucks to the site over 1 year (250 working days) Taking into account that landfill site is located in a sufficient distance from residential areas no increase in incidence of communicable diseases, deterioration in health or access to healthcare facilities is expected to occur during construction activities.

To prevent any potential negative impact on community health, safety and security the following measures are proposed:

- Provide information about landfill development project to the mayors of beneficiary communities;
- Install appropriate warning signs at the entrance of construction site in a visible place;
- Fence construction site to prohibit entrance of unauthorized people;
- Use covered/closed trucks for transportation of construction materials to avoid nuisance from dust;
- Limit speed of trucks, construction machinery passing through communities to minimize nuisance from noise and vibration;
- Terminate the works at the established time (e.g. work in daylight time) and avoid increase of noise and number of peak hours.

## 10.8 Education

During landfill construction process it is not expected that access to educational facilities will be impacted. Taking into account that landfill site is located in a sufficient distance from residential areas it is not likely that project would lead to severance from education facilities. Meantime, education facilities may benefit from the project by having access to the information regarding landfill establishment and providing special thematic training to pupils.

## 10.9 Social Conflict

Commencement of the project related to establishment of municipal solid waste landfill at Kotayk marz may lead to creation of tensions within and between communities; particularly due to limited number of job opportunities available during construction phase of the project. Another issue that may cause some social tension among beneficiary communities is the mechanism to be employed after completion of construction works to ensure proper operation of the landfill site, such as waste collection mechanism (the route of movement of truck that collects waste, frequency of waste removal from communities, etc.)

and fee collection principles (who collect money, what is money used for, who will be involved in landfill operation, why there is a need to engage a private operator, etc.).

The management of the regional landfill will strongly influence the socio-economic impacts that the landfill will have on the neighbouring communities. If the management is sensitive towards the concerns of the community, and develops timely solutions for the anticipated concerns of the communities, than minimal negative impacts are expected. The social monitoring system and grievance mechanism will be established during implementation of the proposed Project for identification and addressing the social conflict issues.

### **10.10 Gender**

Though construction of landfill in Kotayk marz would not have direct impact on men and women's social and economic roles, however, appropriate activities should be undertaken to ensure that both men and women are provided with equal opportunities to benefit from landfill development and to ensure they are not disproportionately adversely affected by any project activities and duly consulted before and during introduction of changes in the waste collection system.

Measures to ensure that gender issues are properly addressed include:

- Education and awareness campaigns organized and conducted at schools, culture clubs, libraries, and community gatherings to enhance men and women awareness and knowledge of solid waste collection and disposal process;
- Encourage female to provide their opinion and input on organization of waste collection services; design of containers, collection times and frequency, collection of recyclables, etc.
- Ensure that requirements of labour code and safety rules are duly applied during construction activities;
- Ensure that landfill facilities include separate toilets and changing rooms for men and women;
- Organize meetings on health hazards of solid waste and on occupational health risks with men and women in local communities.
- Provide equal employment and remuneration opportunities in the work places for men and women.

### **10.11 Impacts on vulnerable groups**

It is anticipated that the landfill construction could benefit low-income and other vulnerable groups of population by creating job opportunities and stimu-

lating local economic growth via Project revenues and increased tourism. Issue of potential concern relevant for implementation of construction works at the landfill and access road, during upgrading of waste collection points is the loss of income of waste pickers. However, waste pickers in Kotayk Region and Sevan municipality typically have other sources of income in addition to participation in informal recycling. Opportunities for participation of waste pickers in collection of recyclable fractions in special containers installed in the cities and business contacts with the recyclers will be considered by the municipalities and companies collecting waste in the Project cities and by the regional landfill company collecting waste in the rural areas.

## 10.12 Assessment of social impacts during construction

Identified social impacts of the Project and measures required for mitigating the potential negative impacts during the landfill construction are briefly summarised in Table 10.1 below.

*Table 10.1 Summary of social impacts and mitigation measures during construction of landfill*

Impacts	Assessment	Mitigation measures required
Increase of tariffs	Major negative	Gradual increase of tariffs, enhancement of public awareness and revenue collection rate
Loss of income for waste pickers	Moderate negative	Involvement in arrangements for collection and sales of recyclables
Labour and working conditions	Negligible positive	-
Occupational health and safety	Minor negative	OHS management plan
Visual impacts	Minor positive	-
Population movements	Negligible	-
Economic displacement (users of land adjacent to landfill, waste pickers)	Minor negative	Information, avoidance, compensation
Community health, safety and security	Moderate negative	Traffic safety measures, fencing during excavation and construction activities
Education	Negligible	-
Social conflict	Moderate negative	Establishment of landfill management company and transparent procedure for regulation of landfill gate fee

<b>Impacts</b>	<b>Assessment</b>	<b>Mitigation measures required</b>
Gender	Minor positive	-
Disturbance during introduction of new waste collection system, construction of new collection points	Minor negative	Information, gradual introduction of changes, grievance mechanism

## **11 Environmental Impacts and Mitigation Measures during Operation and Maintenance**

Environmental impacts and mitigation measures relevant for the operation phase of the Project are in detail discussed in the following sections of this chapter. Their summary is provided after the description.

### **11.1 Change in drainage pattern**

During operation phase the water will be mostly used for washing the wheels of vehicles, sprinkling the earth access roads, as well as in the administration facilities. Operation of the landfill will have minor impact on hydrology and water quality of the area, as the wastewater will be discharged into natural environment only after appropriate treatment. In case the normal operational conditions of the landfill are kept, no impact on surface runoff of areas adjacent to the site is expected. Surface runoff within the site will be managed with installation of facilities for collection of clean runoff separated from collection system for contaminated runoff and leachate. Clean surface runoff and leachate will be collected in separate ponds established on the landfill site, within the lowermost, northern part of the closed drainage area of the former clay quarry.

The following mitigation measures are recommended to ensure adequate drainage control during landfill operation phase:

- Clean and maintain drainage ditches and culverts regularly to ensure proper removal of runoff;
- Do not alter or restrict existing drainage systems, especially in sensitive areas, such as erodible soils or steep slopes;
- Regularly monitor groundwater table through monitoring wells established at the site.

### **11.2 Flooding potential**

Taking into account that there are no natural water bodies located nearby the proposed site, it is considered that there is likely to be a low impact to the soil from flooding. The Kotayk irrigation canal is located about 200 m to the west

from the site. The canal delivers water from Lake Sevan in the southern direction.

To ensure that landfill area is properly drained even in case of heavy rainfall, the landfill operator should develop a Stormwater Management Plan ensuring that runoff from landfill area would not be allowed to migrate away from the site or into surface water bodies, and implement it when necessary.

### **11.3 Landscape impacts of excavation and construction**

Operation of the landfill assumes tipping of waste and covering it with soil. It is recommended to use locally available soil for covering the waste and to carry out this activity without making any deep excavations on the landfill site and close to it. The filling height of 11 m is comparable with the depth of the clay quarry height of natural hills located close to the landfill site. As a result of waste disposal and its covering with soil during the landfill development the existing clay quarry will be somewhat filled up. Thus the impact of excavation and construction works during landfill operation on the landscape will be minor positive.

### **11.4 Pollution of surface water and groundwater**

During the operation phase pollution of water resources may be caused by uncontrolled discharge of runoff or leachate, leakage from the clogged drainage systems, runoff from the raised landfill areas. It may also occur as a result of improper maintenance of machinery and equipment operated at the landfill site, due to spillage of fuel, oil and other substances. Meantime, proper operation of drainage system, leachate collection and treatment facilities, re-use of “clean” soils as capping soils to reduce surface water runoff from the waste, as well as stabilization of stockpiled soil by re-vegetation will minimize the potential adverse influences, and will allow to keep the physical, biological and chemical impacts to the water resources at a very low level.

Rain falling directly on active waste disposal areas within the landfill excavation may lead to an increase in leachate generation. This will be mitigated through leachate management and using temporary capping throughout operation. Areas of completed landfill will be progressively permanently capped.

Rain falling directly on non-active areas within the landfill excavation will not be considered as leachate, and will be collected, stored and tested for surface water quality before discharge to the environment, via gullies or ditches.

Rain falling directly on non-excavated areas of the site will not be considered as leachate, and will flow under gravity to site gullies and ditches before discharge to the environment.

Establishment of the proposed landfill far from natural water bodies will minimize the inflow of surface water that may be polluted by the leachate.

To prevent pollution of surface water and groundwater resources the following mitigation measures are proposed for implementation during operation and de-commission phases:

- Regularly inspect and clean drainage ditches/ culverts;
- Regularly inspect leachate collection and treatment facilities, wheel wash system, water supply and sewerage network at administrative building to ensure proper operational technical conditions;
- To reduce the likelihood of oil spillage from machinery and equipment, and contamination with wastewater from administrative facilities, proper technical condition of machinery and equipment shall be ensured. In addition, sand or fine gravel should be spread on the ground in the locations designated for parking, and servicing machinery. In case of spillage, the polluted layer must be removed and replaced with new layer of sand or fine gravel;
- All vehicles must be regularly checked and their normal operational technical conditions shall be ensured. In case any leakage of oil or other liquid is observed, the vehicle must be moved to a paved impermeable area and be immediately fixed;
- Groundwater and surface water quality shall be monitored at regular intervals during operation and decommission phases.

## 11.5 Air pollution

Air pollution occurring during operation phase of the new waste collection system and the regional landfill includes release of dust during waste and soil transportation and loading, levelling, unloading works, emissions from engines of vehicles and machinery. At present the traffic of waste collection trucks to Hrazdan dumpsite is at the level of 4 trucks a day. The estimated daily number of collection trucks delivering waste to the landfill in Hrazdan will be 25 in 2014 and will reach 56 by 2033.

Taking into account that there are no residential areas within 500 m of the landfill boundaries, the potential for nuisance impacts from dust and subsequent air pollution is considered to be very low. However, the landfill will be operated in line with the good international practice and measures for prevention of impacts on land and biota around the landfill will be implemented. A fence and a belt of trees and bushes will be established around the site as a barrier on the way of waste spreading by wind. Waste accumulated in the green belt will be regularly collected and taken to the landfill. During the windy hours the landfill operations could be stopped. Waste tipping can be carried out in a mobile tent.

Waste from landfill can be also spread by birds and animals. The fence should limit/prevent access to the site for animals. Bird control measures should be

implemented (e.g. by using bird scaring kites, sound signals, trained birds of prey).

Potential sources of air pollution that can occur during the operations within the landfill site include impacts on air quality arising from operation of a diesel generator, impacts on air quality arising from emissions of landfill gas and the potential combustion of landfill gas. Air pollution can occur in case of fires.

Coverage of the delivered waste at the landfill site will considerably reduce impacts on air.

To prevent or minimize the potential impacts the following mitigation measures are recommended:

- Post and enforce speed limits to reduce airborne fugitive dust from vehicles;
- Allow site access only to authorized vehicles;
- Keep soil moist while covering of waste;
- Keep waste collection and transportation trucks closed/covered when travelling on public roads;
- Maintain containers and trucks for preventing spills of leachate during waste collection and transportation
- Water unpaved roads to prevent spreading of dust;
- Regularly check technical conditions of all vehicles operated at the landfill site. These vehicles should be equipped with effective exhaust mufflers according to the requirements of relevant RA and international legislation;
- Arrange daily coverage to control spreading of waste by wind, birds, animals;
- Restrict access to the landfill, train the staff to ensure prevention of waste fires;
- Monitor landfill gas emissions and arrange for their collection and utilisation, when relevant.

## **11.6 Wastewater generation and disposal**

During landfill operation the water will be used at the administrative facilities for drinking, cooking, washing and bathing purposes, as well as for washing the wheels of vehicles. The facilities for daily accommodation of landfill employees shall be equipped with systems for water supply and sewerage collection. The wastewater from administration, control and staff (including sanitary) fa-

ilities will be collected in the wastewater collection tank for further treatment. Wastewater originated from washing the wheels of vehicles and through drainage system will be discharged into the surface water collection and treatment system that includes sand trap and oil separator, and will be treated prior to its discharge into natural environment. Another option would be to use the wastewater for watering the waste. The appropriate facilities will be used to ensure collection, storage, treatment and discharge of the leachate. Improper operation of the drainage system, leachate collection and treatment facilities as well as wastewater collection tank can have medium-scale negative impact and cause pollution of soil and seasonal water pools on the territory of the former clay quarry which is a closed drainage area.

At the landfill site, in order to minimize negative impacts from wastewater generation and discharge, the following measures are recommended for implementation:

- Regularly inspect and ensure proper maintenance of wastewater collection tank, wheel washing system, leachate collection and treatment facilities;
- Regularly inspect and maintain the surface water collection and treatment system that includes sand trap and oil separator. Ensure regular cleaning of drainage ditches/ culverts;
- Avoid potential spills through application of appropriate occupational rules; washing of vehicles and equipment on the site to be restricted;
- Chemicals as well as other liquid and solid dangerous materials must be stored and managed properly;
- Wastewater from the accommodation facilities shall be collected and adequately removed from the site.

## 11.7 Hazard vulnerability

The natural hazards relevant for the landfill site include: drought, earthquake, flood and fire.

To reduce hazard vulnerability at the landfill site during operation the following measures are recommended:

- Prepare Emergency Preparedness and Response Plan, inform the workers on its provisions;
- Regularly inspect of cut-off drains and maintain the sanitary protective zone (radius 500 m from waste disposal areas according to MUD Guideline of 2010) around the landfill;
- Ensure compliance with rules on storage and handling of construction materials, fuel, oil products, chemical substances, etc.;

- Regularly inspect landfill facilities and infrastructure to ensure their proper operation and updating of as-built documentation;
- Provide periodic training to workers on how to act in emergency situations;
- Maintain reliable communication between landfill site and respective regional authorities, first-aid service, rescue service, police office, fire office, operators of electricity, gas and water supply utilities to ensure adequate response in case of emergency.

## 11.8 Noise

The primary source of noise during operation would be machinery working at site (e.g., bulldozers, dump trucks, etc) and vehicular traffic. The magnitude of noise impacts during operation is considered to be limited due to location of the site at a significant distance from residential areas and separation of these areas from the landfill site by the road Yerevan-Sevan with high traffic load..

Noise impacts at the operation phase could be minimized through application of the following mitigation measures:

- Limit noisy activities to the least noise-sensitive times of day (weekdays only between 7 a.m. and 10 p.m.);
- All equipment should have sound-control devices no less effective than those provided on the original equipment. Motorized equipment should be adequately muffled and maintained;
- Insulate the administrative buildings at the landfill site;
- Install sound control devices (baffles, silencers) to limit noise levels of facility equipment;
- Landfill employees in the vicinity of sources of high noise shall wear necessary protection gear;
- Barriers (e.g. fences, etc.) or purpose-built acoustic screens should be used to reduce the noise reaching administrative building, where practicable;
- Avoid use of percussive and impact tools wherever possible;
- Machinery in intermittent use should be shut down or throttled down to a minimum when not in use;
- Personal protective equipment should be provided to employees for hearing protection, the sign boards and training procedure should be in place.

## 11.9 Odour

Operation of the regional landfill will allow to close the existing dumpsites and thus to stop odour nuisance from them for residents and visitors of the adjacent areas.

There are two main sources of odour during operation of the landfill: odour from the degradation of the organic waste and odour from the leachate pond. The key mitigation of odour nuisance will be achieved due to location of the landfill site to the south-south-west from residential areas, while the prevailing wind direction has south-western - north-eastern orientation.

The mitigation of odour can be achieved by the followings:

- Minimize duration of waste exposure at the landfill without cover, particularly during days with high temperatures;
- Unload, spread and compact the waste in the smallest area possible;
- Avoid parking full waste vehicles on site overnight;
- Directly recycle leachate from sumps and drains to leachate pond;
- Closely monitor and maintain the gas collection systems and flares;
- Regularly inspect and maintain top cover of landfill cells to ensure its integrity and development of vegetation cover;
- Washout vehicles and their substructure to reduce on road vehicle odour;
- Use waste collection vehicles with containers for leachate; regularly empty the containers at dedicated leachate collection points.
- Plan waste collection services for shortest possible storage of waste at collection points.

## 11.10 Spillage of hazardous or medical waste

During operation the landfill a dedicated area will be used for temporary storage of hazardous collected as a fraction of municipal waste. Negative impacts may appear if this waste fraction were not properly handled and were released to the environment as a result of accidental spills.

A set of mitigation measures to be applied to prevent spillage of hazardous or medical waste and minimize negative impacts in case of accidental spill include the following:

- Prepare a comprehensive list of all hazardous materials that can be used, stored, transported/kept in facility for temporary storage of hazardous waste during landfill operation;

- Develop a hazardous materials/medical waste management plan addressing storage, use, transportation, and disposal (interim and final) for each item in the list. The plan should identify specific details regarding emergency response;
- Develop a waste management plan identifying anticipated solid and liquid waste streams, and addressing inspection and waste minimization procedures, storage locations, and waste-specific management and disposal requirements;
- Develop a spill prevention and response plan for addressing storage locations of hazardous and medical wastes, spill prevention measures, training requirements, waste-specific spill response actions, spill response kits, and notifications to authorities;
- Train employees to promptly contain, report, and/or clean up any oil, hazardous material and/or medical waste spill;
- Provide portable spill containment and cleanup equipment in all vehicles;
- Develop a stormwater management plan to ensure compliance with regulations and to prevent off-site migration of contaminated stormwater or increased soil erosion;
- Containerize and periodically remove the hazardous waste for recycling or for disposal at appropriate off-site permitted disposal facilities;
- Document accidental releases as to cause, corrective actions taken, and resulting environmental or health and safety impacts.

### **11.11 Biodiversity**

Operation of landfill on the territory of the former clay quarry will not cause any significant negative impact on the wildlife. The site will be fenced and get a green belt of trees and bushes typical for the region. The green belt will prevent spreading of waste by wind and will be attractive for a variety of small birds. Proper coverage of waste during operation of the regional sanitary landfill should result in reduced number of crows on the site. At present, the numerous and noisy flocks of crows are constantly present on Hrazdan dumpsite. Closure of dumpsite and regular covering of waste at the landfill will ensure vermin and rodent control. Generally speaking, the impact of landfill on biodiversity will be negligible.

### **11.12 Sustainable natural resources management**

Issues related to management of natural resources during the landfill operation include optimisation of waste covering with soil (to avoid using too much soil and taking the landfill capacity), management of water resources on the site (for keeping the clean runoff separate and available for use within the area), optimi-

sation of vehicle routes, other energy saving measures. One of the measures for minimisation of soil use will be application of inert waste (e.g. construction waste) as cover material.

### 11.13 Greenhouse gas emissions

The landfill will generate landfill gas during the whole active lifetime, as well as during a long period after the landfilling has been completed. The whole period of landfill gas generation from the site depends on the waste type and anaerobic activity in the landfill. Experience from other landfills indicates that the period may be as long as 70 years. Installation of gas collection system will be carried out during the landfilling. Flaring/utilisation of landfill gas will be implemented after closure of the landfill. Assessment of GHG emissions and Emissions Reduction Units for the existing dumpsites which will be closed after establishment of the regional sanitary landfill in Hrazdan is difficult, because there is no information regarding age, composition, annual amounts and status of waste (e.g. how much of the waste was burned). Emissions from 6 existing dumpsites (Abovyan, Charentsavan, Hrazdan, Sevan, Byuregavan and Yegvard) are estimated to be about 3,500-5,000 tons CO<sub>2eq</sub>/year. This could be considered as a relatively large amount, but it is divided in 7 different locations, so the single source emissions are low. Based on the Feasibility Study, no active emission reduction projects were recommended at the existing dumpsites.

It is proposed to close all the existing dumpsites by a soil cover with a topsoil layer with grass (except for Byureghavan where the proposed cover consists of construction and demolition waste). A top cover layer with a humus layer will reduce methane emission as microorganism will, under favourable conditions, oxidise methane into CO<sub>2</sub> and water. The emission reduction potential is however difficult to assess as much of the landfill gas will penetrate through fissures, cracks etc. in the top cover and most like there will also be areas in the topsoil where humus is not present.

After closure of the sites it is assumed that the total CO<sub>2eq</sub> emissions from the existing sites in Kotayk Marz can be reduced from 3,500 - 5.000 tons CO<sub>2eq</sub> to 1,750-2,500 CO<sub>2eq</sub> per year.

### 11.14 Climate change and adaptation

Operation of landfill will be carried out according to procedures developed for the climate conditions during its design. However, the landfill design and development based on the best international practice allow to mitigate the impacts of extreme temperatures (e.g. lengthy too hot or too cold periods) or precipitation pattern (e.g. heavy rain, thick snow, drought), so that they are negligible for areas adjacent to the landfill. The landfill operation procedures will be updated, if necessary, according to the climate change trends. A trend to desertification of climate in Armenia can lead to higher evapotranspiration of leachate generated at the landfill.

### 11.15 Summary of environmental impact assessment during operation phase

Environmental impacts of the Project and measures required for mitigating the potential negative impacts during operation of the regional landfill and new waste management system for Kotayk Region and Sevan municipality are briefly summarised in Table 11.1.

*Table 11.1 Summary of environmental impacts and mitigation measures during operation of landfill and new waste management system*

<b>Impacts</b>	<b>Assessment</b>	<b>Mitigation measures required</b>
Change in drainage pattern	Negligible	-
Flooding potential	Negligible	-
Landscape impact of excavation and construction	Minor positive	-
Contamination of soil, surface water and groundwater	Moderate negative	Filling of waste in cells with installed bottom liner, surface runoff management, spill control, leachate management
Air pollution (dust and emissions from machinery, dust during soil works, spreading of waste by wind and birds)	Moderate negative	Maintenance of equipment, sprinkling of soil, covers during waste and soil transportation, management of green belt, littering control, fire control
Noise from machinery and vehicles	Minor negative	Operation during day hours, use of silencers, low on-site vehicle speed, PPE for workers
Odour	Minor negative	Maintenance of vehicles and machinery, systematic covering of waste, maintenance of buffer zone
Biodiversity	Negligible	-
Management of mineral resources (soil, grus)	Moderate negative	Use local materials where applicable
Greenhouse gas emissions	Moderate negative	Install and operate landfill gas collection
Climate change and adaptation	Negligible	-

## 12 Social Impacts and Mitigation Measures during Operation

Social impacts and mitigation measures relevant for the operation phase of the Project are described in the following sections of this chapter. The summary is provided after the description.

### 12.1 Socio-economic impacts

Major socio-economic impact during introduction and operation of the new waste collection system including the regional landfill will be related to increase of tariffs for households and other customers. As it discussed during comparison of applicable alternatives, the degree of tariff increase will depend on macroeconomic conditions, but mainly on the selected option of the waste management system and the revenue collection rate. The social impacts will be related to affordability of the future tariffs. Affordability threshold recommended for waste tariffs based on the international practice is 1% of the average income per capita. For the proposed Project the estimated tariff is about 0.95% of monthly income.

Mitigation of social impacts can be achieved by the following measures:

- Development, implementation and adjustment of tariff setting strategy for households and other customers (shops, organisations, hotels, unorganised tourists, etc.),
- Monitoring of incomes on annual basis and introducing the improvements making sure that the tariffs do not exceed affordability threshold approximately estimated as 1% of average income per capita (management of the tariffs will be the responsibility of municipal authorities, who will regulate the tariffs for population and other users of the waste management system),
- Introduction and maintenance of transparent system of waste registration,
- Improvement of billing and collection system,
- Raising of public awareness for improved collection of recyclable fractions,

- Marketing activities of the Company and/or municipalities for increasing sale of recyclable materials,
- Involvement of waste pickers in collection of recyclables and arrangements for their marketing.

Direct socio-economic impacts during landfill operation stage include establishment of new jobs for workers involved in waste collection, transportation and disposal at the landfill site, as well as for those involved in landfill operation activities. Indirect impacts will involve new jobs at businesses that support the expanded workforce or provide project materials, and associated income. Meantime, taking into account that the landfill is constructed (probably by an international contractor with recruitment of qualified local workforce) for the whole Kotayk Region and Sevan municipality, the employment impacts on local economy will be positive, but most likely negligible.

Key adverse social impacts of landfill construction usually include the increased traffic, noise, unpleasant odours and property devaluation of land close to the landfill. Therefore the assessment is that the investment in the regional landfill will have a positive impact on local employment.

Introduction of organized waste collection will contribute to overall sustainable socio-economic development at local and regional level. The potential social impacts during the landfill operation stage are assessed as positive and considered to be a significant step forward towards sustainable development.

Land use impacts are considered to be negligible, as the landfill is located within the community owned land.

## 12.2 Impact on cultural heritage

Impacts on cultural resources are also considered to be negligible, as the excavations have been made in the area of former clay quarry before the project, thus probability of finding or impacting cultural resources at the operation stage is almost nonexistent. However, the following mitigation measures applicable for construction phase remain valid for operation stage as well, in order to prevent cultural resource impacts:

- Use existing roads to the maximum extent feasible to avoid additional surface disturbance;
- Periodically monitor cultural resources in the vicinity of the landfill site (if any);
- An unexpected discovery of cultural resources during any phase of the project shall result in an immediate stoppage of civil works in the landfill site. The relevant information should be provided to the State Agency for Protection of Historical and Cultural Monuments, which after due considera-

tion of the findings will recommend whether the works can be continued or the design must be revised;

- Educate workers and the public on the consequences of chance finds and unauthorized collection of chance findings.

### **12.3 Occupational health and safety issues**

Possible impacts to health and safety during landfill operation stage can include accidental injury or death to workers. Health impacts could result from exposures to chemicals and products used and produced in landfill facilities, air emissions, and noise. Potential fires and explosions will cause safety hazards. Gasoline or diesel might also be stored on site. In addition, health and safety issues include working in potential weather extremes and possible contact with natural hazards, such as uneven terrain and dangerous plants, animals, or insects.

All personnel involved in operation of the landfill would utilize appropriate safety equipment and would be properly trained in required occupational health and safety practices.

Measures recommended for mitigation of potential adverse impacts include the following:

- Closely monitor application of appropriate occupational health and safety practices at the landfill site, in particular while working with electrical equipment, welding equipment, heavy and lifting mechanisms, etc.
- Consult with local planning authorities regarding traffic and traffic hazards. Address specific issues in a traffic management plan;
- Identify all applicable occupational safety standards and establish safe work practices;
- Fence and monitor the landfill site to prevent public access;
- Use appropriate procedures for storage and transportation of explosive materials, including appropriate signage indicating their location;
- Train landfill personnel on appropriate actions to be taken in case of fire, wastewater leakage, etc.;
- Provide appropriate personal protective equipment (uniform, mask, gloves, glasses, boots, etc) to landfill employees;
- Install fire resistance measures, ensure availability of appropriate tools;
- Ensure availability of first aid kit with appropriate medicaments in all vehicles and buildings at the landfill site.

## 12.4 Visual impacts, including view from the main road

It is expected that landfill will be operate during 10-12 hours/day in a 7 days/week. Waste received at the landfill will be placed in cells, covered with a daily soil cover and compacted by tracking plant over the placed waste. It is estimated that the minimum disposal volume at the landfill should be at least 1,200,000 m<sup>3</sup> to enable regional landfill operation for 20 years.

Every batch of waste disposed in the site will be covered with dredged soil of at least 200mm thickness on a daily basis, which means that the colour of the operational cell and the perimeter/surrounding soil bunds will merge with the background (where yellowish-brown colours prevail). The size of the waste mounds at both landfill sites will increase gradually. The expected average height of the landfill is approximately 11m.

As was mentioned above, the surrounding area is generally undeveloped and of limited agricultural interest. It is anticipated that the area surrounding the landfill site will not be used for recreation or purposes other than agricultural. The only industrial developments in the local area is the ongoing excavation of clay for the needs of the cement plant, which is located at some distance from the proposed site and will unlikely be affected by any “deterioration” of landscape and visual amenity. Thus, it can be concluded that the visual impacts during the operation of the proposed landfill will be low.

The following mitigation measures are recommended to ensure minimum impacts during operation phase:

- Maintain the site during operation of the facility. Inoperative or damaged equipment and poor housekeeping, in general, creates a poor image of the activity in the eyes of the public;
- Avoid uncoated galvanized metallic surfaces;
- Use existing roads and disturbed areas to the maximum extent feasible to avoid additional surface disturbance;
- Lighting for facilities should not exceed the minimum required for safety and security.

After completion of the operational life of the landfill, all remaining soil mounds will be graded to merge with the surrounding landscape. Therefore a low residual visual impact is likely, as the mounds will gently merge into the surrounding environment and the office and other facilities will have been removed. Landscaping of the site following closure will replicate as closely as practically possible, the natural features of the surrounding landscape.

## 12.5 Labour and Working Conditions

According to the Labour Code of the Republic of Armenia, employers - as a part of landfill operation process - need to assess potential risks in order to ensure the safety and health of employees (depending on the size of the landfill operator, such assessment can either be performed by its specialists or hired experts), as well as inform landfill employees on safety practices, and develop action plans to be followed in case of emergency. The operator can establish a special committee dealing with worker's health and safety issues. The landfill operator shall ensure appropriate working conditions, so as the employees can duly implement their working duties. In particular, the construction company shall ensure:

- Proper working condition of mechanisms, equipment and other devices;
- High quality and timely provision of materials and tools to be used by employees;
- Reliable and uninterrupted supply of electricity, gas and other sources of energy to ensure proper operation of landfill facilities;
- Safe working conditions for employee's health (preservation of safety norms and rules, proper lighting, heating, ventilation, level of noise lower than the minimum norms accepted, vibration, and other factors that may negatively impact the health of employee);
- Presence of emergency exits that are permanently accessible, free of physical obstacles. All workers should be well aware of location of emergency exits;
- Availability of fire extinguishers in all the vehicles and landfill facilities;
- Availability of first-aid kit in all the vehicles and landfill facilities. All the employees shall be periodically trained in delivering first aid, and should be informed about the location of first-aid kit;
- Monitoring of employee's physical condition, strictly prohibit use of alcohol, psychotropic drugs and narcotics in work sites.

## 12.6 Population movements

No resettlement, temporary or permanent acquisition of land, property and other assets is required for landfill construction.

The likelihood of population growth following the in-migration of the operation workers associated with landfill development and associated facilities in communities is very limited, taking into account the scale of the employment opportunities offered as a part of the project.

## 12.7 Economic impacts

The regional sanitary landfill will be operated by a company with 6 managers and 17 other employees.

The management/administration will include the following staff:

- Managing director
- Financial Manager
- Accountant
- Environmental / HR /Public information Manager
- IT Specialist
- Secretary

Profiles of 17 staff required for landfill operation department will be as follows:

1 landfill foreman,  
6 skilled workers for operation of the landfill installations and on-site vehicles,  
4 unskilled workers for routine work,  
1 foreman of waste collection team for rural areas,  
2 drivers for waste collection from rural areas,  
3 guards for permanent watching of the whole facility.

The overall impact of landfill operation on the regional economy and employment situation is negligible. On the other hand population of Kotayk Region and Sevan municipality will significantly benefit from establishment of organized waste removal, transportation and disposal process. Indirect positive impact on business opportunities will be related to catering services (e.g. for employees of the landfill company, drivers of waste collection vehicles), but also assignments for consulting companies (e.g. for monitoring of leachate wells, runoff, groundwater, preparation of reports according to environmental monitoring programme approved by the environmental authorities and the EBRD),

Traffic volumes on the roadways used to access the landfill will increase during the operation period, in order to transport waste to the site. The overall rating of such impacts is minor.

The impact on farming land is likely to be minimal, as the landfilling should have no impact on the ability to farm nearby lands, providing the facility operates within normal conditions, in particular with respect to control of vermin, dust, litter, and management of surface water and groundwater.

During operation the landfill is not expected to generate any additional demands on utility services (water, electricity, etc.). These services are required for the on-site facilities and employees.

## 12.8 Community Health, Safety and Security

The Project proposed for improvement of waste management system in Kotayk Region and Sevan municipality will have a major positive impact on the health and safety of population. Closure of dumpsites, clean-up of waste from access roads to the dumpsites and prevention of dumping after establishment of modern waste collection system with the regional sanitary landfill will improve the environment in residential areas and will lead to better waste management habits of population.

During the landfill operation the community health, safety and security may be impacted from dust and noise caused by trucks transporting waste from communities to landfill. Health risks at landfill are usually associated with exposure to vermin, contact with leachate and emissions of smoke in case of fires.

Taking into account that landfill site is located at a sufficient distance from residential areas, no increase in incidence of communicable diseases, deterioration in health or access to healthcare facilities is expected to occur during landfill operation. Meantime, it should be noted that timely removal of waste from communities and proper operation of landfill would reduce odour impacts, health risks and infectious diseases, which may appear as a result of waste accumulation and its improper disposal in the communities.

To prevent any potential negative impact on community health, safety and security the following measures are proposed for the landfill operation phase:

- Provide information about waste removal schedule to the communities, ensure that appropriate information leaflets are posted in places of community gatherings (e.g. major office, shops, post office, cultural club, library, medical station, etc.), so as the population is aware of the new waste collection procedures;
- Install appropriate warning signs at the entrance of landfill and at collection points in communities;
- Fence landfill site to prohibit entrance of unauthorized people;
- Use covered/closed trucks for transportation of waste, use vehicles with leachate collection containers to prevent spills;
- Increase frequency of waste collection at hot season of the year;
- Plan waste collection routes and limit speed of waste collection trucks passing through the communities to minimize nuisance from noise and vibration and to ensure traffic safety;
- Obtain feedback from communities and use grievance mechanism for evaluation and adjustment of waste collection and landfill operation;
- Maintain sanitary protective (buffer) zone of the landfill.

## 12.9 Education

During landfill operation it is not expected that access to educational facilities will be impacted. Taking into account that landfill site is located at a sufficient distance from residential areas, it is not likely that project would impact operation of education facilities. The potential minor impacts may include noise and dust nuisance from the trucks that transport the waste. Meantime, education facilities may benefit from the project by organizing practical lessons and visit operating landfill as a part of regular school course on ecology/environment to ensure better understanding of waste disposal practices and provide special thematic training to pupils.

## 12.10 Social Conflict

Introduction of organized waste collection and disposal services requires a change of attitude of the population, services and enterprises that at early stages of the process may cause some social tensions. Population, services and enterprises have to acknowledge that it is their responsibility to care for sustainable and environment friendly development. This responsibility starts with the timely collection of the costs for waste collection and disposal from all stakeholders. The beneficiaries of the municipal waste management system also have to pay at a level that allows the landfill operator to recover the cost of providing a modern, well-regulated and efficient service. In some cases, municipalities, especially rural ones, underestimate landfill operation cost. In some cases representatives of vulnerable groups cannot afford payment for waste collection, which may also lead to creation of social tensions within community.

Uncontrolled scavenging is often perceived as a potential negative impact. There could be fear that the waste-pickers will move to the communities located nearby landfill area. Another issue is that child labour in any stage of waste collection and landfilling process must be strictly prohibited and prevented to the extent possible. No children have been observed to be involved in waste picking in Kotayk Region and Sevan municipality during preparation of the ESIA.

Overall, addressing the major social concerns depends in large part on raising public awareness of the issues and changing behaviour in waste collection and disposal. The behaviour and capacities of the public sector in managing, supervising and monitoring landfilling project activities also needs to be enhanced.

## 12.11 Gender

Gender issues will be addressed during operation of the regional waste management system. Establishment of sufficient number of adequately equipped and placed waste collection points, improved schedule of waste collection, clean-up of waste spread near collection points in the streets will be appreciated by whole communities of Kotayk Region and Sevan municipality, but particularly by women, who are typically caring of taking the garbage out of homes and also spend more time at home and in the areas close to homes, when they take care of children, kitchen gardens and local shopping.

Equal opportunities will be provided for employment and remuneration of men and women with the Landfill Company. By involving the NGOs and/or consulting companies in opinion surveys the PIU, landfill management company and/or the Project cities make sure that men and women are consulted during evaluation of the quality of services and assessment of the improvements achieved and still required. Relevant experience is available with NGO "Women with University Education" operating with a branch in Kotayk Region. The Project would benefit from obtaining from (mostly female) house-keeping personnel of hotels, hospitals, shops, catering companies their feedback on waste collection services. Men will be consulted with regard to collection of recyclables and functioning of bring banks. These and other efforts for receiving a feedback from various groups of population with attention to the interests of men and women are recommended to prevent negative attitude to the Project and to enhance its positive social impacts, so that men and women could benefit from improvement of waste management system in Kotayk Region and Sevan municipality during the Project implementation.

## **12.12 Impacts on vulnerable groups**

Key vulnerable groups during operation of the regional landfill and new waste collection system will include people affected by economic displacement due to temporary or permanent restriction of access to productive assets. The assets to be considered include the land plots near the landfill site (resource for the land owners) and the municipal solid waste (as resource for waste pickers).

Owners of land near the landfill site could be affected by pollution (e.g. littering) from the landfill. Only some of the land plots were actually used (for agriculture) during preparation of the Feasibility Study and the ESIA. A map of land plots titled in the vicinity of the existing dumpsite of Hrazdan and former clay quarry and the names of their owners was received from Hrazdan Mayor Office, but the map was reportedly outdated. This issue will need attention of the landfill company for the local negative impact of this kind could be avoided, mitigated or compensated. The Project grievance mechanism will address the issue. On the other hand, it is expected that proposed closure of Hrazdan dumpsite, upgrading and maintenance of access road to the site will have positive local impact on the conditions of the adjacent land plots.

Attention to the informal waste pickers/recyclers is important as changes in this area (e.g. closure of dumpsites, restricted access to waste in containers and at the regional landfill) can have significant consequences on the livelihoods of vulnerable people.

The impacts on vulnerable groups during operation phase of the Project will be addressed within the Environmental and Social Action Plan (ESAP) of the Project. Approach elaborated during construction of the landfill and establishment of the new waste management system could be further developed during the stage of operation with further elaboration of Livelihood Restoration Framework agreed with the vulnerable groups.

### 12.13 Summary of social impacts during operation phase of the Project

Summary of identified social impacts of the Project and measures required for mitigating the potential negative impacts during operation of the regional landfill and new waste management system for Kotayk Region and Sevan municipality are briefly summarised in Table 12.1. The landfill operation is planned for about 20 years and thus will have long-term social impacts.

*Table 12.1 Summary of social impacts and mitigation measures during operation phase of the Project*

<b>Impacts</b>	<b>Assessment</b>	<b>Mitigation measures required</b>
Increase of tariffs, higher collection rate of fees	Moderate negative	Increase of public awareness, transparency of tariff setting for households and other customers
Labour and working conditions, occupational health and safety	Minor positive	-
Visual impacts	Minor positive	-
Population movements	Negligible	-
Economic displacement (users of land adjacent to landfill, waste pickers)	Minor negative	Information, avoidance, compensation
Community health, safety and security	Major positive	-
Education	Negligible	-
Social conflict	Minor negative	Operation of landfill management company and transparent procedure for regulation of use fees and landfill gate fee
Gender	Minor positive	-

### **13 Environmental Impacts and Mitigation Measures during Final Closure and Aftercare of the Landfill**

This chapter and the next one are related to the Project phase, when the first regional landfill is filled up to its maximum capacity and should be closed, and a new facility for disposal of municipal solid waste should be made available for the Kotayk Region and Sevan municipality. It is assumed that the regional waste collection and transportation system will continue its operation. Certain impacts could be related to decommissioning of containers and waste collection trucks, landfill operation machinery, but they would be the same as during the operation and maintenance phase of the regional waste management system with landfill. That is why the specific environmental impacts and mitigation measures for this phase of the Project should be considered mainly with regard to closure and aftercare of the regional landfill.

Many of impacts related to final closure of landfill are expected to be similar to impacts of landfill construction and operation phases. The impacts and issues should be addressed for this phase in a way similar to construction and operation phases. A Landfill Closure and Aftercare Manual should be developed prior to the landfill construction starts and updated during the operation and the cell-by-cell development of the landfill. The Manual should include the mitigation measures to be implemented at the landfill site during and after the landfill closure, i.e. during and after establishment of the final cover.

Special attention during the landfill closure should be focused on decommissioning of facility used for temporary storage of hazardous waste fraction of the municipal solid waste. The hazardous waste management plan prepared during the landfill operation should be updated and its component related to disposal of the hazardous waste implemented.

Impacts of aftercare will be mostly related to leachate and landfill gas. They are also discussed in the chapter addressing the residual impacts and risks.

Some of the impacts and mitigation measures at the stage of landfill closure and aftercare are briefly described in the following sections of this chapter. The summary assessment of impacts is presented after the description.

### **13.1 Landscape**

During landfill closure and aftercare it is recommended to:

- Remove all unnecessary aboveground structures and facilities from the landfill area;
- Re-establish the terrain and drainage pattern similar to natural conditions of the adjacent areas;
- Restore the vegetation cover, composition, and diversity commensurate with the ecological setting;
- Review reclamation efforts and weed control periodically until the site is determined to have been successfully reclaimed;
- Stabilize all areas of disturbed land using weed-free native shrubs, grasses, and forbs;
- Use plant species characteristic for the landscape in the course of restoration of the vegetation cover on reclaimed areas;
- Restrict construction activities on the landfill site after closure.

#### **13.1.1 Pollution of surface water and groundwater**

During landfill closure and aftercare it is recommended to:

- Regularly inspect and clean drainage ditches/ culverts;
- Regularly inspect leachate collection and treatment facilities to ensure proper operational technical conditions;
- All vehicles must be regularly checked and their normal operational technical conditions shall be ensured. In case any leakage of oil or other liquid is observed, the vehicle must be moved to a paved impermeable area and be immediately fixed;
- Surface runoff should be managed for directing clean runoff away from sources of possible contamination;
- Groundwater and surface water quality shall be monitored at regular intervals during operation and decommission phases.

### **13.2 Assessment of environmental impacts for the Project phase of landfill closure and aftercare**

The environmental impacts of the Project and measures required for mitigation of potential negative impacts during the landfill closure will be rather similar to

impacts during operation of the landfill. The impacts for closure and aftercare phase of the proposed Project are briefly summarised in Table 13.1.

*Table 13.1 Environmental impacts and mitigation measures during landfill closure and aftercare*

<b>Impacts</b>	<b>Assessment</b>	<b>Mitigation measures required</b>
Change in drainage pattern	Negligible	-
Flooding potential	Negligible	-
Landscape impact of excavation and construction	Negligible	-
Contamination of soil, surface water and groundwater	Minor negative	Surface runoff management, leachate management, top cover maintenance, sending hazardous waste from temporary storage facility to final disposal
Air pollution (dust and emissions from machinery, dust during soil works, spreading of waste by wind and birds)	Minor negative	Maintenance of equipment, sprinkling of soil, covers during waste and soil transportation, management of green belt, littering control, fire control
Noise from machinery and vehicles	Negligible	
Odour	Minor negative	Maintenance of vehicles and machinery, systematic covering of waste, maintenance of buffer zone
Biodiversity	Negligible	-
Management of mineral resources (soil, grus)	Moderate negative	Use local materials where applicable
Greenhouse gas emissions	Moderate negative	Install and operate landfill gas collection
Climate change and adaptation	Negligible	-

## **14 Social Impacts and Mitigation Measures during Closure and Aftercare**

This chapter, like the previous one, is related to the Project phase, when the first regional landfill is filled up to its maximum capacity and should be closed, and a new facility for disposal of municipal solid waste should be made available for the Kotayk Region and Sevan municipality. Some of the social impacts and mitigation measures relevant for the landfill closure and aftercare phase of the Project are in described in the following sections of this chapter. The summary of their assessment is included after the description.

### **14.1 Labour and Working Conditions**

It is expected that the Landfill Management Company (the Company) and contractor(s) involved in closure and aftercare activities comply with the EBRDs PR2. The Company should develop and implement the adequate retrenchment policy, which might include re-training of the staff and offering alternative employment opportunities, e.g. with a company operating a new regional landfill for Kotayk Region or for some other region in Armenia.

### **14.2 Population movements**

No temporary or permanent acquisition of land, of property or of economic assets is envisaged during closure and aftercare. No migration into or out of area is envisaged after closure of the landfill.

### **14.3 Economic impacts**

The economic impacts and mitigation measures will be identified and determined prior to closure of the landfill and necessary mitigation measures will be included in the Landfill Closure and Aftercare Manual. These impacts could be related to the following spheres:

- Impact on economic assets including land, access road;
- Reduction of direct and indirect employment.

#### **14.4 Community Health, Safety and Security**

The ESIA may need to identify how the Project could influence the health of the affected communities. There are a number of effects that need to be considered:

- Environmental conditions created by Project which may lead to deterioration in health.
- The impact of the Project on access to health care facilities.
- Security of the site for prevention of access to facilities posing risks (e.g. leachate pond).
- Signage and information for preventing damage and excavation of landfill topcover.

The potential social impacts associated with the landfill closure and aftercare are expected to be less significant than during construction and operation of the landfill, but a set of measures should be taken to mitigate the potential negative impacts.

#### **14.5 Education**

The supplementary environmental and social studies to be completed prior to the start of construction works can address the impact of the Project on access to education facilities. There could also be identified opportunities for the education facilities to benefit from the Project.

#### **14.6 Social Conflict**

At the present stage of the ESIA it is difficult to foresee social conflicts relevant for the Project. The conflicts could be caused by changes in interests of the Project stakeholders and changes in relations between them. These and other issues will need to be considered further during Project implementation.

#### **14.7 Gender**

As discussed above, due to the different roles of men and women in waste collection and with respect to waste picking, the impacts of the project will also be different. These will need to be monitored during implementation to see if any measures are required.

#### **14.8 Impacts on vulnerable groups**

The impacts and mitigation measures will be assessed as part of the supplementary environmental and social studies to be completed prior to the start of construction works.

## 14.9 Assessment of social impacts during the phase of landfill closure and aftercare

It is assumed that by the time of the proposed Hrazdan landfill closure and aftercare a new option for waste disposal (e.g. a new landfill) will be available for the region. Social impacts of the Project and mitigation measures required during the landfill closure and aftercare phase of the proposed Project are briefly summarised in Table 14.1.

*Table 14.1 Social impacts and mitigation measures during landfill closure and aftercare*

<b>Impacts</b>	<b>Assessment</b>	<b>Mitigation measures required</b>
Increase of tariffs	Major negative	Availability of affordable new waste disposal option
Labour and working conditions, occupational health and safety	Negligible	-
Visual impacts	Minor positive	-
Population movements	Negligible	-
Economic displacement	Negligible	-
Community health, safety and security	Major positive	-
Education	Negligible	-
Social conflict	Negligible	-
Gender	Negligible	-

## **15 Management of Residual Impacts and Risks**

The residual impacts and risks of a project are typically considered in terms of the potential for accidents and incidents (such as oil spills, explosions, contaminant release, dam failure, etc). The nature of key residual impacts should be described and their significance assessed in the ESIA.

### **15.1 Residual environmental impacts and risks**

Management of residual environmental impacts and risks should be the subject of contingency planning. The Project will include development of emergency preparedness and response plan for the landfill management company. It will also include requirement for emergency preparedness and response planning in tender documents and in the contracts.

The Emergency Preparedness and Response Plans should be coordinated with the local authorities and establishments of the RA Ministry of Emergency Situations.

Closed landfills with the proper cover and aftercare measures typically do not pose major environmental risks. There is even an internationally known practice of urban development projects implemented on top of former landfills. However, the following risks are to be addressed in the Project:

- fire (even though this risk is lower than during operation of the landfill),
- disruptions of power supply, water supply, telecommunication lines (the back-up arrangements should be included in the Project design),
- escape of landfill gas (and its possible impact on indoor climate),
- spills of leachate (due to malfunctioning of leachate management system),
- erosion or damage of the landfill cover.

For the specific conditions of Armenia it is important that the buildings and installations of the landfill are constructed taking into consideration the high level of seismic activity and the climate change trends.

## **15.2 Residual social impacts and risks**

Social risks are very context-specific and could be related to the following factors:

- Economic changes such as inflationary trends;
- Political changes which may make it difficult to implement particular mitigation measures;
- Unforeseen events such as natural disasters;
- Conflicts between municipalities participating in the Project, collapse of regional cooperation.
- Lack of skilled people to implement mitigation measures;
- Weakness of enforcement measures (e.g. for prevention of waste dumping, for collection of revenues);
- Insufficient capacity for supervision and monitoring.

More detailed information about residual social impacts and risks will become available once the supplementary environmental and social studies are completed.

## **16 Project Benefits and Opportunities for their Enhancement**

The Project is expected to provide major environmental and social benefits for Kotayk Region and Sevan municipality as a result of introduced sound collection and disposal of municipal solid waste, prevention of waste dumping and its burning.

The following specific benefits could be achieved during the Project implementation:

- Improved collection and transportation of waste in urban municipalities;
- Increased coverage of waste collection services for rural municipalities;
- Improved conditions and visual image of residential areas and their surroundings;
- Sound disposal of waste;
- Improved working conditions of waste management operators;
- Gender aspects of the Project;
- Improved environmental awareness, education, public participation
- Improved attractiveness of the region for tourists;
- Local business development and capacity building;
- Improved governance and transparency.

It is expected that the environmental and social benefits of the Project will have a long-lasting effect for Kotayk Region and Sevan municipality, but will also have a demonstration effect for Armenia and other countries. The environmental and social benefits could be enhanced within implementation of the Environmental and Social Action Plan in cooperation with the local stakeholders. Opportunities for enhancement of environmental and social benefits of the Project, as well as the information on the actions in progress and the already completed actions should be presented in the Stakeholder Engagement Plan, which should be systematically updated during the Project.

## **16.1 Enhancement of environmental benefits**

### **16.1.1 Remediation and Clean-up of contaminated sites**

Availability of regional landfill will provide background for remediation and clean-up of sites in Kotayk Region and Sevan municipality currently occupied by dumpsites.

### **16.1.2 Habitat enhancement**

The Project will contribute to protection of natural habitats and improvement of modified habitats.

Habitat enhancement will be ensured by lowering risks of further spreading of dumpsites in natural and modified habitats. This will require enforcement of safe disposal of waste at the regional sanitary landfill.

Enhancement of habitat in the coastal zone of the Lake Sevan will be achieved by closure of existing dumpsites and prevention of further transportation of waste to sites within the catchment area of the lake. The closure will be carried out taking into consideration the site specific landscape peculiarities and drainage conditions.

To avoid impacts on natural habitats, it is proposed to establish the landfill within the modified habitat area of the former quarry of clayey material next to the existing dumpsite of Hrazdan municipality. None of the quarry sections has been rehabilitated after about 30 years of the quarry operation. Waste from dumpsite and heaps of rejected soil left after excavation of the clay cover at least a quarter of the former quarry area. Construction of landfill will result in large-scale habitat improvements.

Enhancement of small-scale habitats associated with the existing two seasonal water pools within the area of former clay quarry will be achieved by using the largest of the pools as a reservoir for collection of clean surface run-off from the landfill area.

### **16.1.3 Set-aside**

The landfill territory, which will be fenced, will include the areas of water pools which are at present visited by cattle. The Project benefits could be enhanced by providing the cattle with access to an outlet of the clean surface water collection pond established within the landfill site.

### **16.1.4 Energy and Resource Efficiency**

The Project includes procurement of modern vehicles and machinery of waste collection, transportation and disposal at the regional landfill. Tender specifications for procurement of all equipment, vehicles and machinery will include requirements regarding energy efficiency.

Resource efficiency of the Project will be achieved in case of gradual purchase of equipment and gradual development of the landfill.

Gradual purchase of equipment and its installation will allow avoiding the purchase of equipment, e.g. containers, not fitting the local physical conditions, waste collection practice and habits.

Gradual development of the landfill will assume construction of the cells according to the filling progress and demand. It is also propose that installation of the landfill gas collection system should be considered at later stage of the landfill development, e.g. after closure of its first cell.

For efficient use of vehicles and machinery the Company will operated a set of equipment sufficient for daily operations at a current stage of the landfill development. For example, equipment for picking up the leachate from the leachate pond and spreading it over the body of accumulated waste could be purchased later or rented (e.g. from a wastewater collection company).

One more aspect of resource efficiency will be collection of recyclable waste fractions, as well as the use of locally available construction materials, wherever applicable.

Installation of covers for the irrigation canal at its crossing by the access road to Hrazdan landfill site will enhance the benefit of preventing contamination of the irrigation water with possible dust from vehicles.

The Project will assume clean-up of areas contaminated with waste along the roads leading to the dumpsites.

Considerable benefit of the Project could be expected in case the recycling schemes are implemented for a few waste fractions at early stage of the system operation and further developed by covering additional fractions at later stage of the Project.

### **16.1.5 Cleaner Technology**

The Project implementation will ensure introduction of the cleaner technologies for waste collection, transportation and disposal. Enhancement of the Project's benefit could be achieved by a set of arrangements with recyclers of selected waste fractions. At a later stage of the Project it would be advisable to consider opportunities for collection of landfill gas and utilisation of its flaring energy, e.g. for district heating, hot water supply or heating of greenhouses.

### **16.1.6 Institutional Strengthening**

The Project will result in establishment of the first Project Implementation Unit and the first Company for a regional waste management system in Armenia. Institutional strengthening will be enhanced and it cooperation with the waste management companies providing services in 8 urban municipalities. Institu-

tional strengthening of the system could be enhanced by the PIU's and the Company's support to the regional administration and to authorities of urban municipalities in establishment of an efficient institutional setup for cooperation with the rural municipalities.

### **16.1.7 Capacity Building**

The Project benefits related to building of the local waste management, community mobilisation and environmental management capacity could be enhanced by involving the staff of municipal waste management companies in the training sessions and workshops.

Enhancement of the Project benefit for the local capacity building could be supported by including the requirements for training of the local staff into the tender documents and contracts for the equipment and machinery suppliers.

## **16.2 Enhancement of social benefits**

Whilst social impact assessments are generally concerned with mitigation of negative impacts, they also present an opportunity for impacted people to take advantage of and benefit positively from the Project. Areas of the Project benefit may include:

- temporary and permanent jobs within the Project
- opportunities for local firms to sub-contract services
- opportunities for local firms to supply goods
- in cases where relocation is required there may be opportunities to improve the housing condition of people relocated.
- Project may be able to link up with local schools and other educational centres to create opportunities for learning.

Like many other projects financed by the EBRD and other international organisations, the Kotayk Solid Waste Project will have its particular opportunities for facilitating the local development. These opportunities should be considered in dialogue with the local authorities and during the public consultation.

In exploring the strategy for development opportunities, particular attention should be given to vulnerable categories within the area of impact. Unless very specific measures are taken, they are likely to be excluded from development gains. It is important to remember that particularly with this group of people, participatory or community demand driven approach to campaigning will not necessarily ensure that they are included in the benefits. Moreover, special measures may be required to enable certain categories to take part in activities, for example employment of disabled people may require the setting of special facilities.

Communities participating in the Project will consider involving the elderly and disabled people in communicating the advantages of the new waste collection system in urban and rural communities. The elderly people should be consulted, before the closure of chutes is implemented in each specific residential block. The Project would advise the municipal waste management companies to make sure that the elderly and disabled persons receive adequate support for collection of their waste. The PIU and the Company could arrange workshop(s) to discuss the lessons learned and to promote the best practice.

#### Gender analysis

Gender aspects of social benefits and opportunities for their enhancement should be identified and addressed during the Project. Questions that need to be discussed could be as follows:

- What are men and women's social and economic roles in municipalities involved in the Project?
- Will the project impact adversely on men and women's social and economic roles.
- What institutional arrangements have been made for consulting with women?
- Are there equal opportunities for both men and women to benefit from the Project?
- Are there barriers to women's participation and how can they be overcome without creating tensions within the community?

#### Public monitoring

Elderly and disabled people, who spent most of their time at home, could be involved in selecting the optimal location of waste collection points and in monitoring the performance and status of the waste collection points. Elderly people are typically rather attentive to cases of vandalism, incompliance with established rules, spreading of waste, disruptions in services, etc. Elderly people are used to conveying messages to local authorities on phone and during meetings. This experience can be used for a public monitoring system, which can facilitate for improvement of waste collection services in Kotayk Region and Sevan municipality. At the same time many elderly people in Armenia are very much interested in improvements and are opened for expressing their opinions in telephone interviews. This kind of social feed-back and public monitoring services could be remunerated (payment, presents, promotional items with logo, etc.) by the Landfill Management Company or by the municipal waste management companies.

Public monitoring and community mobilisation could be an efficient measure for prevention of unauthorised dumping of waste in coastal zone of the Lake Sevan. This measure should be combined with other measures, e.g. with introduction of a fee for cars entering the most visited tourist sites within the Lake Sevan coastal area. Experience from various countries shows that even a very low "symbolic" fee will facilitate for more precise assessment of the number of visitors and quantities of their waste during the year and at the same time can

cover some of the costs related to collection and disposal of waste generated by the unorganised tourists.

Enhancement of Project benefits for building of the local capacity for waste management could be achieved by inviting the staff of municipal waste collection companies to training sessions and workshops arranged by the Project for the staff of the landfill management company. One of the key issues during the training sessions would be the local capacity building for environmental management in line with the EBRD Performance Requirements.

## 17 Environmental and Social Monitoring

Monitoring of the Project performance should focus on key indicators agreed with the EBRD and the Ministry of Nature Protection of Armenia for assessment of the social and environmental impacts. Indicators should be aligned to elements of the existing pre-project baseline and be specific, measurable, achievable, relevant and conducted at an appropriate frequency.

In order to verify the effectiveness of mitigation measures and the compliance of the Project with the national regulations and the EBRD Performance Requirements, the Project implementation will include establishment and implementation of the following three major monitoring programs:

- Contractor/Supplier Compliance Monitoring Program (CCMP)
- Environmental Monitoring Program (EMP) for the landfill
- Social Monitoring Program (SMP) focused on the Project impact on the communities

The programs will provide information on the actual impacts and could also serve as tools for identification of unforeseen and not addressed impacts.

The CCMP will be carried out as part of contractor supervision during construction works.

### 17.1.1 Environmental monitoring program (EMP) for the landfill

The EMP will include baseline monitoring activities which will be started during construction of the landfill and monitoring activities during operation, closure and aftercare of the landfill.

#### Objectives of monitoring

Environmental monitoring program will be an integral part of the Landfill Operation Manual. The objectives of the monitoring are as follows:

- collection of information on the situation before landfill establishment and before landfill closure;

- assertion of the effect of environmental measures as provided in the design;
- evaluation of processes within the waste mass;
- assertion of compliance with the permit provisions.

The monitoring program will include field measurements, laboratory analyses and preparation of reports. Some of the field measurements could be carried out by the landfill company staff; however, most of the monitoring activities should be assigned to competent contractors.

#### **Maximum allowable/permitted concentrations (limit values)**

These are parameter values indicating significant environmental pollution and the need for corrective actions aimed at evaluation and prevention in case of exceeded limit values. These values must be specified in the permit for landfill operation and assessed by a landfill operator. The limit values are established by the national regulatory authorities typically with reference to the national or international (EU) standards. They are case specific for each landfill and should be identified based on the results of baseline monitoring and verified during the monitoring of landfill compliance with the permit. The exceeded values of main parameters demanding implementation of corrective action program must be indicated in the environmental permit for landfill establishment and operation or approved by the national regulatory authorities.

#### **Scope of EMP**

Monitoring is required during the whole lifetime of a landfill. The monitoring program typically includes pre-operational, operational and post-operational phases. The monitoring program will be launched before the landfill operation. The monitoring results will be regularly evaluated, so that the monitoring program can be adjusted and a corrective action implemented, if required.

A scope of monitoring program for landfills typically includes the following environmental aspects that may be influenced during landfill operation:

- Waste acceptance
- surface water;
- groundwater;
- leachate;
- landfill gas;
- meteorological data;
- odour;
- noise;
- dust;
- flora and fauna;
- landfill stability and settlement of disposed waste.

For the regional landfill in Hrazdan the key aspects of monitoring will include monitoring of surface water, leachate, landfill gas and groundwater.

**Waste Acceptance Monitoring**

A topographic survey of the waste disposal area will be carried out prior to commencement of the waste deliveries to the landfill and then on an annual basis for monitoring of amount and settlement of waste deposited.

During the landfill operation the Company will carry out a routine monitoring of waste received at the landfill and prepare monthly and annual reports including, inter alia, the following information on the Company operations:

- Types and amounts of waste (in tonnes) delivered and disposed of at the site
- Estimated volume of waste disposed off (based on topographic survey)
- Estimated remaining disposal volume at available disposal units (cells)
- Mileage and/or number of operating hours for trucks and other movable equipment belonging to the Company.
- Fuel consumption
- Staff employed at the plant during the year
- Costs

The results should be analysed, evaluated and recommendations made to management for improving performance. The remaining capacity of the landfill and its life span should also be evaluated.

**Surface water monitoring**

The landfill site is located in the closed basin on the bottom of the former clay quarry. Surface water entering the landfill site from adjacent territory (e.g. during snow melting or heavy rains) and from precipitation on the landfill territory will be collected in ditches, and thus prevented from contact with waste, and accumulated in a surface water collection pond established in the lowest elevation area in the northern part of the landfill site. The monitoring will be carried out for assessment of amount and quality of surface runoff from the landfill area. It is expected that no discharge will occur from the landfill area to any surface water bodies located off-site, because the surface water accumulated in the pond will evaporate during summer months, as it happened before construction of the landfill.

The quality of water in the pond will deteriorate, if the surface runoff management system on the landfill site is not efficient. Water samples from the pond will be collected on a quarterly basis and analysed for presence of components typical for leachate (see Table 17.2 further below).

If the social survey performed during the supplementary environmental and social studies to be carried out prior to construction of the landfill reveals that access to water accumulated in the surface water pond within the site area is important for cattle owned by residents of areas adjacent to the landfill site, possible alternative solutions will be assessed and agreed with the cattle owners.

### Leachate monitoring

Aerobic and anaerobic biological decomposition processes of organic matter, resulting in the production of soluble organic and non-organic components and water, will take place on the landfill. Leachate is the most frequent source of environmental pollution causing serious consequences. The objectives of the leachate monitoring program are the following:

- checking conformity of the leachate handling system to the design criteria;
- obtaining information on biodegradation processes in the waste;
- timely review of the parameters for the underground and surface water analyses based on the information about leachate composition changes.

The concentration of organic matter in the produced leachate may reach several tens of grams per litre. The intensity and duration of the process, concentrations of various substances in the leachate, the amount of the leachate depend on the origin of the organic waste, the compression level, thickness of the waste layer, humidity, temperature, aeration conditions, etc.

At the landfill in Hrazdan the leachate will be re-circulated, i.e. flow from waste cells via leachate collection system into the leachate pond and then will be spread over the surface of waste cells (e.g. in a way similar to irrigation), where from it can be evaporated.

Level of leachate for assessment of leachate volume will be measured in the leachate pond and in the leachate collection system of cells. Samples of leachate will be taken from leachate pond. Frequency for leachate monitoring activities is specified in Table 17.1.

Table 17.1 Frequency of leachate monitoring

Parameters	Operation phase	Closure and aftercare phase
Leachate level	Every week	Every month
Leachate volume (amount)	Every month	Every 6 months
Leachate composition	Every 3 months	Every 6 months

Leachate composition depends on landfill age, waste composition, intensity of waste biodegradation processes, amount of precipitation in the waste, and temperature. The leachate analyses could be selected considering the impact from each of the above factors. Standard leachate analyses include parameters listed in Table 17.2. The analyses will be made by an accredited laboratory.

Table 17.2 Leachate monitoring parameters

pH	Total dissolved solids TDS
Temperature	Lead Pb
Ammonia nitrogen NH <sub>4</sub> -N	Magnesium Mg
Biochemical oxygen demand	Manganese Mn
Chemical oxygen demand	Nickel Ni
Conductivity EL	Potassium K
Calcium Ca	Sodium Na
Cadmium Cd	Sulphates SO <sub>4</sub>
Chrome Cr	Zinc Zn
Chlorides Cl	Total alkalinity (CaCO <sub>3</sub> )
Copper Cu	Total organic carbon C org tot
Mercury Hg	Total nitrogen oxides NO tot
Iron Fe	Total petroleum hydrocarbons TPH

Evaluation of leachate monitoring, groundwater monitoring and surface water monitoring data will be carried out to verify that the leachate is adequately re-circulated within the landfill and is not polluting the surface water and groundwater.

#### Monitoring of landfill gas

Landfill gas composition will be monitored at the top of the gas collection wells. The landfill gas typically contains methane and hydrogen which can form flammable mixtures with air. The critical flammable concentration limits are known as Lower Explosive Limits (LEL). The measurements of methane and hydrogen concentrations in landfill gas will be carried on a quarterly basis by means of standard gas monitoring equipment. When concentration of the flammable gases in the landfill gas reaches 5% of LEL, the measurements will be carried out more frequently. The monitoring results will be used for assessment of the waste decomposition process and for assessment of possible utilisation options. Quarterly measurements of air quality in various points within the landfill may be used for assessment of the landfill cover and the landfill gas collection system. Air quality measurements within the sanitary protective zone will be carried out for identification of any landfill gas leakage zones.

The results of leachate and gas analyses will be displayed in a graphic form (concentration versus time), the resulting trends analysed and where necessary remedial actions implemented.

### Groundwater monitoring

Groundwater will be monitored for checking the efficiency of implemented protection measures and identification of possible leachate intrusion and groundwater contamination. In order to select correct sampling points and receive the results of analyses reflecting on the situation, the hydrogeological site conditions should be very well known. Groundwater level will be measured and groundwater samples will be taken 4 times a year in five monitoring wells installed outside the landfill perimeter. Only three monitoring wells will be installed during construction of the landfill. Groundwater levels in them will be measured once a month during construction of the landfill, so that the groundwater flow direction and seasonal fluctuations could be determined and during the first year of the landfill operation the additional monitoring wells could be installed: one downstream the landfill (for monitoring of groundwater passing the landfill) and one upstream and far from the landfill, e.g. at the border of sanitary protective zone (as a reference point for monitoring of groundwater definitely not affected by the landfill). Since groundwater monitoring wells are significantly different in design from drinking water wells, the wells should be installed by a certified well driller with experience in the construction of groundwater monitoring wells.

Groundwater samples will be analysed for determining the baseline/background concentrations of various components before operation of the landfill. During the following years the analyses will be carried out for identification of changes in groundwater quality due to contaminants potentially originating from leaks of leachate. The results of the analyses will be displayed in graphic form (concentration versus time), and compared with the baseline concentrations and/or national/international standards for drinking water.

Table 17.3 provides a list of parameters recommended for baseline monitoring and for compliance monitoring.

Table 17.3 Parameters for groundwater analyses

Monitoring parameter	Baseline monitoring	Compliance monitoring
PH	•	•
Conductivity EL	•	•
Total dissolved solids TDS	•	•
Temperature	•	•
Ammonium nitrogen NH <sub>4</sub> -N	•	•
Oxygen O <sub>2</sub>	•	•

Monitoring parameter	Baseline monitoring	Compliance monitoring
Residue after evaporation (180°)	•	•
Calcium Ca	•	•
Cadmium Cd	•	•
Chrome Cr	•	•
Chlorides Cl	•	•
Copper Cu	•	•
Cyanides CN, tot	•	•
Iron Fe	•	•
Lead Pb	•	•
Magnum Mg	•	•
Manganese Mn	•	•
Nickel Ni	•	•
Zink Zn	•	•
Potassium K	•	•
Natrium Na	•	•
Mercury Hg	•	•
Sulphates SO <sub>4</sub>	•	•
Tot alkalinity (CaCO <sub>3</sub> )	•	•
Tot organic carbon C org tot	•	•
Total amount of nitrogen oxides NO tot	•	•
Total petroleum hydrocarbons TPH	•	•
Arsenic As	•	

Monitoring parameter	Baseline monitoring	Compliance monitoring
Barium Ba	•	
Boron B	•	
Fluorides F	•	
Phenols	•	
Phosphorus P	•	
Antimony Se	•	
Silver Ag	•	

An evaluation monitoring exercise should be started when the results of the compatibility monitoring show the parameter values exceeding the ambient level. The purposes of the evaluation monitoring are the following:

- identification of pollution emission source;
- identification of pollution origin, amount and flow;
- environmental risk and human health hazard assessment;
- evaluation of pollution elimination or reduction measure;
- collection of required information for the implementation of corrective project.

Evaluation monitoring program may require an increased number of borings, increased sampling frequency and additional pollution dissemination analyses. A number of software modules for contamination transport modeling are used to identify contamination spreading direction and conditions.

The output of the evaluation monitoring exercise should be the clearly defined corrective measures aimed at reduced pollution emission and environmental impact.

#### **Air quality**

Air quality monitoring for assessment of dust, emissions from waste and odour nuisance will be carried out on a quarterly basis at the border of sanitary protective zone established for the landfill. An accredited contractor will be hired by the Company.

#### **Meteorological data**

Registration of meteorological data will be an obligatory part of a landfill monitoring program. Precipitation, temperature, evaporation and humidity are important factors having effect on the total amount and composition of the

leachate produced. The data will be used for the estimation of the water balance, required for operation of leachate collection and recirculation systems. Exact water balance may be estimated based on the meteorological data from the landfill site. Applicable meteorological data may be received from measurements on the site and from the nearest meteorological station (Hrazdan).

Parameters and their registration frequency required for water balance estimations and evaluation of leachate generation are included in Table 17.4.

*Table 17.4 Frequency of meteorological registrations for monitoring*

Parameter	Operation	Closure and aftercare
Amount of precipitation	Daily	Every month
Temperature min/max	Daily	Average monthly
Wind speed and direction	Daily	Not required
Evaporation	Daily	Every month
Air humidity	Daily	Average monthly

### **Flora and fauna**

It is important for the landfill operation to have no significant effect on the ecosystems. Thus regular observations of the flora and fauna around the landfill should be performed and any changes or stress traces of the ecosystem should be registered. Landfills attract birds and small rodents and provide favourable conditions for the development of some vermin, worms, flies. The information provided by the monitoring will be used for the selection of means to prevent the appearance of unwanted fauna, e.g. for bird control measures.

### **Landfill stability and subsidence**

Stability monitoring will be carried out to assess the integrity of the landfill structure. The sliding of landfill disposal slopes may produce certain human health hazard, thus regular landfill slope monitoring should be carried out. Slope stability should be evaluated once per year by a qualified inspector.

The waste volume settles primarily due to the increasing waste density, when some biological materials degrade and the space is filled by others, while the relative waste weight is increasing. The settling rate is difficult to predict, since it depends on a number of factors, specific to each particular landfill, such as humidity, composition, density. The settling process may also start due to the damages of the bottom or top insulation, leachate collection, gas collection or drainage systems. Regular monitoring during the operational and post-operational periods should facilitate the identification of required changes in the operational procedures aimed at reducing the risk of uneven settling. The evaluation of settling should be made by a qualified inspector at least once a year.

### **Documents**

Annual reports will be issued with a full monitoring program description, implementation report and summary of monitoring results. These reports will be kept on the landfill premises and will be accessible for the EBRD, for the controlling institutions and for the public.

### **Review of the program**

Landfill operator performs periodical check-ups to ensure the compatibility of the program with the monitoring objectives and, if required, update the program. The check-ups are important for program quality, efficiency and continuous appropriateness. The interval between check-ups should not be more than 12 months.

### **Duration of monitoring**

Landfill constructed on the proposed site in Hrazdan will receive waste for about 20 years. After the final cover is established the landfill aftercare might be carried out for more than 50 years.

There are no Armenian criteria defining the criteria for landfill aftercare and monitoring duration. Article 13(d) of the European Landfill Directive (CEC,1999) states: „... for as long as the competent authority considers that a landfill is likely to cause a hazard to the environment..., the operator of the site shall be responsible for monitoring and analysing landfill gas and leachate ... and groundwater regime in the vicinity of the site ...“. Accordingly, aftercare cannot be ended, or in other words landfill aftercare completion cannot be agreed upon, until the competent authority can be convinced that the landfill is no longer causing a hazard.

In many countries the authorities accept that landfills can be released from aftercare if they do not endanger the well-being of society and in particular do not endanger the groundwater protection. The criteria for the competent authority to assess this situation are to a large extent related to degradation of organic matter and stability of the landfill.

The period for aftercare will be decided during the preparation of the Landfill Closure and Aftercare Plan considering the emission limit values and the assessment of the compliance of an entire landfill with these limit values.

### **17.1.2 Social monitoring program (SMP)**

Social monitoring program of the Project will be carried out in Kotayk Region and Sevan municipality. It will be particularly important during the first years of the Project, i.e. during construction of landfill and the first years of its operation with roll-out of the new regional waste collection system. The SMP will include the following key elements:

- Monitoring of tariffs for waste management services as a percentage of household income with special attention to incomes of vulnerable groups;

- Monitoring of waste fee collection procedures/practice and collection rate;
- Monitoring of grievances and comments received from the public and response to them;
- Monitoring of grievances and comments received from the workers and response to them;
- Social surveys for evaluation of new waste collection system (with assessment breakdown according to various communities, population groups, men and women) and response to them;
- Monitoring of livelihood restoration for waste pickers and job opportunities or informal recyclers;
- Monitoring and evaluation of public outreach activities related to implementation of the new regional waste management system in Kotayk Region and Sevan municipality;
- Review of social benefits from the Project, including coordination with other development initiatives.

Project performance in line with the Environmental and Social Policy and Performance Requirements of the EBRD will be presented in regular (typically annual) reports submitted by the Project Implementation Unit to the EBRD. The reports will contain information on progress in implementation of the ESAP.

## **18 Preparation and Implementation of Environmental and Social Action Plan**

According to the Environmental and Social Policy of the EBRD, an Environmental and Social Action Plan (ESAP) is developed for and should be implemented during the Project. The ESAP includes the programmes and systems to address, in an integrated and comprehensive fashion, environmental and social impacts, issues and opportunities should be established with clearly stated outcomes or targets, timeframes, responsibilities and resources required.

The ESAP is based on adaptive management and include appropriate monitoring activities to ensure that:

- mitigation measures are effective,
- unforeseen negative impacts or trends are detected and addressed,
- expected project benefits or opportunities are achieved.

The ESAP prepared for the Project should also include a provision for:

- capacity building such as training of project staff and/or third parties (if appropriate),
- contingency and emergency response plans and measures (including adequate resources).

## 19 Supplementary Environmental and Social Appraisal Studies to be Carried Out

Information available on the project details was not sufficient to carry out detailed assessments of certain issues in the ESIA. In addition, time constraints on the project schedule did not allow to carry out detailed baseline assessments in some areas. Therefore, the following further detailed baseline data collection and assessments will need to be carried out prior to start of any construction works for the Project:

### 1. Updating the description of environmental and social baseline:

- Including information on rare and endangered species based on the updated Red Book of Armenia preparation of which has been launched by the RA Ministry of Nature Protection in 2011;
- Collection of additional information about waste pickers and other persons/organisations potentially affected by physical or economic displacement caused by the Project (in case of imposed restrictions for access to assets), elaboration of Livelihood Restoration Framework in line with PR5 of the EBRD Environmental and Social Policy (2008), if required;
- Updating the topographic map of the quarry section operated during the Feasibility Study and coordination of clay quarry operation completion activities;
- Collection of additional information on vulnerable groups in Sevan municipality;
- Updating the information on the current environmental and social pressures in Kotayk region and Sevan municipality, as well as about ongoing and planned infrastructure development, tourism development and other projects in Kotayk Region and Sevan municipality for assessment of the cumulative impacts relevant for the Project;
- Review of impacts and mitigation measures for technical solutions selected by landfill construction contractor for connections to engineering infrastructure (water supply, power supply, telecommunication networks);

2. Development and launching of environmental and social monitoring program;
3. Updating of stakeholder engagement plan (SEP) and assisting the Client to implement the SEP including the public consultation activities during the Armenian EIA procedure;
4. Review of the law adopted in Armenia in June 2011 and later adopted documents for regulating the waste tariffs and development of recommendations on capacity building and public awareness raising activities (as part of SEP and ESAP) for improvement of the revenue collection system; development of recommendations for setting and monitoring of affordable waste tariffs for households (including vulnerable groups) and for other customers of the solid waste management system.
5. Support to PIU and the Project cities in obtaining approval of the updated EIA by the RA State Environmental Expertise Authority.

During implementation of the Project the consultancy services will be provided to the PIU and the Company for implementation of the ESAP and preparation of reports to the EBRD and other parties according to the agreed format.

## **Appendix 1 Names of those responsible for preparing the ESIA**

Carsten Skov, Project Manager, COWI A/S, Denmark

Kresten Berntsen, Waste Management Expert, COWI A/S, Denmark

Larissa Lauritzen, Environmental and Social Due Diligence Expert, COWI A/S, Denmark

Niels Erik Houe, Landfill Design Expert, COWI A/S, Denmark

Niels Aagaard Jensen, Waste Management Expert, COWI A/S, Denmark

Eduard Martirosyan, Transproject CJSC, Armenian subconsultant

Armen Pogosyan, Transproject CJSC, Armenian subconsultant

Gevorg Martirosyan, Transproject CJSC, Armenian subconsultant

Albert Manukyan, Transproject CJSC, Armenian subconsultant

Armine Simonyan, local coordinator, Armenian EIA specialist, COWI

## Appendix 2 References and Sources of Information

### Documents prepared by COWI within the Feasibility Study for Kotayk Solid Waste Management Project:

- Baseline Report
- Landfill Site Selection Report
- Project Proposal

### Documents prepared by COWI within the Environmental and Social Due Diligence of Kotayk Solid Waste Management Project:

- Inception/Scoping Report
- Draft Stakeholder Engagement Plan
- Environmental and Social Action Plan

### Other sources of information:

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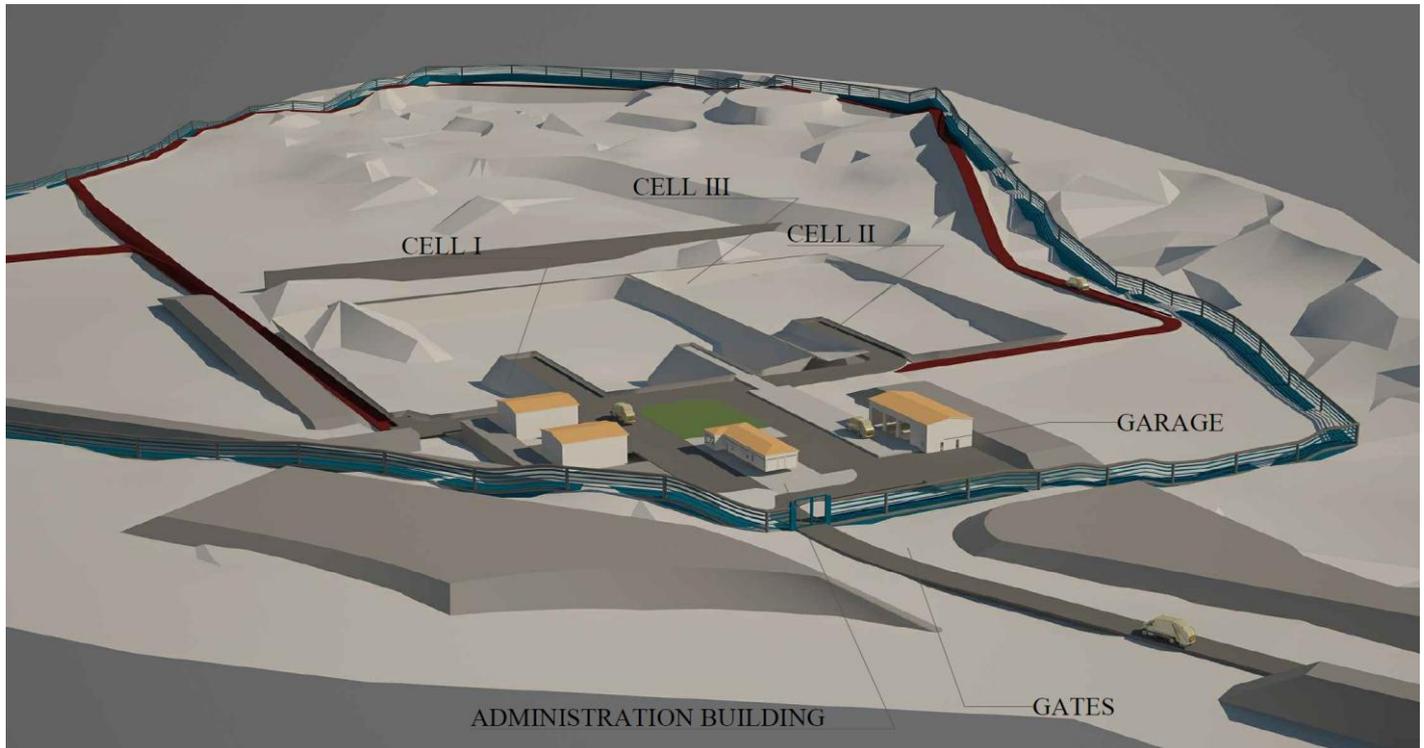
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## Appendix 5 Artist image of proposed regional landfill at Hrazdan site



## Appendix 6 Proposed elements of landfill cross-section upon the closure

