Assessment of Water Supply System, Senaki
Republic of Georgia

Technical Report Number 11

Integrated Natural Resources Management in the Republic of Georgia Program

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Global Water for Sustainability Program

Florida International University

Biscayne Bay Campus 3000 NE 151 St. ACI-267

North Miami, FL 33181 USA

Email: glows@fiu.edu

Website: www.globalwaters.net

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List of Acronyms and Abbreviations

1. ^{o}C - degree Celsius
2. CENN - Caucasus Environmental NGO Network
3. Cfu - Colony forming unit
4. D - diameter
5. E. coli – Escherichia Coli
6. EU - European Union
7. FIU - Florida International University
8. GIS - Geographic Information Systems
9. GLOWS - Global Waters for Sustainability
10. GNEWRC - Georgian National Energy and Water Regulatory Commission
11. GWP - Georgian Water and Power
12. INRMW - Integrated Natural Resources Management in Watersheds
13. km – kilometer
14. kW – kilowatt
15. LLC - Limited Liability Company
16. L - liter
17. L/sec - Liter per second
18. m - meter
19. m^3 - cubic meter
20. m^3/h – cubic meter per hour
21. m^3/sec – cubic meter per second
22. mm - millimeter
23. m^2 - square meter
24. mg/l - milligram per liter
25. ml - milliliter
26. NGOs - Non-governmental Organizations
27. UNESCO - United Nations Educational, Scientific and Cultural Organization
28. UNESCO-IHE – UNESCO Institute for Water Education
29. USAID - United States Agency for International Development
30. USSR - United States of Soviet Republics (Soviet Union)
31. UWSCG - United Water Supply Company of Georgia
32. WHO - World Health Organization
33. WI - Winrock International
34. WSP - Water Safety Plan

1. Introduction

In September 2010, USAID-Caucasus launched a four-year program entitled "Integrated Natural Resources Management in Watersheds of Georgia" (INRMW-Georgia), implemented within the framework of an umbrella program "Global Water for Sustainability" (GLOWS) by a consortium of international and national organizations under the leadership of Florida International University (FIU), in partnership with CARE International, Winrock International (WI), UNESCO-IHE, and the Caucasus Environmental NGO Network (CENN).

Among various planned activities within the INRMW framework, it is envisaged to develop Water Safety Plans (WSPs) for six cities (Akhmeta, Telavi, Dedoplistskaro, Oni, Ambrolauri and Senaki) in the pilot watershed areas of the Rioni and Alazani-Iori river basins. To accomplish this task, a local WSP Team was established with the support of UNESCO-IHE. In accordance with the program work plan, the work was divided into two stages. In the initial stage, WSPs were to be developed for four cities (Akhmeta, Telavi, Oni, and Ambrolauri) of the upper pilot watershed areas of the Alazani-Iori and Rioni basins. In the subsequent stage, WSPs were to be developed for urban areas (Dedoplistskaro and Senaki) in the lower pilot watershed areas of Alazani-Iori and Rioni basins. Assessments of water supply systems serve as baseline studies for WSPs that include detailed description of centralized water supply systems, identification of existing and potential hazards, including hazardous events/situations/hazard sources, and assessment of their risks.

The current report is a detailed assessment of the water supply system for the City of Senaki. It includes description of the system, identification of existing hazards to drinking water quality and their sources as well as related hazardous events/situations together with water safety risk assessments. In addition, the report includes a list of recommended control measures to avoid and/or mitigate risks, including management and monitoring measures. It also contains a description of the methodology used to gather data of the existing water supply system, identification of hazards, assessment of their risks and determination of control measures. The report will serve as the basis for developing WSP for the water supply system of the City of Senaki in accordance with WHO guidelines.[1]

[1] World Health Organization (2005) Water Safety Plans: Managing Drinking-water Quality from Catchment to Consumer. WHO/SDE/WSH/05.06, http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf

2. Methodology

Assessments of water supply systems in the targeted cities of pilot watershed areas are based on WHO guidelines that recommend investigation of existing systems from source to tap, together with identification of hazards as well as their sources, and/or hazardous events/situations posing threat to water safety, and assessment of their risks.

The analysis is based on information and data collected by the WSP Team directly from the United Water Supply Company of Georgia as well as through site inspections of water supply systems from the catchment to the consumer, and interviewing local staff of the company based on sanitary observation questionnaires.

The WSP Team visited each pilot city to collect information and elaborate flow diagrams which reflect all units of water supply systems from catchment to point of use. The following aspects were assessed:

- Land use in the catchment area;
- Abstraction method and location;
- Likely changes of water quality at the source;
- Detailed description of the water supply system;
    - Intake unit, treatment facilities and methods employed.
    - Water disinfection
    - Water distribution system
    - Storage (service reservoir and tankers)
    - Network
- Water consumption and consumers;
- Drinking water quality monitoring procedures, databases and availability of trained staff.

In the next step, the WSP Team identified hazards and their sources, and/or related hazardous events/situations as well as assessed risks. More specifically, the team identified all potential biological, physical and chemical hazards associated with each step/element of the drinking water supply system that can affect the drinking water safety, followed by a basic risk assessment of these hazards. The final step for the drinking water supply system assessments was the determination of control measures for each hazard and hazardous event/situation, including key capacity development (support) and monitoring measures and re-assessment of risks in terms of likelihood of impact taking into consideration the effectiveness of each control measure[2]. Risks were prioritized in terms of their estimated impact on the capacity of the system to deliver potable water.

[2]The means by which risks may be controlled

3. Institutional and Legal Frameworks for the Drinking Water Supply Sector

Currently, issues related to potable water are regulated by laws on Public Health, Water, and Mineral Resources, as well as by a number of regulations. According to the Water Law, in the allocation of water resources, the first priority is to be given to water for drinking and bathing purposes. Furthermore, the law requires establishing water sanitary zones for water bodies used for drinking water purposes. Rules for sanitary zones are further defined by the Order of the Minister of Health and Social Protection on Ambient Environmental Quality Standards (16 August, 2001). The Law on Mineral Resources of Georgia requires licensing of groundwater abstractions for drinking water supply (for further details, refer to the relevant sections on surface waters and mineral resources)[3]. The Law on Public Health segregates responsibilities among various ministries with regard to water safety. The list of laws and regulations governing potable water supply sector is given on the page 9 below.

Potable water quality standards and rules for its quality monitoring are stipulated in the "Technical Regulation on Drinking Water" approved by the Decree #349/N, 17.07.2007 of the Minister of Health, Labor and Social Protection.[4] More specifically, the regulation defines rules of self-monitoring to be conducted by water suppliers. The "Technical Regulation on Drinking Water" is based on the Georgian Law on Public Health, WHO recommendations, EU directives, and regional characteristics, including climate and relief conditions. The document regulates the quality of natural and treated tap water as well as the quality of bottled water. However, it does not cover the quality of small scale water supply systems with a capacity of 10 m^3/day serving less than 50 people and natural mineral waters where mineralization exceeds 1,500 mg/l. The regulation defines requirements against common parameters of odor, taste, color and turbidity, as well as against organoleptic, microbiological, intra-microbiological, epidemiological, chemical composition, including inorganic and organic substances (common pesticides and individual organic pesticides) and maintaining safe level of radioactivity in potable water (refer annex 4). The quality of water in a natural water body intended for drinking purposes should not exceed the ambient water quality standards stipulated by the Decree #297/N of the Minister of Labor, Health and Social Affairs on "the Approval of Ambient Environment Quality Standards," issued on 16.08.2001.[5]

According to the "Technical Regulation of Drinking Water", the regulations for state compliance ensuring monitoring and control of drinking water quality, including components to be inspected, frequency of sampling and analysis methods should be defined by the relevant law enforcement agency, currently by the Service of Food Safety, Plant Protection and Veterinary Service of the Ministry of Agriculture. In case the state laboratory of the Ministry of Agriculture does not have enough capacity to carry out the testing of potable water quality, it may delegate its functions/outsource the assignment to an accredited independent laboratory. In instances where the required standards are not in conformity with the Technical Regulation, the supplier of drinking water is liable to carry out appropriate measures, including reporting to relevant authorities,

[3]Technical Report 1. Rapid National Assessment, February 2011, http://www.globalwaters.net/wp-content/uploads/2012/12/Technical-Report-1-Repid-National-Assesemnet-of-Legal-Policy-and-Institutional-Settings.pdf
[3]https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=52384&lang=ge;
[4]: i) http://www.momxmarebeli.ge/images/file_955911.pdf; ii) http://water.gov.ge/uploads/kanonmdebloba/standarti.pdf; iii) P. 105, Annex 4, Technical Report 1. Rapid National Assessment, February 2011, http://www.globalwaters.net/wp-content/uploads/2012/12/Technical-Report-1-Repid-National-Assesemnet-of-Legal-Policy-and-Institutional-Settings.pdf
[5]https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=52384&lang=ge;

identifying contaminating sources, restricting water supply and implementing corrective measures for the safety of the population[6].

The legal relations between the water supplier and the consumer are regulated by the "Rules on Drinking Water Supply and Consumption" adopted by the Georgian Energy and Water National Regulatory Commission, dated 26 November, 2008.

Listed below is the set of laws and regulations governing potable water supply sector:

- Water Law.[7]
- Law on Public Health.[8]
- Decree #297/N of the Minister of Labor, Health and Social Affairs, 16.08.2001 on "Approval of Ambient Environment Quality Standards."
- Decree #349/N of the Minister of Labor, Health and Social Affairs of Georgia, 17.07.07 on "Technical Regulation of Drinking Water."
- Decree #59 of the Minister of Environment, 07.05.1998 on the "Approval of the Provision on Water Protection Zone."[9]
- Law on Sanitary Protection Zones of Resorts and Resort Areas, 20.03.1998.
- Decree #16/N of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of the Guidelines for Hygienic Assessment of Materials, Chemicals, Equipment and Technologies Used in Centralized Water Supply Systems."
- Decree #15/N of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Drinking Water Sampling."
- Decree #17/N of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Water Treatment by UV Radiation."
- Decree #250/N of the Minister of Health, Labor and Social Protection, 15.09.2006 on the "Approval of Sanitary Rules on Chlorination of Centralized Urban and Rural Waters Supply Systems and Disinfection of Technical Facilities of these Systems."
- Ordinance #32 of the GNEWRC, 26.11.2008 on the "Approval of the Rules on Drinking Water Supply and Consumption."
- Ordinance #18 of the GNEWRC, 29.08.2008 on the "Approval of the Methodology for Setting out Water Use Tariffs."
- Ordinance #14 of the GNEWRC, 26.11.2008 on "Penalizing Illegal Users of Centralized Water Supply and Sanitation Systems."
- Ordinance #17 of the GNEWRC, 17.08.2010 on "Water Use Tariffs."
- Decree # 10 of the Government of Georgia, 30.01.2009, on "Approval of the Charter of the Ministry of Regional Development and Infrastructure."

[6]For more details on water related issues please refer INRMW technical report 1. Rapid National Assessment at http://www.globalwaters.net/projects/current-projects/inrmw/
[7]http://nfa.gov.ge/files/kanonebi/wylis_shesaxeb.pdf
[8]http://www.nsc.gov.ge/files/files/legislations/kanonebi/sazogadoebrivi%20janmrteloba.pdf
[9] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=80770

- Regulations of the "United Water Supply Company of Georgia" LLC, approved by the Order No. 02/01, dated 1st March, 2010, of the Director of "United Water Supply Company of Georgia," LLC.[10]

The institutional framework for potable water supply management sector is as follows:

- The Ministry of Labor, Health and Social Protection establishes ambient water quality standards in accordance with WHO guidelines.
- The Ministry of Agriculture executes state control of drinking water quality.
- The Ministry of Environmental Protection develops and coordinates the implementation of state water resources management policies and protection of water bodies from pollution and exhaustion. Currently, as a result of the Parliamentary Elections of October, 2012, reorganization of the Ministry is ongoing. More specifically, the agency of natural resources, together with environmental inspectorate will shift to the Ministry of Environmental Protection from the Ministry of Energy.
- The Ministry of Regional Development and Infrastructure is responsible for state planning and coordination of development of water supply systems throughout Georgia. With the exception to the population of Tbilisi, Mtskheta, Rustavi and Autonomous Republic of Adjara, provision of water supply to the remaining Georgian population is carried out by the state company "The United Water Supply Company of Georgia" LLC, owned by the Regional Development Ministry. It has regional branches, and subordinated to these branches are service centers in all relevant regions, including regions targeted by the INRMW program. More specifically, the company has seven regional branches: i) Kakheti; ii) Shida Kartli and Mtskheta-Mtianeti; iii) Kvemo Kartli; iv) Samktskhe-Javakheti; v) Samegrelo, Zemo Svanety and Guria; vi) Imereti, Racha-Lechkhumi and Kvemo Svaneti; vii) Kutaisi. These branches have their laboratories which conduct monitoring activities for drinking water quality in the urban water supply system under their jurisdiction.
- The Georgian National Energy and Water Regulatory Commission (GNEWRC) establishes water supply and consumption rules, approves methodologies for setting up water usage tariffs, determines tariffs, and approves rules on penalizing illegal water users, including those illegally discharging wastewaters in sanitation systems
- Georgian Water and Power (GWP) is the leading company in the water supply sector of Georgia. The company provides water supply services to the population of Tbilisi and its adjoining areas, as well as to State organizations, industrial and commercial entities. The company also provides wastewater services to the capital city of Tbilisi. GWP serves around 400,000 customers throughout the city, of which approximately 2,000 are budget organizations, 15,000 are commercial entities and the remaining are residential consumers.

[10] http://water.gov.ge/uploads/kanonmdebloba/debuleba5.pdf

4. Description of Water Supply System from Catchment to Consumer

The water supply system of the city of Senaki operates under the Abasha, Senaki and Khobi Service Center of Samegrelo-Zemo Svaneti and Guria Regional Office of the United Water Supply Company of Georgia. The Service Centre consists of 35 employees, of which 20 belong to technical-engineering and operations department. The Service Center is divided into following units/divisions: i) technical division composed of 3 staff members; ii) operations team composed of 9 staff members; iii) laboratory unit composed of 3 staff members; iv) accidents/maintenance team composed of 5 staff members. Pictures of the service center are given in pics. 1-2, Annex 7.

The city is located in the south-west of Georgia on the Kolkheti plain, on the right bank of the Tekhuri River, at 25-90 m above sea level.

The city receives water through headworks (E 42°06'29.38; N 42°16'17.76") located near the village of Nosiri. The headworks are connected to two systems: i) system 1 serves the city of Senaki and a number of adjacent villages; ii) system 2 delivers water to the city of Poti. Water from headworks to Senaki is supplied by the means of electric pumps.

4.1 Main Characteristics of the Water Source and its Catchments

Water sources. Water source of the Senaki drinking water supply system is represented by groundwaters.

In general, Lower Rioni pilot watershed area, including the city of Senaki, is located on the border of two hydrogeological zones/districts of the Hydrogeological Region III: Artesian Basin of the Georgian Belt (A. Buachidze, 1970) composed of: 1) Samegrelo Artesian Basin (III_3) of fractured and fractured-karst waters located in the north; 2) Kolkheti Artesian Basin of fractured and fractured-karst waters (III_5).There are following types of groundwaters in the region: i) Aquifer of Upper (late) Quaternary (recent) alluvial deposits with 30-40 m^3/sec yield; ii) Aquifer of Quaternary boggy deposits with around 0.1-1.0 m^3/sec yield; iii) Aquifer of Lower (early) Quaternary alluvial deposits with roughly 0.1-1.0 L/sec yield in the upper horizon and up to 3.0 L/sec well capacity in the subducted horizon; iv) Water bearing complex of Pontic-Meotic lagoon-marine deposits; v) Water bearing horizon of Upper and Middle Miocene deposits with around 0.1-1.0 L/sec yield of fractured and fractured-karst waters and up to 20 L/sec yield of karst waters; vi) Aquifer of Paleocene-Upper Cretaceous calcareous deposits with karst, fractured-karts and fractured-stratal groundwaters and; vii) Aquifer of Senomian-Alb-Apt clay-marl deposits with fractured and fractured-stratal waters.[11]

Groundwaters of the city of Senaki and Nosiri Village, where the headworks are located, belong to the aquifer of Lower Quaternary alluvial deposits. These sediments are related to old marine and riverine terraces that are subduced under alluvial sediments of deltas. Lithologically, the deposits are composed of sandstones, clays, sands and gravels. The average depth of the deposits is up to 30 m. In the Kolkheti lowland, maximum depth of the water bearing horizon reaches 500 m. In the upper layers, the groundwater aquifer has a yield of 0.1-1.0 L/sec, while in the lower pressured layers, well capacity reaches 3.0 L/sec. In the area of the Kolkheti plain, groundwaters circulate from north-east to south-west. Groundwaters are mostly recharged/fed by major rivers, including the Tekhuri River on the banks of which Senaki and Nosiri are located.

[11] Detailed Assesssment of Natural Resources of Lower Rioni Pilot Watershed Area

Location of intakes and abstraction methods. As aforementioned, Nosiri headworks, situated on the left bank of the Tekhuri River at a distance of 100 m, supply water to Senaki and Poti through two systems, system 1 provides water to Senaki and its neighboring villages, and system 2 provides water to Poti. Headworks of the system 1 are composed of 16 bore wells, 17-28m deep each and located at a distance of 150 m from each other. Water is pumped through submersible/deep pumps. Water intake points are located at 26-30 m above sea level. The area of the 1st sanitary zone is 25.6 ha and is located 5 km from Senaki. It is fenced, but not guarded/supervised round the clock. Geographic coordinates of the headworks is as follows: E 42°06'29.38; N 42°16'17.76. Location map of the Senaki water supply system is given in Annex 1 and its major characteristics in Annex 2.

Water quality issues at sources. Headworks are fenced, but not guarded and therefore, there is a risk of encroachment of humans and domestic animals in the source water territory and polluting the water. In accordance with the water quality testing laboratory of the local service center, drinking water quality is satisfactory.

4.2 Description of Water Supply System

4.2.1 Water Abstraction and Treatment

The flow diagram of the water supply system of Senaki is presented in Annex 3.

Water is abstracted from 15 bore wells of the Nosiri headworks N1 (pic. 4, Annex 8), supplying Senaki City, by the means of Russian-made deep pumps with the following specifications: Q=120 m^3/h (water abstraction/pumping rate), H=60 m (submersion depth) (pic. 10-11, Annex 7). The 16th bore well and the pump are out of order and do not function at present. Out of the total pumps, only 7 are new units that were replaced in 2010-2011. During summer (2 months), due to the decrease in water discharge, only 10 pumps are operated. The average well capacity is 1,000 m^3/h. Water is pumped to the 100 m^3 spherical concrete collection tank (pic. 5, Annex 7) where it is not treated mechanically, but chlorinated when it is flowing out of the collection tank (pics. 6-7, Annex 7). Disinfection is carried out continuously by liquid chlorine and monitoring of residual chlorine is conducted every day on-site. Treated water flows to the 500 m^3 underground spherical concrete storage reservoir, located 50 m from the collection tank (pics. 8-9, Annex 7).

Nosiri headworks have been operational since 1972, all bore wells are polluted, one well is out of order and chlorination equipment is outdated. Storage reservoir is old, fractured in several areas and water leaks out if it. Therefore, it needs renovation/replacement.

4.2.2 Water Conveyance and Distribution

Water is transported from 500 m^3 storage reservoir located on the territory of headworks of Nosiri-1 system to the distribution network through a water main (pic. 15, Annex 7) by the means of electric pumps. There are 4 units of pumps in the pump station (pics. 11-14, Annex 7) with following specifications: N1 and N2 pumps: Q=1,200 m^3/h (water extraction/pumping rate), H=90 m (submmersion deapth), N=450 KW (power capacity). One unit is operated 4 hours a day, and 8 hours a day during summer. The other unit serves as a backup. Units N3 and N4 have following specifications: Q=1,000 m^3/h, H=180 m, N=630 KW. One pump is operated 15 hours a day and the other unit serves as a reserve.

The water main is composed of three pipes: one measures 400 mm in diameter and 5 km long steel pipe, and the other two measuring 4.5 and 5.3 km long steel pipes with each having a diameter of 300 mm. These pipes convey water to the distribution network. The total length of the water main is 13.8 km. However, all three pipes are obsolete, corroded and leaking at many points. Only 2.7 km section of 300 mm diameter pipes were replaced with PVC pipes. Pressure in the water main varies within 10-16 bars.

There are two regulating reservoirs in the entrance of the Senaki City, each having a capacity of 750 m^3, located at 116 m above sea level. Though, the technical condition of these reservoirs is good, they are not used and water from the main pipes feeds directly into the distribution network. More specifically, the 150 mm in diameter and 400 m long inlets entering reservoirs and the two 150 mm in diameter and 400 m long outlets have lower capacity and do not ensure the regulating function of the reservoirs. This leads to the diminution of normal operating conditions within the network. Moreover, under such conditions, reservoirs need longer time to be filled that increases power consumption and makes the system inefficient. In addition, there is one 500 m^3 underground regulating reservoir in the city that was used during the Soviet times, but its operation was stopped since Georgia's independence from the USSR.

Water is supplied from Nosiri-1 headworks for 4 hours a day to the Akhalsopheli Village and sections of the villages of Menji and Nosiri through 300/100 mm, 100 mm and 80 mm diameter branch pipes.

The total length of the distribution network of the city is 77 km. The majority of the network is old, corroded and leaking. The system was built in the 1960s. Mostly, 40-100 mm in diameter steel and, in a limited scale, cast iron pipes were used. In recent years, 25 km section of the network has been replaced with PVC pipes.

The average pressure in the network is 2.5 bars, and in the lower area of the city, it is regulated by 5 valves/shutters. In the upper parts, there are K 15-25 type 8 pumps thrusting water to consumers in these areas. There is no leakage and water loss monitoring conducted by the service center, and it is estimated that water losses make up 20%. However, the figure may be higher if we take into account the obsolescence of the network and the limited water supply.

4.2.3 Water Use and Consumers

The water supply system of Senaki City serves 6,099 households and 329 organizations (13,612 individuals). In addition, it supplies water to the Akhalsopheli Village and sections of the villages of Menji and Nosiri.

According to Resolution #17 (17 August, 2010) of the Georgian National Energy and Water Supply Regulation Commission on Water Supply Tariffs, consumers with water meters pay 0.423 GEL per cubic meter of water (including the price for water sanitation service). Whereas, the tariff for consumers without water meters is set at 2.03 GEL per capita (including the price for water sanitation service). Organizations (legal entities) pay 3.65 GEL per cubic meter of water (for the time being, this rate includes the price for water sanitation service). Currently, households pay a flat rate fee per individual family members. The daily average is roughly 800 l per capita.

The city population is supplied with water for only 4 hours a day. Many families have their own storage tanks, but water stored in these reservoirs is only used for bathing and washing.

According to the local service center, annual average per capita consumption is 1,175 l per day that includes 20% leakages. This is a very high indicator compared with water consumption rates of European countries, where daily consumption is 120-150 l per capita. Such a high rate of water consumption can be attributed to the intermittent water supply regime, with people filling up their storage reservoirs every day, regardless they consume the water or not.

5. Risk Assessment

Identification of hazards, their sources and potential hazardous events/situations as well as risk assessment of the Senaki water supply system were conducted through field observation/inspection of the system using a special sanitary inspection questionnaire. This approach is based on WHO WSP guidelines (2005)[12], which recommend the identification of hazards and hazardous events by using sanitary observation questionnaires. This questionnaire should be elaborated for sanitary inspection of key points of the water supply system (headworks, water treatment plant, main and distribution network, etc.) and water abstraction methods (e.g. drilled wells, pit wells, spring water collectors, etc.).

Stemming from the fact that almost all key components of water supply systems have the same problems and pose the same risks to water safety, sanitary inspection questionnaires were elaborated for the water supply systems in its entirety and not confined to specific elements. Furthermore, a risk prioritization matrix using hazard likelihood and impact criteria was developed, and the risks were prioritized based on this matrix.

5.1 Compliance of Drinking Water Quality with National Standards

Monitoring parameters, sampling points and frequencies are defined by the Georgian Technical Regulation on Drinking Water, 2007 (please refer Annex 5). Currently, regular water quality monitoring of the Senaki water supply system focuses on the following basic set of parameters: *Microbial parameters – E. coli and total coliforms*; *Physical parameters* - taste, odor, color, turbidity and temperature; *Chemical parameters* – residual chlorine, pH, total hardness, nitrites, ammonium chlorides, sulfates and iron.

The laboratory control of water is carried out by the Service Centers of UWSCG, and the water quality monitoring points are established by the central office of UWSCG in compliance with the Georgian Technical Regulation on Drinking Water, 2007. For all water supply systems, control points should include:

i) Water intake (surface water filtrate);
ii) Water intake (groundwater);
iii) Release points (treated water);
iv) Distribution network.

Senaki drinking water monitoring laboratory is located in the newly built office of Abasha, Senaki and Khobi service centers. It is relatively well equipped with chemicals and auxiliary materials. The staff of the lab is qualified, though they need re-training in modern monitoring methods. The lab does not have water distillation equipment (pic. 3, Annex 7). Therefore, distillates together with standard chemical solutions are supplied from the regional laboratory. Bacteriological analysis of samples taken from the water main and pipes are conducted every day, and samples from headworks undergo analysis once a month, in the laboratory of Poti Service Center.

Assessment of drinking water quality for the Senaki water supply system is based on 2011 water quality monitoring data (refer Annex 5). According to this data, 844 samples were collected, of which 822 samples were collected from the distribution network, 12 from released (treated) water

[12] World Health Organization (2005) Water Safety Plans: Managing Drinking-water Quality from Catchment to Consumer. WHO/SDE/WSH/05.06, http://www.who.int/water_sanitation_health/dwq/wsp170805.pdf

and 10 from groundwater sources[13]. Table 1 illustrates drinking water quality compliance with the national standards in 2011.

Table 1. Drinking Water Quality Compliance with the National Standards for the Senaki Drinking Water Supply System, 2011[14]

Monitoring Point	Number of Samples	Compliance with the National Standards %			
		Compliance		Noncompliance	
		Number of samples	%[15]	Number of samples	%
Groundwater source (raw water)	10	9	90	1	10
Released (treated) potable water	12	12	100	0	0
Potable Water in Distribution System	822	801	97	21	3
In total	844	822	97	22	3

The table reveals that although most components of the water supply system were in compliance with the National Standards (97%), there were instances of noncompliances in 2011 (3%). 100% of the samples from released (treated) potable water, 97% of the samples from distribution network and 90% of the samples from groundwater sources (raw water) met the National Standards. Monthly distribution of noncompliances are as follows: January – 1 out of 69 samples (1%); February – 2 out of 59 samples (3%); March – 4 out of 64 samples (6%); April – 4 out of 52 samples (8%); May – 4 out 68 samples (6%); June – 6 out of 81 samples (7%); December – 4 out of 53 samples (8%). As observed, noncompliances have increased from 1-3% in January-February to 6-8% in March-June. This may be attributed to the snowmelt, heavy rains and consequent seasonal floods and flashfloods, leading to high volumes of storm waters reaching headworks and pipes, as well as to the absence of mechanical and chemical water treatment at the headworks.

Regardless the fact that the overall compliance to national standards was high, the real picture might be different and noncompliances may be more frequent, due to poor water testing capacities of the Service Center.

With the purpose of identifying issues related to the particular parameters, additional information was requested from the service center laboratory staff. Based on this information, it was learned that noncompliance of water quality with the national standards was generally due to microbiological contamination i.e. noncompliant concentrations of total Coliform bacteria and E.coli. Physical parameters, in general, met the national standards, with the exception of noncompliant turbidity/transparency in May and June. According to chemical parameters, water quality met national standards. However, concentration of residual chlorine was sometimes lower than the national standard (0.3 – 0.5 mg/l). It is unknown if chlorination was ever carried out in these instances or if it was conducted inadequately.

Concerning contagious diseases for Senaki City, 2011 statistics show 8 cases of acute viral hepatitis B, 22 cases of chronic hepatitis and 47 cases of diarrhea. However, there is no evidence that these cases resulted from water contamination. For detailed information please refer Annex 6.

5.2 Identification of Hazards, their Sources and Potential Hazardous Events/ Situations

For identification of hazards, their sources and potential hazardous events/situations and assessment of risks, visual observation of the water supply system was conducted by the WSP

[13] From this monitoring data it is difficult to judge which parameters are not in compliance with the national standards
[14] Source: UWSCG
[15] Rounded off to the nearest whole number

Team jointly with the representatives of the local Service Center of United Water Supply Company of Georgia. In addition, a sanitary inspection questionnaire was developed, handed out and filled up by the technical personnel of the Senaki Water Supply Service Center. It consisted of 10 questions with "Yes" or "No" answers. The sum of the "Yes" answers gave the scale/level of the risk divided into following classes: 9 -10 = Very High; 6-8 = High; 3 -5 = Medium; 2-0 = Very Low/no risk. Stemming from the fact that the situation in all headworks is the same (with minor differences), sanitary inspection questionnaires were elaborated for the water supply systems in its entirety and not confined to particular elements.

As defined in the WHO WSP Guidelines (2005):
- *A hazard is any biological, chemical, physical or radiological agent that has the potential to cause harm.*
- *A hazardous event is an incident or situation that can lead to the presence of a hazard (what can happen and how).*

Presented below is the completed questionnaire for Senaki Water Supply System. The answers for all headworks were identical.

Table 2. Filled up Questionnaire for Sanitary Observation

#	Question	Yes	No
1	Is the area around the catchment unprotected?	X	
2	Do animals have access to the surrounding areas of the catchment?		X
3	Are there any solid or liquid waste collecting sites within 30 m of the catchment?		X
4	Are there any sources of pollution within a 10 m radius of the catchment (e.g. animal breeding, cultivation, roads, industry etc.)?		X
5	Are coagulation and sedimentation tanks absent?	X	
6	Is the main pipeline corroded or damaged?	X	
7	Is water treatment plant absent?	X	
8	Is the chlorine tank improperly arranged?	X	
9	Has there been a discontinuity in water supply in past 10 days?	X	
10	Did the community report of any pipe breakages in the past week?	X	
In total		7	3

As revealed by the aggregate responses to the questions on the Inspection Questionnaire, 7 positive responses out of 10 questions were received indicating that the system belongs to the ***high risk category.***

Accordingly, the WSP Team has identified the following hazardous events/situations/sources of water contamination:

1. Absence of 24-hour guard/supervisor at the headworks;
2. Obsolete and dilapidated water abstraction and collection facilities at the headworks;
3. Absence of any preliminary water treatment stage (sedimentation/coagulation reservoir and chlorination) at intakes;
4. Obsolete and damaged storage reservoir (500 m^3);
5. Presence of corroded and damaged sections in main pipes;
6. Obsolete and leaking pipes in the distribution network;
7. Improper design and outdated technologies for chlorination;
8. Intermittent water supply;
9. Frequent accidents in distribution systems.

All above listed hazardous events/situations/hazard sources may lead to any of the following three hazards: i) deterioration of physical properties of the drinking water; ii) microbial contamination of the drinking water; iii) chemical contamination of the drinking water. These hazards may cause the spread of waterborne diseases, particularly during heavy rains, floods, increased air temperatures and droughts. Chemical contamination and deterioration of organoleptic (physical) properties (e.g. odor, taste, color and transparency) of drinking water are also possible though, serious source of chemical contamination is not located in the surroundings of the headworks.

5.2 Prioritization of Hazards

In accordance with WHO WSP guidelines (2005), hazards revealed for the entire water supply scheme were prioritized by the application of a risk assessment matrix. Risks were quantified according to categories of hazards (e.g. microbial, chemical, etc.) for various hazardous events/situations/sources of hazards, as suggested in the WHO WSP guidelines.
The risk of hazards was assessed by two factors: likelihood and potential impacts (results of water quality self-monitoring of the water supply system). The likelihood was expressed by anticipated occurrences of hazards identified through the sanitary observation of the system. Hazards threatening the water supply system were prioritized using the matrix in Table 3. The priority matrix is based on risk scores of the sanitary inspection questionnaire and water quality monitoring data received from UWSCG.

By WHO WSP definition, risk is the likelihood (probability) of identified hazards causing harm in exposed populations in a specified timeframe, including the magnitude of that harm and/or the consequences.

Table 3. Hazard Prioritizing Matrix for Senaki Water Supply System

Deviations from Drinking Water Quality Standards (%)	**Sanitary Inspection Score (SIS)**			
	0 – 2	3 – 5	6 – 8	9 – 10
71-100	0	0	0	0
31 – 70	0	0		0
11-30	0	0	0	0
1-10	0	0	3[16]	0
Risk level	low	medium	high	very high
Priority action level	none	low	high	urgent

Despite the fact that 97% of water samples met the national standards and merely deviated from the standard by 3%, according to the results (score 7) of the sanitary questionnaires, the entire system, including the distribution network, is assessed at ***high risk.*** The water supply points scored as “yes” on the sanitary inspection form represent the potential sources/factors of hazards for microbiological contamination of drinking water, and to lesser extent, sources of hazards for the deterioration of physical properties of water and its chemical contamination.

Consequently, on the basis of the sanitary questionnaire and hazard prioritizing matrix for Senaki water supply system, biological, chemical and physical contamination risk factors were identified that have a negative impact on the quality of drinking water and cause a hazard of exposure to waterborne diseases or chemical contamination. In more detail, on the basis of visual inspection and the results of the sanitary observation questionnaire, the following components/steps of water supply system were identified as the most probable causes of contamination of potable water:

[16]The figure reflects (in total) deviation from standards, identified at all monitoring points

- Headworks and intake points;
- Water disinfection;
- Reservoirs;
- Main pipes and distribution network.

In addition to the above, technical conditions and capacities of water testing laboratory, and the quality of the water testing can be considered as factors that may indirectly impact water quality. Regardless, the water quality testing component/step was not included in the identification of hazards and hazardous events/situations, because it is not a source for water contamination and represents the means for tracking the progress towards achieving operational limits/targets (in our case, national drinking water quality standards). Meanwhile, we have included measures related to the improvement of water quality testing as recommendations for inclusion in the WSP.

To calculate a priority score (based on WHO guidelines) for each identified hazard, we used semi-quantitative risk assessment and a prioritization matrix. The objective of this matrix is to rank hazardous events and identify the most significant hazards. Risk ratings, calculated based on the likelihood and severity of impact, were made based on matrices of tables 4 and 5.

Table 4. Definitions of Likelihood and Consequence/Impact Categories that could be used in Hazard Prioritization

Rank	Level of Likelihood/Impact	Description of a Level of Likelihood/Impact
	Likelihood	
A	Very high likelihood.	Very frequent (e.g. to happen continuously or once a day).
B	High likelihood.	Frequent (e.g. to happen once a week)
C	Moderate likelihood.	Moderately frequent (e.g. to happen once a month).
D	Low likelihood.	Rare (e.g. to happen once a year)
E	Very low likelihood/Unlikely.	Very rare (e.g. to happen once in every 5 years).
	Impact/consequence	
5	Catastrophic: Public health impact.	Mortality expected from consuming water.
4	Major: Regulatory impact.	Morbidity expected from consuming water.
3	Moderate: Aesthetic impact.	Major aesthetic impact possibly resulting from the use of alternative but unsafe water sources.
2	Minor: Compliance impact.	Minor aesthetic impact causing dissatisfaction but not likely to lead to the use of alternative less safe sources.
1	Insignificant: No impact or not detectable.	No detectable impact.

Table 5. Qualitative Risk Analysis Matrix – Risk Categories

	Consequences				
Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
	1	2	3	4	5
A	H	H	E	E	E
B	M	H	H	E	E
C	L	M	H	E	E
D	L	L	M	H	E
E	L	L	M	H	H

Note: The number of categories should reflect the need of the assessment.

E– Extreme risk, immediate action required; H– High risk, management attention needed; M– Moderate risk, managements' responsibility must be specified; L-Low risk, manageable by routine procedures.

Based on the above matrices, each identified hazardous event/situation/hazard source was ranked against the level of hazard risk. The results are given in Table 6.

Table 6. Evaluation of Hazard Levels for Senaki Water Supply System

Drinking Water Supply System Component	Hazardous Event/Situation/ Hazard Source	Hazard	Likelihood	Impact/ Severity	Qualitative Risk
Water disinfection	Inadequate disinfection, and insufficient amount of residual chlorine in water system.	Microbial pathogens.	D Chlorination is carried out by liquid chlorine, but with outdated equipment, which is not effective for proper concentration of chlorine.	*4*	H *(High risk, management attention needed)*
Water disinfection	Inadequate disinfection and high amount of residual chlorine in water system.	Chemical.	D Chlorination is carried out by liquid chlorine, but with outdated equipment, which is not effective for proper concentration of chlorine.	*4*	*H* *(High risk, management attention needed)*
Headworks and water abstraction points	Domestic and wild animals and people can access the water catchment area that may lead to microbial contamination of water.	Microbial pathogens.	D Although the area is easily accessible by domestic animals and humans, headworks are fenced, but not guarded/supervised round the clock. Likelihood of contamination is not high.	*3*	*L* *(Low risk, manageable by routine procedures)*
Headworks and water abstraction points	People may access the water catchment area and intentionally or unintentionally discharge chemicals into the collection wells.	Chemical.	E Headworks are fenced but not guarded/supervised round the clock. Besides, there no single case of the source water chemical contamination recorded; Therefore, the likelihood of source water chemical pollution is low.	5	H (High risk, management attention needed)
Headworks and water abstraction points	Damaged headworks structures may result *in easy access of organic and chemical pollutants into source water*	Microbial, physical chemical.	D Water abstraction strictures, all bore wells are polluted, especially 7 wells, which was not rehabilitated at all. In 2011 only 10% of samples from ground water sources and 3% from distribution network didn't comply with national drinking water standards, these data is not sufficient enough to judge about the frequency of source water contamination due to insufficient number of samples taken from ground water sources and possible measurement errors of the laboratory. However, stemming from the fact that	4	H (High risk, management attention needed)

			headworks are located in easily accessible areas, but the headwork territory is fanced the likelihood of source water contamination is not high.		
Headworks and water abstraction points	Increased water turbidity and changed color during heavy (seasonal) rains.	Physical.	D Mechanical treatment (clarification, filtering and settling) is not carried out at the headworks and there is a risk of increased turbidity during heavy rains.	3	M (Moderate risk, management responsibility must be specified)
Reservoirs	Domestic and wild animals can access the areas where reservoirs are located, and contaminants may enter damaged (fractures) storage reservoirs.	Microbial pathogens and physical.	C The area is fenced and there is low probability of animals entering the reservoir area, and there is moderate to high probability that pollutants will reach through damaged reservoir.	3	H (High risk, management attention needed)
Main pipes and distribution network	Damaged pipes and insufficient pressure and water interruption can result in backflow from customer systems into the network or cross-contamination from sewerage systems.	Microbial pathogens.	B Water mains and distribution network are old and dilapidated at many points; many pumps are outdated; two regulating reservoirs are not used and there is frequent interruption of water supply that causes water pollution in the system.	4	E (Extreme risk, immediate action required)

6.0 Determination and Validation of Control Measures

6

6.1 Determination of Control Measures

WSP control measures were determined based on information and data collected by the WSP team through interviewing of the staff of Senaki Service Center, visual inspection of the system and analysis of existing drinking water quality data. At the assessment stage, control measures are suggested as recommendations to be included in the WSP as planned actions. In addition to measures to control risks, necessary monitoring and other management measures are suggested to be included in the WSP.

To mitigate hazards and ensure safe drinking water for the population of Senaki, the following control measures should be carried out:

1. **Source and Source Protection**

- Provision of round the clock guard/supervisor to avoid the potential hazard of surface contamination of source water in case of anthropogenic involvement at the intake point/territory.
- Cleaning of 15 bore wells, installation of protection covers (e.g. Umbrellas) and rehabilitation of the 1 damaged well that is currently non-operational.
- Replacement of existing 7 deep pumps.

2. **Water Treatment**

- Renovation of the building that houses the chlorination station and replacement of the equipments.

3. **Reaservoirs**

- Repair/renovation of covers and vents of the reservoirs and ensuring that they are always covered.
- Rehabilitation of the 500 m^3 storage reservoir.
- Putting into operations the two750 m^3regulating reservoirs. For this, it is necessary to replace inlet and outlet 150 mm pipes with 250 mm pipes.
- Renovation of the 500 m^3 regulating reservoir located in the city.
- Equipping reservoirs with modern devices (e.g. flow meter, water table measuring device, observation window/vent, etc.).

Distribution System

- Installation of individual customer water meters.
- Carrying out full-scale rehabilitation of the water main and distribution network.

Regarding the water quality monitoring, reporting and communications, the following measures are recommended to be carried out:

- Equipping the water testing laboratory with modern equipment and conducting training for laboratory staff.
- Increasing the number of personnel to at least two.
- Elaborating an accurate and detailed database of laboratory testing results (particularly microbe contamination parameters).
- Developing a plan on how to inform the population about incidents of water contamination and what protection measures should be taken from their side (boiling, etc.) to avoid waterborne diseases.
- Conducting regular trainings for service personnel to introduce new approaches of improving potable water quality monitoring and water safety plans.

Summary information on identified hazards, hazardous events and control measures for Senaki water supply systems is given in Table 7.

Table 7. Identified Hazards and Control Measures for Senaki Water Supply System

#	Drinking water supply system component	Hazardous event/situation/hazard source	Hazard	Risk level	Control measures
1	Water disinfection	Inadequate disinfection, Insufficient or high amount of residual chlorine in water system.	*Microbial pathogens*	*H (High risk, management attention needed)*	***Short term strategy:*** • Rehabilitate chlorination facility; • Increase the frequency of bacteriological analysis. ***Long term strategy:*** • Modernize chlorination
2	Headworks and water abstraction points	Domestic and wild animals and people can access the water catchment area that may lead to microbial contamination of water.	*Microbial pathogens*	*L (Low risk, manageable by routine procedures)*	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:*** • Rehabilitate existing 7
		People may intrude the water catchment area and intentionally or unintentionally discharge chemicals into the collection wells.	Chemical	H (High risk, management attention needed)	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:*** • Rehabilitate 7 bore wells
		Damaged headworks structures may result in easy access of organic and chemical pollutants into source water.	Microbial, physical chemical	H (High risk, management attention needed)	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:*** • Rehabilitate existing 7 bore wells and replace

		Increased water turbidity and changed color during heavy (seasonal) rains.	Physical.	M (Moderate risk, management responsibility must be specified)	***Short term strategy:*** • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:*** • Rehabilitate existing 7
3	Reservoirs	Domestic and wild animals can access the areas where reservoirs are located, and contaminants may enter damaged (fractures) storage reservoirs.	Microbial pathogens and Physical.	H (High risk, management attention needed)	***Short-term strategy:*** • Repair/renovate covers and vents of the reservoirs and ensure that they are always covered. ***Long term strategy:*** • Equip reservoirs with modern devices (e.g. flow meter, water table measuring device, observation window/vent, etc.); • Rehabilitate 500 m^3
4	Main pipes and distribution network	Damaged pipes and insufficient pressure and water interruption can result in backflow from customer systems into the network or cross-contamination from sewerage systems.	Microbial pathogens.	E (Extreme risk, immediate action required)	***Short-term strategy:*** • Detect leaks in water main and distribution network and rehabilitate priority/critical sections. ***Long-term strategy:*** • Install individual customer water meters; • Carry out full-scale rehabilitation of the

6.2 Risk Reassessment and Validation of Control Measures

Subsequent to detailed description and identification of hazards for Senaki water supply system, the next steps consisted of risk reassessment and validation with technical personnel and the Head of the Senaki Service Center. For this purpose, under the INRMW program, a meeting was organized with the management team of Senaki Water Supply Service Center. In this meeting, consultants from UNESCO-IHE and a team working on water safety plans participated. The team presented actual and potential hazards to the Senaki water supply system, risks which can provoke deterioration of drinking water quality and also control measures related to these risks (Table 7).

In general, hazards, their sources, related hazardous events and control measures presented by the working group were approved and judged acceptable for the Senaki Water Supply Service Center with certain comments, particularly:

- Increase of the frequency of water quality monitoring, particularly residual chlorine and bacteriological components;
- Construction of additional 1,000 m^3 regulating reservoir for better regulated and improved water supply to the city;
- Installation of automated shutters at reservoirs;
- Development and implementation of safety and health measures for chlorination facility and the process.

For effective implementation of the control measures, the following supporting programs should be implemented:

- Capacity building of laboratory for improving water quality monitoring;
- Defining the actual water demand and losses (elaboration of water balance). The Service Center possesses leak detection devices;
- Developing a hydraulic model;
- Elaborating long term development plans for the water supply and sanitation systems.

A consolidated list of hazards, related hazardous events/hazard sources and suggested control measures, monitoring and supporting programs which include abovementioned remarks, is presented in the table 8 bellow.

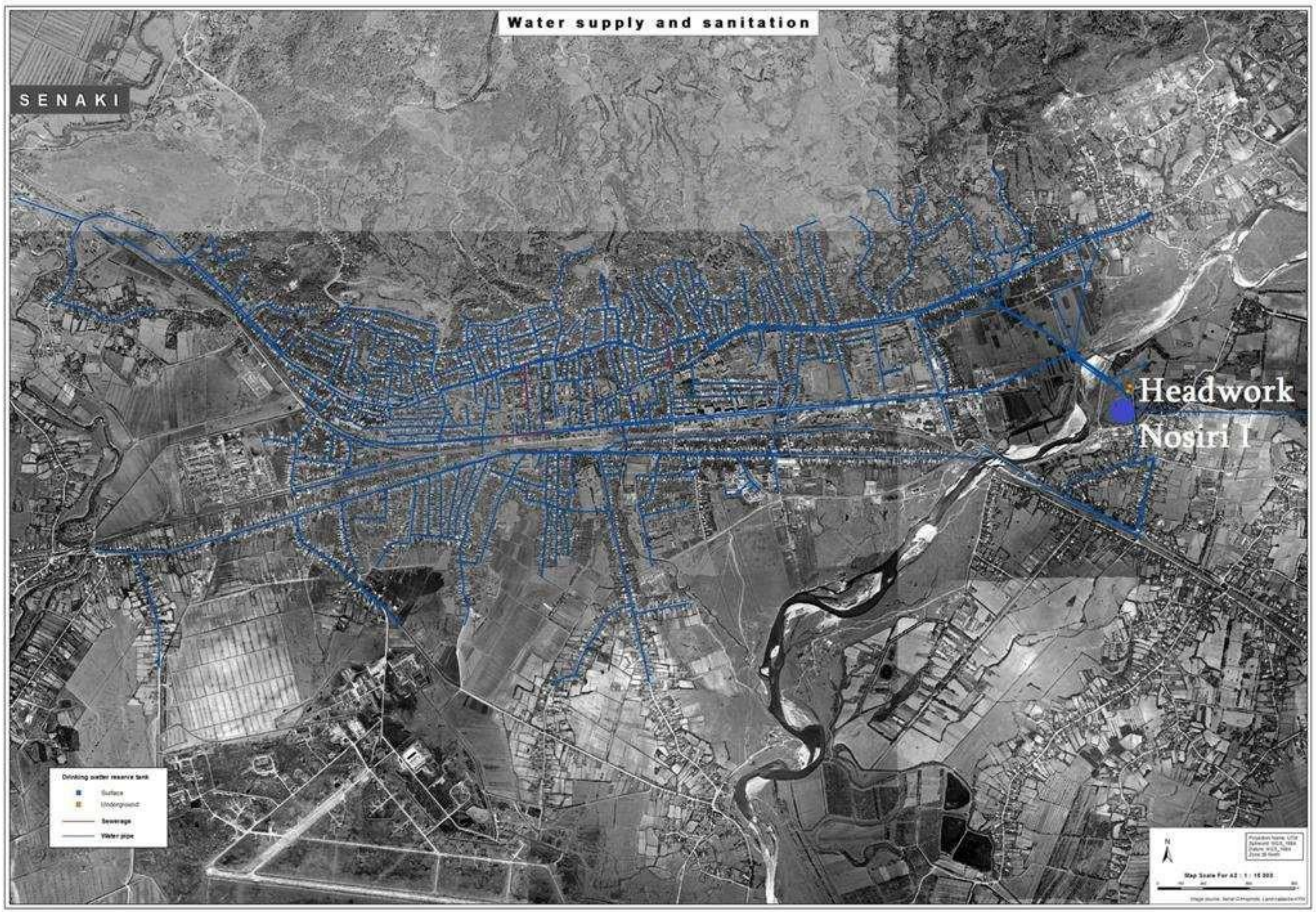
Table 8. Hazardous Events, Hazards, Control and Monitoring Measures and Supporting Programs Identified for Senaki Water Supply System

#	Drinking water supply system component	Hazardous event/situation /hazard source	Hazard	Risk level	Control and monitoring measures		Supporting programs
					Developed by water safety team	Additional measures after validation workshop	
1	Water disinfection	Inadequate disinfection, Insufficient or high amount of residual chlorine in water system.	*Microbial pathogens*	*H (High risk, management attention needed)*	***Short term strategy:*** • Rehabilitate chlorination facility; • Increase the frequency of bacteriological analysis. ***Long term strategy:*** • Modernize chlorination procedure and technology.	• Increase frequency of water quality monitoring related to residual chlorine and bacteriological parameters; • develop and implement	• Strengthening of the technical capacity of service center laboratories • Training of laboratory staff on water monitoring implementati on • Results of laboratory testing (particularly microbial contaminati o n parameters) require more detailed description and quantitative reflection. • Identificatio
2	Headworks and water abstraction points	Domestic and wild animals and people can access the water catchment area that may lead to microbial contamination of water.	*Microbial pathogens*	*L (Low risk, manageable by routine procedures)*	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas).	• Increase frequency of water quality monitoring at headworks.	
	Headworks and water abstraction points	People may intrude the water catchment area and intentionally or unintentionally discharge chemicals into the collection wells.	Chemical	H (High risk, management attention needed)	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas).	• Increase frequency of water quality monitoring at headworks.	

	Headworks and water abstraction points	Damaged headworks structures may result in easy access of organic and chemical pollutants into source water.	Microbial, physical, chemical	H (High risk, management attention needed)	***Short term strategy:*** • Provide round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:***	• Increase frequency of water quality monitoring at headworks.	water supply system • Development of action plan for public information and recommendation in case of drinking water pollution and emergency situation • Elaboration of long term development plan for water supply system • Periodical update of water safety plan and service training of staff
	Headworks and water abstraction points	Increased water turbidity and changed color during heavy (seasonal) rains.	Physical	M (Moderate risk, management responsibility must be specified)	***Short term strategy:*** • Clean-up 15 bore wells and install protection covers (umbrellas). ***Long term strategy:*** • Rehabilitate existing 7 bore wells and replace pumps.		
3	Reservoirs	Domestic and wild animals can access the areas where reservoirs are located, and contaminants may enter damaged (fractures) storage reservoirs.	Microbial pathogens and Physical	H (High risk, management attention needed)	***Short-term strategy:*** • Repair/renovate covers and vents of the reservoirs and ensure that they are always covered. ***Long term strategy:*** • Equip reservoirs with modern devices (e.g. flow meter, water table measuring device, observation window/vent, etc.); • Rehabilitate 500 m^3 storage reservoir; • Renew operations of	• Increase frequency of water quality monitoring at headworks; • install automated shutters/self-closing gate valves on reservoirs; construct additional 1,000 m^3 regulating reservoir.	
4	Main pipes and distribution network	Damaged pipes and insufficient pressure and water interruption can result in backflow from customer systems into the network	Microbial pathogens.	E (Extreme risk, immediate action required)	***Short-term strategy:*** • Detect leaks in water main and distribution network and rehabilitate priority/critical sections. ***Long-term strategy:*** • Install individual customer water meters; • Carry out full-scale rehabilitation of the water main distribution network.	• Increase frequency of water monitoring in the network; • expand capacities of headworks by adding new sources.	

Annexes

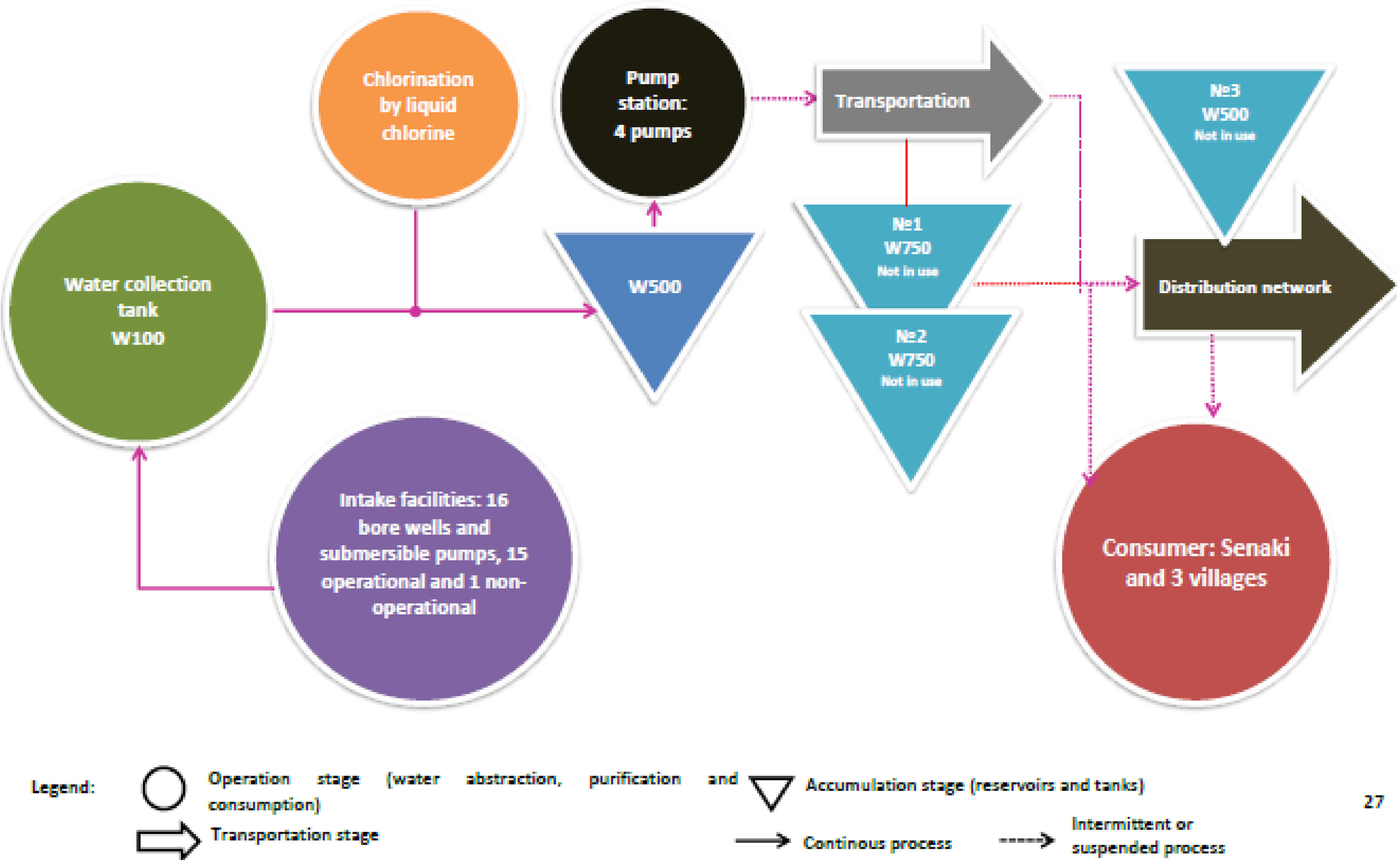
Annex 1. Map of the Senaki Water Supply System



Annex 2. Basic Data on Senaki Water Supply System

Number of Consumers Served by the Company	Number of Households and Organizations Served	Water Source Name, Type and Discharge Rate	Number and Volume of Water Collector Reservoirs	Water Treatment Method	Total Metric Length of the System
13612	6099 households; 329 organizations.	Groundwaters; artesian/bore wells. 1000 m^3/sec.	One 100 m^3 reservoir; One 500 m^3 reservoir; 3 regulating reservoirs of two 750 m^3 each and one 500 m^3 that is currently non-functional.	Chlorination by liquid chlorine.	Water main -13.8 km; Distribution network – 77 km.

Annex 3. Senaki Water Supply System Flow Diagram



Annex 4. Sanitary Requirements for Drinking Water Quality (Defined by the Technical Regulation of Drinking Water, Decree #349/N of the Ministry of Labor, Health and Social Affairs of Georgia 17.07.07)

Index	Measuring Unit	Standard Not Exceeding
Odor	Numbers	2
Taste	Numbers	2
Coloration	Degree	15
Turbidity	Turbidity unit (by formazin or Mg/l by kaolin)	3.5 2
Sulphate (SO42-)	mg/l	250
Chloride (Cl-)	mg/l	250
Oil products, total	mg/l	0.1
Surfactant substance anion active	mg/l	0.5
Rigidity	mg. eq/l	7-10
Calcium (Ca)	mg/l	140
Magnesium (Mg)	mg/l	85
Sodium (Na)	mg/l	200
Zinc (Zn 2+)	mg/l	3.0
Iron (Fe, total)	mg/l	0.3
Mezophilic aerobes and facultative anaerobes	Colony forming unit/ml 37 0C 22 0C	 20 100
Total coliformic bacteria	Amount of bacteria in 300 ml	not allowed
E.coli	Amount of bacteria in 300 ml	not allowed
Pathogenic microorganisms, including Salmonella	In 100 ml	not allowed
Coliform	Negative colony forming unit in 100 ml	not allowed
Pseudomonas aeruginosa (only for pre-aliquoted)	in 250 ml	not allowed

Annex 5. Number of Completed Analysis by Months, 2011, Samegrelo-Zemo Svaneti and Guria Regional Branch Office,
Senaki Service Center

TOTAL INSPECTIONS	NAMES OF INDEPENDENT WATER SUPPLY SYSTEMS: Nosiri 1 Headworks — Number of Portable Water Quality Inspections at Control Units												Period of Time
	Headwork At Surface Water Headwork (raw water)			At Ground Water Headwork (raw water)			Released (treated) portable water			Portable Water in Distribution System			
		inter alia			inter alia			inter alia			inter alia		
	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL	Within normal range	Divergence from a norm (+)	TOTAL			
844				**14**	**14**	**0**	**7**	**6**	**1**	**289**	**267**	**22**	**Total**
70										**6**	**6**	**0**	**January**
60										**5**	**4**	**1**	**February**
66				**1**	**1**	**0**				**13**	**10**	**3**	**March**
54				**1**	**1**	**0**				**12**	**12**	**0**	**April**
70				**1**	**1**	**0**				**18**	**18**	**0**	**May**
83				**2**	**2**	**0**				**18**	**18**	**0**	**June**
73				**1**	**1**	**0**	**1**	**1**	**0**	**22**	**20**	**2**	**July**
87				**1**	**1**	**0**	**2**	**1**	**1**	**37**	**35**	**2**	**August**
72				**1**	**1**	**0**	**1**	**1**	**0**	**43**	**41**	**2**	**September**
64				**2**	**2**	**0**	**1**	**1**	**0**	**33**	**29**	**4**	**October**
75				**3**	**3**	**0**	**1**	**1**	**0**	**29**	**25**	**4**	**November**
70				**1**	**1**	**0**	**1**	**1**	**0**	**53**	**49**	**4**	**December**

Annex 6. Registered Cases of Contagious Diseases for the City of Senaki in 2011   Source: Statistical Yearbook, Medical Statistics, 2011

#	Cases of Contagious Diseases, 2011	
	Senaki	
1	Viral hepatitis A	0
2	Acute viral hepatitis B	8
3	Acute viral hepatitis C	9
4	Chronic viral hepatitis B	21
5	Chronic viral hepatitis C	21
6	Typhus	0
7	Para typhus A, B, C	0
8	Salmonellosis	0
9	shigellosis (shigella infection)	0
10	Other bacterial intestinal diseases	0
10.1	Including escherichiosis	0
11	Yersiniosis	0
12	Amebiasis	0
13	Food poisoning	224
13.1	Including botulism	0
14	Diarrhea	47
15	Brucellosis	0
16	Leishmania	0
17	Malaria	0

Picture 1. Technical Service/Operation Unit of Senaki Service Center, Old Premises

Picture 2. New Office of Abasha, Khobi and Senaki Service Center


Picture 3. Water Quality Monitoring Laboratory


Picture 4. Intake Point of one of the Bore Wells of Nosiri-1 Headworks

Picture 5. 100 m3 Underground Collection Tank

Pictures 6-7. Chlorination Facility and Equipment

Pictures 8-9. 500 m^3 Storage Reservoir at the Headworks

Picture 10. Rehabilitated Pumping Station and Old Premises of Operations Unit

Picture 11. Pump Station with Pumps

Picture 12-13. Control Board/Operations Panel

Picture 14. Valves/Shutters of the Water Mains

Picture 15. Residual Chlorine Testing Equipment at Headworks

Picture 16. Water Testing Logbook

Global Water for Sustainability Program

Florida International University

Biscayne Bay Campus

3000 NE 151St. ACI-267

North Miami, FL 33181 USA

Phone: (+1-305) 919-4112