Assessment of Water Supply System, Akhmeta
Republic of Georgia

Technical Report Number 6

Integrated Natural Resources Management in the Republic of Georgia Program

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List of Acronyms and Abbreviations

1. ^{o}C – Temperature degree by Celsius scale
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. LLC – Limited Liability Company
14. L - liter
15. L/sc – Liter per second
16. m – meter
17. m^3 – cubic meter
18. mm - millimeter
19. m^2 – square meter
20. mg/l – milligram per liter
21. ml - milliliter
22. NGOs – Non-governmental Organizations
23. UNESCO –United Nations Educational, Scientific and Cultural Organization
24. USAID – United States Agency for International Development
25. UWSCG – United Water Supply Company of Georgia
26. WHO – World Health Organization
27. WI – Winrock International
28. 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).

Within the INRMW framework, among various planned activities, 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 support of UNESCO-IHE. In accordance with the program work plan, the work was divided into two stages. During the first 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. During the second stage WSPs were to be developed for urban areas (Dedoplistskaro, Senaki) in the lower protions of pilot watershed areas. Assessments of water supply systems are baseline studies for WSPs that include a detailed description of centralized water supply systems, and identification of existing and potential hazards, hazardous events/situations/hazard sources and an assessment of their risks.

The present report is a detailed assessment of the water supply system for the city of Akhmeta. It includes a description of the system, identification of existing hazards to drinking water quality, their sources and 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, together with management and monitoring measures, a description of the methodology used to gather data of the existing water supply system, an identification of hazards, an assessment of their risks and a determination of control measures. The report will serve as a basis for developing the WSP for the water supply system of the city of Akhmeta 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_sa_nitation_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, their sources and/or hazardous events/situations imposing hazards 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 of 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 and treatment facilities and methods;
    - Water disinfection;
    - Water distribution system;
    - Storage (service reservoirs, tanks);
    - 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, 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) and monitoring measures and re-assessment of risks in terms of likelihood and impact taking into consideration effectiveness of each control measure.[2] Risks were prioritized in terms of their likely impact on the capacity of the system to deliver safe water.

[2] The means by which risks may be controlled

3. Institutional and Legal Framework 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. In accordance with the water law, during the allocation of water resources, first priority is given to water allocation 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 ground water abstractions for drinking water supply (for more details see relevant parts on surface waters and mineral resources). The law on Public Health divides responsibilities among various ministries with regard to water safety. The list of laws and regulations governing the potable water supply sector is given on the following page.

Drinking water quality standards and rules for drinking water quality monitoring are set out in the "Technical Regulation on Drinking Water" approved by the #349/N Decree, 17.07.2007 of the Minister of Health, Labor and Social Protection.[3] 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. It does not cover the quality of small water supply systems with a capacity of 10 m^3/day serving less than 50 persons as well as natural mineral waters, where the mineralization exceeds 1,500 mg/l. The regulation sets requirements against common parameters of smell, 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 radioactive safety of potable water (See annex 4). The quality of water in a natural water body intended for drinking water use should not exceed ambient water quality standards set out by the #297/N Decree of the Minister of Labor, Health and Social Affairs on "the Approval of Ambient Environment Quality Standards", issued on 16.08.2001.[4]

According to the "Technical Regulation of Drinking Water", rules for state compliance assurance monitoring and control of drinking water quality including components to be checked, 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 drinking water quality testing, it may delegate its functions/outsource the assignment to an accredited independent laboratory. In cases where the required standards are not met under the Technical Regulation, the supplier of drinking water is liable to carry out appropriate measures, including reporting to relevant authorities, identification of pollution sources, restriction of water supply and implementation of corrective measures for the safety of the population[5].

[3]: 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

[4] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=52384&lang=ge;

[5] For more details on water related issues please see INRMW technical report 1. Rapid National Assessment at http://www.globalwaters.net/projects/current-projects/inrmw/

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.

Below is given the list of laws and regulations governing the drinking water supply sector:

- Water Law.[6]
- Law on Public Health. [7]
- #297/N Decree of the Minister of Labor, Health and Social Affairs, 16.08.2001 on "Approval of Ambient Environment Quality Standards".
- #349/N Decree of the Minister of Labor, Health and Social Affairs of Georgia, 17.07.07 on "Technical Regulation of Drinking Water".
- #59 Decree of the Minister of Environment, 07.05.1998 on the "Approval of the Provision on Water Protection Zone".[8]
- Law on Sanitary Protection Zones of Resorts and Resort Areas, 20.03.1998
- #16/N Decree 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".
- #15/N Decree of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Drinking Water Sampling".
- #17/N Decree of the Minister of Health, Labor and Social Protection, 22.01.2004 on the "Approval of Sanitary Rules on Water Treatment by UV Radiation.
- #250/N Decree 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".
- #32 Ordinance, 26.11.2008 of the GNEWRC on the "Approval of the Rules on Drinking Water Supply and Consumption".
- #18 Ordinance, 29.08.2008 of the GNEWRC on the "Approval of the Methodology on Setting Out Water Use Tariffs".
- #14 Ordinance, 26.11.2008 of the GNEWRC on "Penalizing Illegal Users of Centralized Water Supply and Sanitation Systems".
- #17 Ordinance, 17.08.2010 of the GNEWRC on "Water Use Tariffs".
- # 10 Decree, 30.01.2009 of the Government of Georgia on "Approval of the Charter on the Ministry of Regional Development and Infrastructure".
- 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. [9]

[6] http://nfa.gov.g e/files/kanonebi/wylis_shesaxeb.pdf
[7] http://www.nsc.gov.ge/files/files/legislations/kanonebi/sa_zogadoebrivi%20janmrteloba.pdf
[8] https://matsne.gov.ge/index.php?option=com_ldmssearch&view=docView&id=80770
[9] http://water.gov.ge/uploads/kanonmdebloba/debuleba5.pdf

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

- The Ministry of Labor, Health and Social Protection sets out ambient water quality standards in accordance with WHO guidelines.
- The Ministry of Agriculture carries out state control of drinking water quality.
- The Ministry of Environmental Protection develops and coordinates 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 for natural resources, together with environmental inspectorate will be moved 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. Provision of water supply to the Georgian population, except for the populations of Tbilisi, Mtskheta, Rustavi and the Autonomous Republic of Ajara 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 and, vii) Kutaisi. These branches have their laboratories, which conduct monitoring activities for drinking water quality in the urban water supply system under their responsibility.
- The Georgian National Energy and Water Regulatory Commission (GNEWRC) sets out water supply and consumption rules, approves methodologies for setting up water use tariffs, sets water use tariffs, and approves rules on penalizing illegal water users, including those illegally discharging wastewaters in sanitation systems
- Georgian Water and Power (GWP) is a leading company in the water supply market of Georgia. The company provides water supply services to the population of Tbilisi and its neighborhoods, as well as to State organizations, industrial and commercial objects. The company also delivers wastewater services to the capital. GWP serves about 400 000 customers throughout the city, out of which about 2000 are budget organizations, 15 000 are commercial objects and the rest are residential customers.

4. Detailed Description of Water Supply system from Catchment to User

The water supply system of the city of Akhmeta operates under Kakheti regional office of the LLC "United Water Supply Company of Georgia" UWSCG. The Service Center of Akhmeta consists of 17 employees, of which 12 are technical-engineering and operational staff (including 4 employees from emergency group). Please see Annex 7, pic. 1 and 2.

The city of Akhmeta is located in east Georgia on the southern slopes of the Main Caucasus Range, near the Alazani river. The city is located at about 529-650 m above sea level.

Four water sources: "Chartala" (E 45°6'35.223" N 42°5'44.14"), "Sabue"(E 45°7'37.338" N 42°3'18.246"), "Garistskali"(E 45°7'4.8" N 42°3'1.67"), "Shirimi" (E 45°10'47.436" N 42°1'26.383") are used for abstraction of drinking water. The system is a simple gravity type scheme. Please see Annex 1 and 2.

4.1 Main Characteristics of the Water Source and its Catchment

Land use. All water intake facilities of the Akhmeta Water Supply System are located in remote areas without any settlements, agricultural land use or any other anthropogenic pressure on the catchments. There are mostly hills with sharp slopes, covered with forests (please see Annex 7 for pictures of the water supply system, including catchments).

Main characteristics of water intake sources. Sources of headworks "Chartala" and "Sabue" are fed from filtrates of the Ilto river and the "Shirimi" headworks from filtrates of the Orveli river. Source for "Garistskali" intake is ground water of the aquifer of Upper Cretaceous carbonate flysh composed of limestone, marls and sandstones.[10] Please see Annex 1.

Abstraction method and location. "Chartala" headworks has a drainage system collecting filtrates of the Ilto river. It consists of 26 concrete round wells (with 1.2 m diameter and 7 m depth), connected to 400 mm diameter and 300 m long drainage pipes. The last well is collector, from where water flows to the main pipe (same as water main). Water is abstracted from 7 m deep drainage network. The headworks is located at 713 m above sea level, the territory is fenced and guarded 24 hours. Total area of the first sanitary zone is 21,495 m^2 and is located 12 km from Akhmeta.

Water source of the "Sabue" intake is represented by filtrates of the Ilto river. Water is abstracted by drainage network, which consists of polyethylene pipes (total length is 300 m, diameter -400 mm) and 5 circular concrete wells (diameter is 1.2 m, depth - 5 m). Drainage collector was renovated in 2006. The headworks is located at 633 m above sea level, the sanitary zone is fenced but not guarded/supervised. Total area of the first sanitary zone is 6,000 m^2 is located 5.5 km from Akhmeta.

Water source of the "Shirimi" headworks is a filtrate of the Orveli river. From the drainage collector water directly flows to the 200 mm diameter main pipe. The drainage collector is located at 650 m

[10] Annex 2. Map of Groundwater Aquifers, Detailed Assessment of Natural Resources of Upper Alazani Pilot Watershed Area. http://www.globalwaters.net/publications/

above sea level. The source is unprotected. Total area of the first sanitary zone is 4,000 m^2 and is located 3 km from Akhmeta.

Water source of the intake facility "Garistskali" is ground water. The spring water captation system is located at 648 m above sea level. The source is unprotected. Total area of the first sanitary zone is 3,000 m^2. The source is located 6 km from Akhmeta.

Water Quality at Source. Potential cause for deterioration of water quality (microbiological cause) might be unprotected headworkss, especially "Shirimi" and "Garistskali". Domestic and wild animals can easily access the unprotected water catchment area, which could result in the animal fecal matter entering the water supply system and affecting the quality of the source water.

At the "Chartala" headworkss during heavy rains, water quality does not meet national drinking water quality standards (physical parameters: color and turbidity) and consequently, for this period of time population of Akhmeta receives poor quality water. Therefore, during such events the service center of Akhmeta limits water supply to consumers. High turbidity is caused by two factors: i) water filtrate drainage system is very close to the river bed and during high waters, the filtering capacity of turbid water is very low; ii) there are no embankments along the river banks as a result of which water intake facility is flooded during high waters. The map of water supply system of city Akhmeta is presented in Annex 1.

4.2 Description of Water Supply System

4.2.1 Headworks and Treatment Facilities

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

Water discharge at the "Chartala" headworks is about 150 L/sc. Infiltrated water of the river flows through drainage wells to 420 mm diameter steel main pipe. There is no water technological treatment module(s) at the headworks. The headworks was renovated in 2009.

Water discharge at the "Sabue" headworks is about 21-25 L/sc. From drainage wells water directly flows to 50 mm diameter main pipe. There is no water technological treatment module(s) at the headworks At this headworks water disinfection is carried out by chlorine lime only in summer time once or twice a week as preventive measures. There is no chlorination tank, water is chlorinated directly in the well, where collected water flows to the main pipe. The headworks was renovated in 2006.

Average water discharge of "Shirimi" source is 21 L/sc. From drainage pipes water directly flows to 200 mm/150 mm diameter main pipe through valves. There is no water technological treatment module(s) at the headworks. The headwork has never been renovated and currently, is in unsatisfactory condition. Moreover, asbestos cement drainage pipes of the collector are obsolete corroded and leaking in many areas.

Water discharge at the "Garistskali" headworks source is 6 L/sc. From the spring water captation, water is collected to the concrete collector well, with specipication – round 1.5 m X 1.5 m. Through the valves, water directly flows to the 150 mm diameter main pipe. There is no water technological treatment module(s) at the headworks . Since 1947 water intake facility has not been renovated. Now its condition is unsatisfactory, the water collector is obsolete and damaged.

It should be noted that water disinfection is not carried out at any headworks, except for "Sabue" headworks , where chlorination is conducted only in summer time.

Mainly water disinfection is carried out at storage reservoirs (please see the diagram in Annex 3) by simple method and with chlorinated lime. The solution of chlorine is prepared manually in separate tanks (solution retention time is 24 h) and then flows to the storage reservoirs by dropping. Testing of residual chlorine is carried out every day. Pease see Annex 7. pic. 3 and 4 for chlorination process of Akhmeta water supply system.

4.2.2 Water Distribution Network

From the "Chartala" headworks water flows to 420 mm diameter and 11 km long steel main pipe (same as water main), built in 1982. About 40% of the pipeline is corroded. In 2009, 5-km section of the water main was fully replaced with a new pipe of similar specifications. From the main pipe water flows into two N1 and N2 concrete 1,000 m^3 storage reservoirs of rectangular and circular shape, where water is disinfected by chlorinated lime.

From "Sabue" intake facility water flows to 250 mm diameter 5.5 km long main pipe composed of obsolete pipes. Consequently, there are high leakages in the system. From the main pipe water flows to concrete circular reservoirs N5 and N6, 500 m^3 each, where water is disinfected by chlorinated lime.

From the headworks "Garistskali" water flows to 150 mm diameter and 6 km long main pipe. About 80 % of the pipe is obsolete and in poor condition. From the main pipe water flows into two reservoirs N5 and N6, 500 m^3 each (water from the "Sabue" headworks is collected here as well).

From the "Shirimi" source, water flows into 20 m^3 steel tank through 150-200 mm diameter and 3 km main pipe. The main pipe is renovated. In the tank water is chlorinated twice a week (once a week in summertime) and then delivered to 900 residents of the city of Akhmeta 24-hour a day.

Total length of main pipes is 25.5 km.

In total, the water supply system of Akhmeta consists of 6 reservoirs: N1 and N2 – 1,000 m^3, N3 1,200 m^3, N4 – 2,000 m^3, N5 and N6 - 500 m^3. Total capacity of reservoirs is capacity 6,220 m^3, recharge time of reservoirs is 3.5 hours. Water chlorination is carried out in N1,N2,N5 and N6 reservoirs. For chlorination process please see chapter 4.2.1. From N1 and N2 reservoirs, which are located at 651 m above sea level, water is delivered to distribution network either directly or through passing two other rectangular concrete regulating reservoirs: N3 - 1,200 m^3 and N4 – 2,000 m^3, located at 592 m and 579 m above sea level correspondingly. The distance from reservoir N3 to reservoirs N1 and N2 is 1 km and from reservoir N4 - 0.7 km. From N5 and N6 reservoirs water flows directly to distribution network. The physical state of all reservoirs is satisfactory and there are no water losses. All reservoirs are fenced and full-time operators work there, but the poor condition of the covers and aeration pipes creates risks for water contamination. Please see Annex 7 pic. 5 and pic.6. Reservoirs do not have equipment for monitoring of water level and it is very difficult to regulate water supply.

The total length of the Akhmeta distribution network is 22 km. It is more than 20 years old and was mainly constructed in 1980s. The state of the network is unsatisfactory. In 2009, 10-km section of the network was replaced by plastic (PVC) pipes. Pressure in the network is regulated by 2-3 main valves. Average pressure in the distribution network is about 2.5 – 3 Bars.

According to information of Akhmeta service center, water losses in the network are about 30%. This amount is calculated without any water metering equipment. Although, proceeding from the poor state of water supply system and high consumption of water per resident, the losses might be considerably higher.

4.2.3 Water Consumption and Consumers

The water supply system of Akhmeta serves up to 8,780 consumers (2,069 households). This is about 89% of the total population of the city. The system also serves 104 organizations. About 75% of total consumers have no 24-hour water supply, they receive water only 12 hours a day, in critical periods 8-10 hours a day. The process of installation of water meters is already started In Akhmeta, water meters are installed for 704 consumers (600 households).

According to the 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 m^3 (including the price for sanitation service); 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 1 m^3 of water (for the time being this rate includes the price for sanitation service).

On average, 800 l daily norm of drinking water consumption is set for households by the service center of Akhmeta, which is calculated without individual water meters. This amount might be high to take into account 12 hours working regime of 6 storage/regulating reservoirs (with total capacity 6,200 m^3), capacity of water supply sources and water losses in the network which is approximately 30% according to the Service Center. Daily water consumption for the city of Akhmeta is extremely high in comparison with the established rate by European countries, which varies from 120 to 150 l/day per resident.

5. Risk Assessment

Identification of hazards, their sources and potential hazardous events/situations as well as risk assessment of the Akhmeta 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)[11], 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, and 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 entire water supply systems and not for particular 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 see Annex 4. Regular water quality monitoring of the Akhmeta system currently focuses on the following basic set of parameters: *Microbial parameters – E. coli and total coliforms*; *Physical parameters* - taste, odor, color, turbidity, 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; water quality monitoring points are set up by the central office of UWSCG and are 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 (ground water).
iii) Release points (treated water).
iv) Distribution network.

Water quality monitoring is partially carried out by the laboratory of the Akhmeta of UWSCG. At present, the laboratory is in a poor condition (See annex 7, pic.7 and 8). There is a lack of basic equipment, while the esixting one is outdated or does not work. The laboratory only ensures taking samples and monitoring of organoleptic parameters and residual chlorine, mainly, samples for microbiological analysis are transferred to the Telavi Regional Laboratory of the United Georgian Water Company, which is in a good condition. Monitoring results are reported in the registration books. Water quality monitoring of the Akhmeta water supply system is carried out for released (treated) water - reservoirs and water distribution network. From distribution network samples are taken every day and from reservoirs once a month analyzed for parameters listed above.

[11] 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

Assessment of drinking water quality for Akhmeta water supply system is based on 2011 water quality monitoring data (see Annex 5). According to these data, 369 samples were collected, from which 21 were collected from released (treated) water and 348 – from the distribution network.[12] In 2012 none of the samples were taken from headworks. Table 1 reflects drinking water quality compliance with the national standards in 2011.

Table 1. Drinking water quality compliance with the National Standards for the Akhmeta Drinking Water Suppy System, 2011[13]

Monitoring Point	Number of samples	Compliance with the National Standards %			
		Compliance		Non-compliance	
		Numb. of samples	%[14]	Numb. of samples	%
Released (treated) portable water	21	21	100	0	0
Water in Distribution System	348	322	93	26	7
In total	369	343	93	26	7

The table shows that although most components of the water supply system were in compliance with the National Standards, there were instances of non-compliance in 2011. The figures in the table show that 100% of samples from released (treated) potable water and 93% of samples from distribution network met the National Standards. 348 samples were collected from the distribution network and among them, 26 (7%) samples did not meet requirements. Deviations were detected in the following months: March - 4 (1%), May - 8 (2%), June - 6 (1%), July 2 - (1 %), and August - 6 (2%). This might be caused by the damaged distribution system, inadequate chlorination process and/or water interruptions.

Despite that current results of laboratory analyses, which reflects good compliance with the National standards, probability of water contamination might be higher than indicated by the monitoring results, due to old laboratory equipment, methodology and damaged water distribution system.

In order to identify issues related to particular parameters, additional information was requested from the service center laboratory staff. Based on this information it was learned that non-compliance of water quality with the national standards was generally due to microbiological contamination – non-compliant concentrations of total coliform bacteria and E.coli. Physical parameters in general met the national standards, except in May and June, when water transparency was not in compliance with the standards. According to chemical parameters, water quality met national standards. However, concentration of residual chlorine was sometimes lower than the national standard (0.3 – 1.5 mg/l).

Concerning contagious diseases for the city of Akhmeta, statistics for 2011 shows 2 cases of hepatitis A, 15 cases of acute viral hepatitis B, 10 cases of chronic hepatitis B, 1 case of bacterial intestinal diseases and 33 cases of brucellosis. However, there is no evidence that these cases resulted from water contamination. For detailed information please refer the Annex 6.

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

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 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 in by the technical personnel of the Akhmeta 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.

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).*

Stemming from the fact that the situation in all headworks is the same (with little differences), sanitary inspection questionnaires were elaborated for entire water supply systems and not for particular elements.

Presented below is the completed questionnaire for Akhmeta water supply system. The answers for all headworks were identical.

Table 2 . Filled in questionnaire for sanitary observation

#	Question	Yes	No
1	Is the area around the catchment not protected?	X	
2	Do animals have access to the area around the catchment?	X	
3	Are there a solid or liquid collecting sites within 30 m of the catchment?		X
4	Is there any source 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 covered?	X	
9	Has there been a discontinuity in water supply in last 10 days?	X	
10	Does the community report any pipe breaks in the last week?	X	
	In total	8	2

As it is shown from the aggregate responses to the questions of Akhmeta Water Supply the Sanitary Inspection Questionnaire, 8 positive responses out of 10 questions were received indicating that the system belongs to the **high risk** category systems.

Thus, the WSP team has identified the following hazardous events/situations/sources of water contamination:

1. Absence of the sanitary protection zone around headworks, leaving the headworks easily

accessible to wild animals and livestock

2. Absence of any preliminary water treatment (sedimentation/coagulation reservoir, chlorination) at intake
3. Presence of large corroded and damaged sections in pressure pipes
4. Application of out of date technologies for chlorination.
5. Frequent interruptions in water supply
6. Frequent accidents in distribution systems

All above listed hazardous events/situations/hazard sources may lead to any of three hazards: i) deterioration of physical properties of the drinking water, ii) microbial contamination of the drinking water and; iii) chemical contamination of the drinking water. These hazards may cause the spread of water borne diseases, in particular during heavy rains, floods, increased air temperatures and droughts. Chemical contamination and deterioration of organoleptic (physical) properties (e.g. odor, taste, color, transparency) of drinking water are also possible.

5.3 Hazard Prioritization

In accordance with WHO WSP guidelines (2005), hazards revealed for the whole water supply scheme were prioritized by 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.

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.

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.

Table 3. Hazard prioritizing matrix for Akhmeta water supply system

Deviations 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	7[15]	0
Risk level	low	medium	high	very high
Priority action level	none	low	high	urgent

Despite the fact that 343 (93%) water samples out of 369 meet the national standards and just 26 (7%) are deviated from the standard, according to the results (score 8) of the sanitary questionnaires, the entire system, including the distribution network, is assessed at *high risk*. The water supply points

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

scored as “yes” on the sanitary inspection form represent the potential sources/factors of hazards for microbiological contamination of drinking water.

Thus, on the basis of the sanitary questionnaire and hazard prioritizing matrix for Akhmeta 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 water borne 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:

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

Apart from above, technical conditions of water testing laboratory, capacities of its staff and the quality of the water testing can be considered as factors that may indirectly impact the water quality. As it was described in the above paragraphs of this chapter, water testing equipment of the laboratory of the Akhmeta Service Center is in very poor condition. The majority of equipment is outdated or does not work. The laboratory only monitors organoleptic parameters and residual chlorine, mainly, samples for microbiological analysis are transferred to the Telavi Regional Laboratory. Water quality monitoring of the Akhmeta water supply system is carried out at following points: i) reservoirs filled with treated (released) water and; ii)distribution network. From distribution network samples are taken every day and from reservoirs once a month and analyzed for parameters listed above. Furthermore, in 2011 samples were not taken from any headworks. This is judged to be insufficient given that the majority of headworks structures are damaged, water intake facilities are not fenced or guarded, no technological treatment or disinfection is provided and water abstracted at the headworks goes directly to the main pipe of water supply system. 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 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 for 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 at least once a day)
B	High likelihood	Frequent (e.g. to happen at least once a week)
C	Moderate likelihood	Moderately frequent (e.g. to happen at least once a month)
D	Low likelihood	Rare (e.g. to happen at least once a year)
E	Very low likelihood/Unlikely	Very rare (e.g. to happen at least once 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 use of alternative less safe sources
1	Insignificant: No impact or not detectable	No detectable impact

Table 5: Qualitative risk analysis matrix – risk categories

Likelihood	Consequences				
	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, management responsibility must be specified; L – Low risk, manage by routine procedures.

Based on above matrices each identified hazard and hazardous event, was ranked. The results are given in table 6 below.

Table 6. Evaluation of Hazard levels for Akhmeta water supply system

Drinking water supply system component	Hazardous events	Hazard	Likelihood	Severity	Qualitative risk
Water disinfection	Inadequate disinfection - insufficient amount of residual chlorine in water system	Microbial pathogens	D Chlorination is carried out through a primitive method (chlorine lime), 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 through a primitive method (chlorine lime), 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 can access the water catchment area, which could result in the animal fecal matter entering the water supply system	Microbial pathogens	D Two headworks are fenced but not guarded/supervised 24 hours a day. Two other headworks are not fenced and not guarded. However, the headworks are located at places that are not easily accessible and the likelihood of contamination is not high	4	H (High risk, management attention needed)

Headworks and water abstraction points	Increased water turbidity during heavy (seasonal) rains (especially at the "Chartala" intake facility)	Physical	D Water filtrate drainage is very close to the river bed and during high waters it could not filtrate high volume of turbid water it receives, lack of embankments cause flooding of the water intake facility during high waters	3	*M* (Moderate risk, management responsibility must be specified)
Headworks and water abstraction points	People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells leading to chemical pollution of the source water	Chemical	*E* Two headworks are fenced but not guarded/ supervised 24 hours a day. Two other headworks are not fenced and not guarded. However, the area is not easily accessible to humans; besides, there is not a single case of source water chemical contamination record; therefore, the likelihood of source water chemical pollution is very 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 structures at two headworks are damaged to different extents because no fundamental maintenance/renovation has been carried out. In 2011, samples were not taken from the headworks, regardless of the fact that in 2011 only 7% of samples 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 the absence of water samples from headworks and insufficient number of samples taken from distribution system and possible measurement errors of the laboratory. However, stemming from the fact that headworks are located in remote unpopulated areas with no/low human activities there, the likelihood of source water contamination is not high	4	H (High risk, management attention needed)
Reservoirs	Domestic and wild animals can access the reservoirs	Microbial Physical	E The territory of reservoirs is fenced and protected, reservoirs are in a satisfactory condition and bird and other animal fecal matters are unlikely to enter the reservoir	4	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 At some points pipes are damaged ,there are frequent water interruptions and contamination by backflow is likely	4	E (Extreme risk, immediate action required)

6. Determination and Validation of Control Measures

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 Akhmeta 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 Akhmeta the following control measures are recommended to be carried out:

1.***Source and Source Protection***

- Fencing of water intake facility sanitary zone (where it is possible) and 24-hour guarding/supervising should be ensured at all headworks to avoid potential hazards of surface spring water contamination in case of anthropogenic involvement at the intake point/territory.
- Rehabilitation of water intake unit on the "Garistskali" and "Shirimi" headworks.
- Construction of the river revetment structures (e.g. gabions, etc.) on "Chartala" headworks to avoid flooding of abstraction points and respectively water contamination.

2.***Water treatment***

- Carrying out chlorination in compliance with corresponding norms.
- Modernization of chlorination procedure and technology.
- Installation of water technological treatment modules (sedimentation and clarification tanks) at headworks (where it is possible).
- Interruption of water supply during high turbidity.

3.***Reservoirs***

- Cleaning of reservoir bottoms periodically.
- Modernization of reservoirs with technical equipment (water level meter, window for observation, etc.).

4.***Water Mains and Distribution System***

- 6 km (40%) long and 420 mm diameter corroded main steel pipeline connecting "Chartala" source to distribution network should be replaced.
- Old part of the main steel pipeline (150 mm.), which is 6 km in length (80%) and connects "Garistskali" water source to distribution network should be replaced.
- To eradicate leakages in the city distribution network, old part of pipelines with a total length of 16 km (about 30%) should be replaced.

- Installation of water meters will help to use water more efficiently and to avoid illegal connections.
- Detailed inventory of the water supply system should be carried out and GIS compatible electronic database of the system technical specifications, condition, drawings and maps should be created.

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

- Equipping the water testing laboratory with modern equipment and conducting training for laboratory staff.
- Elaboration of an accurate and detailed database of laboratory testing results (particularly microbe contamination parameters).
- Development of a plan for 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.
- Regular trainings for service personnel to introduce new approaches to improve potable water quality monitoring and water safety plans.

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

Table 7. Identified Hazards and control measures for Akhmeta 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 Chemical	H *(High risk, management attention needed)*	***Short term strategy:*** • Carry out chlorination in compliance with corresponding norms ***Long term strategy:*** • Modernize chlorination procedure and technology
2	Headworks and water abstraction points	Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply	Microbial pathogens	H *(High risk, management attention needed)*	***Short term strategy*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone (where it is possible)
		People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells *leading to chemical pollution of the source water*	*Chemical*	H *(High risk, management attention needed)*	***Short term strategy*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy:*** • Rehabilitate and modernize damaged water intake units

		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*** • Appoint guard for supervision of water intakes • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy*** • Rehabilitate and modernize damaged water intake units
3	Headworks and water abstraction points	Increased water turbidity during heavy (seasonal) rains *(especially at the "Chartala" intake facility)*	Physical	M *(Moderate risk, management responsibility must be specified)*	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long time strategy:*** • Arrange technological treatment modules (sedimentation, coagulation and filtration) nearby storage reservoir, as there is no possibility to arrange it at the intakes due to the geographic location • Arrange river revetment structures
4	Reservoirs	Domestic and wild animals can access the reservoirs	Microbial Physical	H *(High risk, management attention needed)*	***Short term activities:*** • Rehabilitate/Install reservoir roofs and ventilation equipment and keep it always closed ***Long time strategy:*** • Modernize reservoirs with technical equipment (water level meter, window for observation)
5	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:*** • Ensure corresponding water pressure in the pipes • Increase disinfection concentration and frequency ***Long term strategy:*** • Rehabilitate damaged pipes • Install water meters and revealing illegal connections

6.2. Reassessment of Risks and Validation

After detailed description and identification of hazards for Akhmeta water supply system, the next steps consist of risk reassessment and validation with technical personnel and the head of the Akhmeta service center. For this purpose under the INRMW program a meeting was organized with the management team of Akhmeta 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 Akhmeta 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 Akhmeta Water Supply Service Center with certain comments, particularly:

- For timely prevention of population from turbid water automatic shutters should be installed on reservoirs;
- Increase monitoring for the whole system (install water discharge and pressure meters, water level meters in reservoirs);
- Install washing valves at the respective points of the distribution network.

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

- Laboratory capacity building for improving water quality monitoring;
- Defining the actual water demand and losses (elaboration of water balance);
- Developing a hydraulic model;
- Elaboration of long term development plans for the water supply system.

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

Table 8 . Hazardous Events, Hazards, Control and Monitoring Measures and Supporting Programs Identified for Akhmeta 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 Chemical	H (High risk, management attention needed)	***Short term strategy:*** • Carry out chlorination in compliance with corresponding norms ***Long term strategy:*** • Modernize the chlorination procedure and technology	• Increase the frequency of water quality monitoring regarding residual chlorine	• Strengthening of the technical capacity of the 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); • 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
2	Headworks and water abstraction points	Domestic and wild animals can access the water catchment area, which could result in the animal faecal matter entering the water supply	Microbial pathogens	H (High risk, management attention needed)	***Short term strategy:*** • Appoint a guard for supervision of the water intakes • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy:*** • Renovate and modernize damaged water intake units	• Increase the frequency of water quality monitoring	
		People may access the water catchment area and purposefully or unintentionally discharge chemicals into the wells leading to chemical pollution of the source water	Chemical	H (High risk, management attention needed)	***Short term strategy*** • Appoint a guard for supervision of the water intakes • Fence water intake facility sanitary zone (where it is possible) ***Long term strategy:*** • Renovate and modernize damaged water intake units	• Increase the frequency of water quality monitoring	

		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:*** • Appoint a guard for supervision of the water intakes • Fence water intake facility sanitary zone (where it is possible)	• Increase the frequency of water quality monitoring	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 staff.
		Increased water turbidity during heavy (seasonal) rains (especially at the "Chartala" intake facility)	Physical	M (Moderate risk, management responsibility must be specified)	***Short term strategy:*** • Interrupt water supply during high turbidity ***Long time strategy:*** • Arrange technological treatment modules (sedimentation, coagulation and filtration) nearby storage reservoir, as there is no possibility to arrange it at the intakes due to the geographic location • Arrange river revetment structures	• Increase the frequency of water quality monitoring	
3	**Reservoirs**	Domestic and wild animals can access the reservoirs	Microbial Physical	H (High risk, management attention needed)	***Short term activities:*** • Renovate/Install reservoir roofs and ventilation equipment and keep it always closed ***Long time strategy:*** • Modernize reservoirs with technical equipment (water level meter, window for observation)	• Equip reservoirs with automatic valve (self-closing gate valve) for immediate interruption of turbid water	
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:*** • Ensure corresponding water pressure in the pipes by installing additional valves ***Long term strategy:*** • Assess hotspots and carry out full renovation of the main pipes and network • Install water meters	• Increase the frequency of water monitoring in the network • Install washing valves at the respective points of the distribution network	

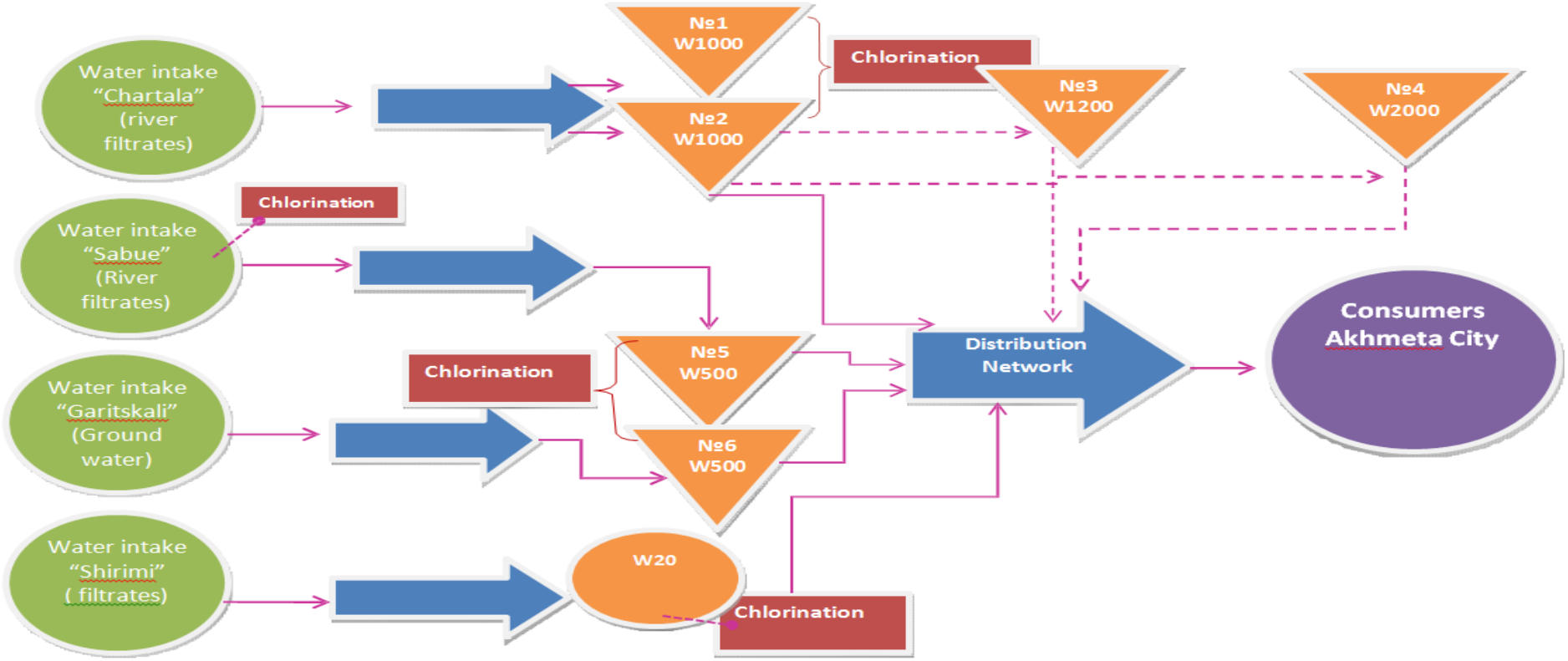
Annexes

Annex 1. Map of water supply system of the city of Akhmeta

Annex 2. Basic data on Akhmeta water supply system

Number of consumers served by the company	number of customers served	Consumers with water meters	Water source name, type and discharge	Number and volume of water collector reservoirs	Water treatment method	Total length of the main pipe and network
8780	2069 households and 104 organizations	600	Chartala; Drainage from river filtrate; 151 l/sc Sabue intake; river filtrate drainage; 21 l/sc Shirimi intake; river filtrate drainage; 21 l/sc Garistskali intake, captage; 6 l/sc	500 m^3 - 2 pieces; 1000 m^3 - 2 pieces; 1200 m^3 - 1 piece 2000 m^3 - 1 piece	Chlorination (chlorinbe lime)	47.3 km

Annex 3. Akhmeta water supply system flow diagram



Explanations:

Operation stage (water abstraction, purification, consumption)

Accumulation stage (reservoirs and tanks

Transportation stage

Uninterrupted process

interrupted proses

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

Index	Measuring unit	Standard not more than
Smell	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 ^{0}C 22 ^{0}C	 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 aerugiosa (only for pre-aliquoted)	in 250 ml	not allowed

Annex 5. Number of completed analysis by month during 2011 year
Kakheti Regional Branch Office, Akhmeta Service Center

NAMES OF INDEPENDENT WATER SUPPLY SYSMENS: 1. CHARCHALA; 2. SABUE; 3. GARISTSKALI; 4. SHIRIMI													
Number of Portable Water Quality Inspections at Control Units													
TOTAL INSPECTIONS	Headworks At surface water headwork (raw water)			At ground water headworks (raw water)			Released (treated) potable water			Potable water in distribution system			Period of Time
	TOTAL	inter alia		TOTAL	inter alia		TOTAL	inter alia		TOTAL	inter alia		
		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)		With normal range	Divergence from a norm (+)	
369							21	21	0	348	322	26	TOTAL
34										34	34	0	January
29							1	1	0	28	28	0	February
39							1	1	0	38	34	4	March
23										23	23	0	April
30							2	2	0	28	20	8	May
36							5	5	0	31	25	6	June
23							3	3	0	20	18	2	July
29										29	23	6	August
34							6	6	0	28	28	0	September
32							2	2	0	30	30	0	October
36							1	1	0	35	35	0	November
24										24	24	0	December

Annex 6. 2011 Registered Cases of Contagious Diseases for the City of Akhmeta

Source: Statistical Yearbook, medical statistics, 2011

#	Cases of Contagious Diseases, 2011	
	Akhmeta	
1	Viral hepatitis A	2
2	Acute viral hepatitis B	15
3	Chronic viral hepatitis B	10
4	Typhus	0
5	Para typhus A, B, C	0
6	Salmonellosis	0
7	shigellosis (shigella infection)	0
8	Other bacterial intestinal diseases	1
8.1	including: escherichiosis	0
9	Yersiniosis	0
10	Amebiasis	0
11	Diarrhea	0
12	Brucellosis	33
13	Malaria	0

Annex 7. Pictures

Picture 1 & 2. Service center of Akhmeta

Picture 3.1and 3.2. Process of chlorination in #1and #2 reservoirs

Picture 4 & 5. Unprotected reservoir roofs and aeration holes

Picture 6,7 and 8. Laboratory of Akhmeta service center

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