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Drinking Water Safety Plan for Senaki Water Supply System, Republic of Georgia

Drinking Water Safety Plan Series

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Integrated Natural Resources Management for the Republic of Georgia Program

Drinking Water Safety Plan for Senaki Water Supply System, Republic of Georgia

Drinking Water Safety Plan Series

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Contents

List of Acronyms and Abbreviations

CARE - Cooperative for Assistance and Relief Everywhere
CENN – Caucasus Environmental NGO Network
GLOWS – Global Water for Sustainability
FIU – Florida International University
INRMW-Georgia – Integrated Natural Resources Management in Watersheds of Georgia
SOPs- Standard Operating Procedures
USAID – United States Agency for International Development
UWSCG – United Water Supply Company of Georgia
WHO – World Health Organization
WI – Winrock International
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), initiated by a consortium of international and national organizations led by Florida International University (FIU) in partnership with CARE International, Winrock International (WI), UNESCO-IHE, and Caucasus Environmental NGO Network (CENN).

Within the INRMW framework, among various planned activities, it was envisaged to develop Water Safety Plans (WSPs) for six cities (Akhmeta, Telavi, Dedoplistskaro, Oni, Ambroaluri and Senaki) in the pilot watershed areas of the Rioni and Alazani-Iori river basins. To accomplish this task, a local water safety planning team, supported by UNESCO-IHE, was established. A short course on water safety planning was also offered to the staff of the United Water Supply Company of Georgia (UWSCG) in October, 2011. In accordance with the program work plan, the further work was divided into two stages. During the first stage, WSPs were developed for four cities (Akhmeta, Telavi, Oni, and Ambroaluri) in the upper pilot watershed areas of Alazani-Iori and Rioni river basins, followed by the second stage of developing WSPs for two cities (Dedoplistskaro and Senaki) in the lower pilot watershed areas.

The WSP for the water supply system of the city of Senaki is elaborated in accordance with WHO guidelines. The Drinking Water Safety Plan represents a system wide approach to ensure that the water delivered to consumers is of good and consistent quality. The WSP is based on a comprehensive assessment of risk factors that could adversely affect the quality of the water delivered to consumers, and sets out control measures to minimize or eliminate risk factors.

Assessments of water supply systems preceding the preparation of WSPs serve as baselines for WSPs. They include: i) a detailed description of the centralized water supply systems; ii) assessments of existing and potential hazards; iii) assessments of risks; and iv) recommended control measures to avoid and/or mitigate risks.

2. Methodology and Objective(s)

For elaboration of the Drinking Water Safety Plan for the Senaki water supply system, WHO "Water Safety Plan Manual – 2009" was used as a guideline. The manual presents step-by-step guidance for preparing an assessment of the water system and the WSP.

The objective of the WSP is to ensure the safety of drinking water by applying good water supply practices, including: i) prevention of contamination of the source water; ii) treatment of the water to reduce or remove contamination and meet water quality targets; and iii) prevention of re-contamination during storage, distribution and handling of drinking-water.

The focus of this document is the development and implementation of a WSP to be used by the water supplier of Senaki.

The initial step for water safety planning was the assessment of the water supply system based on WHO guidelines[1]. It was conducted from the source to the tap together with the identification of hazards, hazardous events and assessment of their risks.

The analysis was based on the information and data collected by the WSP team directly from the central office of the UWSCG as well as through site inspection of the water supply system and catchment, and by interviewing local staff of the company using questionnaires. 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 and treatment facilities and methods:
    - Water disinfection;
    - Water distribution system;
    - Storage (service reservoirs and tanks);
    - Network;
- Water consumption and consumers; and
- Drinking water quality monitoring procedures, databases and availability of trained staff.

In the next step the WSP team identified hazards, their sources and/or related hazardous events/situations and 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 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, together with key capacity development (support), monitoring measures, and re-assessment of risks in terms of likelihood and impact, taking the effectiveness of each control measure into consideration.[2] Risks were prioritized in terms of their likely impact on the capacity of the system to deliver safe water.

[1] Technical Report 11. Water Supply System Assessment for the City of Senaki, INRMW-Georgia, October, 2012 http://www.globalwaters.net/projects/current-projects/inrmw/

[2] The means by which risks may be controlled

In addition, some actions are important for ensuring water safety, but do not affect water quality directly; supporting programs fall into this category. They incorporate the principles of good process control that underpin the WSP. Codes of good operation, management and hygiene practices are essential elements of supporting programs. These are often captured within standard operating procedures (SOPs) or system operating rules. The list includes:

- Hygienic working practices documented in maintenance SOPs;
- Training and improvement of the competence of personnel involved in the water supply;
- Tools for managing the activities of staff, such as quality assurance systems;
- Securing stakeholder commitment, at all levels, to the provision of safe water;
- Education of communities whose activities may influence water quality;
- Calibration of monitoring equipment; and
- Record keeping.

3. Short Overview of Identified Hazards, Hazardous Events and Control Measures

According to the WHO WSP guidelines (2005) [3], risks of the hazards revealed for the whole water supply scheme of the city of Senaki were assessed by two factors: likelihood and potential impacts (results of self-monitoring of water quality by the water supply system). The likelihood was expressed by anticipated occurrences of hazards identified through the sanitary observation of the system. Hazards threatening the whole water supply system were prioritized using 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 priority matrix is based on risk scores of the sanitary inspection questionnaire and water quality monitoring data received from UWSCG.

Thus, on the basis of the sanitary questionnaire and hazard prioritizing matrix for Senaki water supply system, biological, chemical and physical contamination risk factors that have a negative impact on the quality of drinking water and cause a hazard of exposure to water borne diseases or chemical contamination were identified. 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:

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

Apart from the factors mentioned above, technical conditions of water testing laboratory, capacities of its staff and the quality of water testing can be considered as factors that may indirectly impact the water quality, as it was described in Technical Report 11. Water Supply System Assessment for the City of Senaki (INRMW- Georgia), the laboratory is relatively well equipped with chemicals and auxiliary materials, but there is a lack of some of the standard chemical solutions, which are supplied from the regional laboratory. Bacteriological analysis of samples taken from the water main and pipes are conducted every day, and the samples from headworks undergo analysis once a month, in the laboratory of Poti service center. 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 of 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 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. Please see the table in Annex 1 for Evaluation of Hazard levels for Senaki water supply system. [4]

[3] 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

[4] Detailed description of hazard and risk assessment methodology is given in the Technical Report 6. Water Supply System Assessment for the City of Senaki, INRMW-Georgia, May, 2013; http://www.globalwaters.net/projects/current-projects/inrmw/

After compiling a detailed description and identification of hazards for the Senaki water supply system, the next step was the risk re-assessment and validation. For this purpose, a meeting was organized with the management team of Senaki water supply service center. International experts from UNESCO-IHE and the local WSP team participated in this meeting. The team presented actual and potential hazards of the Senaki water supply system, the risks which can provoke deterioration of drinking water quality and also control measures related to these risks. Results were either validated by the staff of the service center or revised to reflect actual hazards. Hazards were also prioritized in discussions with the staff of the Senaki service center.

All the above steps were the basis for drafting the WSP control measures and supportive programs, which were discussed with and validated by the staff of the Senaki water supply service center. The table of control measures for each hazardous event is shown in Annex 2.

For effective implementation of the WSP, the following supporting programs were identified along the control measures:

- Strengthening the technical capacity of the service center laboratories;
- Training of the laboratory staff on water monitoring implementation;
- Improvement of the interpretation and reporting of laboratory results (particularly microbial contamination parameters);
- Identification of real water supply-demand and water losses (development of real water balance);
- Setting up of a hydraulic model of water supply system;
- Development of an action plan for public information and recommendation in case of drinking water pollution and emergency situation;
- Elaboration of a long term development plan for the water supply system; and
- Periodical update of the WSP and service training of staff.

4. Water Safety Plan

After the prioritization of control measures and supporting programs, the approximate costs[5] of the suggested measures and timelines for their implementation were defined. For costs, four ranges were used: i) Low cost (L) – less than 10,000 GEL; ii) Medium cost (M) – 10,000-100,000 GEL; iii) High cost (H) – 100,000-1,000,000 GEL; and iv) Extremely high cost (E) – more than 1,000,000 GEL. Apart from this, the WSP includes measures that do not require additional finances and whose costs are embedded in existing operational/running costs of the company.

For the time category, the short term (S) timeline was considered to be up to two years; middle term (M) – three to five years; and long term (L) – six to ten years. Apart from the three categories of timelines, the WSP contains measures that should be implemented continuously or periodically during the occurrence of specific events.

The final step for the water safety planning was the prioritization of control measures[6] using risk reduction potential and cost criteria for control measures in accordance with the following matrix:

Table 1. Criteria for Prioritization of Control Measures

Risk reduction potential of the control measure		Cost of the control measures			
		L	M	H	E
		4	3	2	1
E	4	16	12	8	4
H	3	12	9	6	3
M	2	8	6	4	2
L	1	4	3	2	1

12-16-high priority
6-11- medium priority
1-5- low priority

Risk reduction potential:[7] E=4 – extremely high potential; H=3 – high potential; M=2 – medium potential; L=1 – low potential

Cost:[8] L=4 – low cost; M=3 – medium cost; H=2 – high cost; E=1 – extremely high cost

The WSP including the timeline for the Senaki water supply system is presented below in the Table 2:

[5] The cost estimate is based on the market prices currently existing in Georgia and on the document of "Prices of construction resources" 2012 II quarter
[6] If one control measure has reduction potential for two or more risks (with different risk category), prioritization of control measures will be calculated with highest category of risk.
[7] The highest rank is assigned to the control measures needed for reduction of the extreme risk
[8] The highest rank is assigned to the lowest cost control measures

Table 2. Water Safety Plan for Senaki Water Supply System

	Drinking water supply system component	Hazardous event	Hazards and risk category	Control measures	Cost, GEL	Implementer	Time Line	Priority score and level
1	Water treatment and disinfection	*a) Inadequate disinfection - Insufficient or high amount of residual chlorine in water system*	*Microbial pathogens Chemical H (High risk, management attention needed)*	Renovate chlorination facility	M <30,000	Service center of Senaki	S	9 Medium
				Modernize chlorination procedure and technology	H <170,000	UWSCG Service center of Senaki	L	6 Medium
				Develop and implement safety and health measures regarding chlorination	L <5,000	Service enter of Senaki	S	12 High
		b) Increased water turbidity and changed color during heavy (seasonal) rains	*Physical M (Moderate risk, management responsibility must be specified)*	Arrange technological treatment modules (sedimentation/ coagulation/ filtration)	E >500,000	UWSCG	L	2 Low
2.	Headworks and water abstraction points	*a) Domestic and wild animals and people can access the water catchment area that may lead to microbial contamination of water* *b) Damaged headworks structures may result in easy access of organic and chemical pollutants into source water* *c) People may access the water catchment area and purposefully or unintentionally discharge*	*Microbial pathogens L (Low risk, manage by routine procedures)* *Chemical H (High risk,*	Provide a 24-hour guard/supervisor at the headworks	L <5 000 (annually)	Service center of Senaki	S	12 High

		chemicals into the collection wells	*management attention needed)*[9]	Clean-up 15 bore wells and install protection umbrellas (for 12 bore wells)	M <100,000	UWSCG Service center of Senaki	S	9 Medium
				Renovate 7 bore wells and replace pumps	M <100,000	UWSCG	**L**	9 Medium
		d) Increased water turbidity and changed color during heavy (seasonal) rains	*Physical M (Moderate risk, management responsibility must be specified)*	Install automated shutters/ self-closing gate valves on reservoirs (to interrupt water supply during high turbidity)	M >10, 000	UWSCG Service center of Senaki	M	6 Medium
3.	Reservoirs	*Domestic and wild animals can access the areas where reservoirs are located Contaminants may access damaged (fractures) storage reservoir*	*Microbial Physical H (High risk, management attention needed)*	Repair/renovate covers and vents of the reservoirs and assure that they are always covered	L >5,000	UWSCG	S	12 High
				Modernize reservoirs with technical equipment (water level meter, window for observation, automatic shutters – SCADA system)	M >10 000	UWSCG Service center of Senaki	M	9 Medium
				Renovate the 500 m^3 storage reservoir	H <200,000	UWSCG	M	6 Medium
				Install inlet and outlet pipes and valves at the two regulating reservoirs and renew its operations	M <10,000	Service center of Senaki	M	9 Medium
4.	Main pipes and distribution network	*Damaged pipes and insufficient pressure, water interruption can result in backflow from customer systems into the network*	*Microbial pathogens E (Extreme risk, immediate action required)*	Detect leaks in water main and distribution network and renovate priority/critical sections	H >100,000	UWSCG Service center of Senaki	M	8 Medium
				Increase frequency of water monitoring in the network	L <10,000	Service center of Senaki	S	16 High
				Expand capacities of operating wells and renovate and renew operations of 16th well	M <100,000	UWSCG Service center of Senaki	M	12 High

[9] If one control measure has reduction potential for two or more risks (with different risk category), prioritization of control measures will be calculated with highest category of risk.

				Install individual customer water meters for remaining part (30 %) of customers	H <200,000	UWSCG	L	8 Medium
				Carry out full-scale renovation of the distribution network	E >1,000,000	UWSCG	L	4 Low
5	All components of the water supply system	*Emergency conditions: breaking of the main pipeline and network, destruction of the headworks by natural disasters; contamination of water at the headworks or in the network; emergency situation during chlorination, etc.*	*- Microbial* *- Physical* *- Chemical* *E* *(Extreme risk, immediate action required)*	Elaborate action plan for emergency situations	L <10,000	UWSCG Service center	S	16 High

Annexes

Annex 1. 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 - insufficient amount of residual chlorine in water system	Microbial pathogens	D Chlorination is carried out by using 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 - high amount of residual chlorine in water system	Chemical	D Chlorination is carried out by using 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 to 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 is not a single case of source water chemical contamination record; 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 and chemical	D Water abstraction structures, all bore wells are polluted, especially 7 wells, which were not renovated at all. In 2011, only 10% of samples from ground water sources and 3% from distribution network did not comply with national drinking water standards; this data is not sufficient enough to judge the frequency of source water contamination due to insufficient number of samples taken from ground water sources and possible measurement errors of the laboratory. Though the headworks are located in easily accessible areas, the headworks territory is fenced and the likelihood of source water contamination is not high	4	H (High risk, management attention needed)
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 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 a 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, water interruption can result in backflow from customer systems into the network*	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)

Annex 2. 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:*** • Renovate the chlorination facility; • Increase the frequency of bacteriological analysis ***Long term strategy:*** • Modernize chlorination procedure and technology	• Increase the frequency of water quality monitoring related to residual chlorine and bacteriological parameters • develop and implement safety and health measures related to chlorination	• Strengthening of the technical capacity of service center laboratories; • Training of the laboratory staff on water monitoring implementation; • Improvement of the interpretation and reporting of the results of laboratory testing (particularly microbial contamination parameters);
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 a round the clock guard/supervisor at the headworks; • Clean-up 15 bore wells and install protection covers (umbrellas) ***Long term strategy:*** • Renovate existing 7 bore wells and replace pumps	• Increase the frequency of water quality monitoring at headworks	

		People may intrude into 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 a round the clock guard/supervisor at the headworks • Clean-up 15 bore wells and install protection covers (umbrellas) ***Long term strategy:*** • Renovate 7 bore wells and replace pumps	• Increase the frequency of water quality monitoring at headworks	• Identification of actual water supply-demand and water losses (development of real water balance); • Setting up of a hydraulic model of water supply system; • Development of an action plan for public information and recommendation in case of drinking water pollution and emergency situation; • Elaboration of a long term development plan for water supply system; • Periodical update of the WSP and service training of the staff .
		Damaged headworks structures may result in easy access of organic and chemical pollutants into source water	Microbial, physical and chemical	H (High risk, management attention needed)	***Short term strategy:*** • Provide a round the clock guard/supervisor at the headworks • Clean-up 15 bore wells and install protection covers (umbrellas) ***Long term strategy:*** • Renovate existing 7 bore wells and replace pumps	• Increase the frequency of water quality monitoring at headworks	
		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:*** • Renovate the existing 7 bore wells and replace the pumps		

3	Reservoirs	Domestic and wild animals can access the areas where reservoirs are located, and contaminants may enter damaged 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 3 (W750; W750; and W500) regulating reservoirs	• Increase the frequency of water quality monitoring at headworks • install automated shutters/self-closing gate valves on reservoirs • construct an additional 1,000 m^3 regulating reservoir	
4	Main pipes and distribution network	Damaged pipes and insufficient pressure, 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 renovate priority/critical sections ***Long-term strategy:*** • Install individual customer water meters • Carry out full-scale renovation of the water main distribution network	• Increase the frequency of water monitoring in the network • expand capacities of headworks by adding new sources	

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