CLIENT:

MUNICIPALITY OF DIMITROVGRAD

PROJECT:

„PREPARATION OF TECHNICAL AND LABORATORY ANALYSES AND DEVELOPMENT OF A PLAN FOR THE APPLICATION AND OPERATION OF TELEMETRIC STATIONS IN THE PROJECT "IMPLEMENTATION OF INNOVATIVE TECHNIQUES FOR IMPROVING THE QUALITY OF POTATONE WATER IN URBAN AREAS" – AQUA-LITY"

DEVELOPMENT № 3:

„RESEARCH OF ECOTOXICOLOGICAL AND FINANCIAL EVALUATION OF PILOT ACTIVITY "

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Content:

1 GENERAL PART

Environmental pollution with heavy metals and other toxic chemical elements is particularly important for people's health. Toxic metals include a group of minerals that do not have known functions in the living organism but are actually harmful. Toxic metals are everywhere and affect all living organisms on the planet earth. They have become a major cause of disease, aging, and even genetic defects. Today, humanity is exposed to the highest levels recorded in history, lead, mercury, arsenic, aluminum, copper, nickel, tin, antimony, bromine, bismuth and vanadium.

Drinking water pollution is of great importance for the population's morbidity, which may be microbiological and chemical agents. Deviations in the microbiological qualities of drinking water may be the cause of a number of infectious and parasitic diseases borne by drinking water (Viral hepatitis type A, Shigerose, Abdominal thymus and paratyphocele, Cholera, Tummy, Polio, Kidney fever, Brucellosis, Amoeba dysentery and others.)

1.1 ESSENCE OF ECOTOXICOLOGICAL ASSESSMENT

Assessment of the harmful impact of chemicals, physical agents and natural products on the populations and societies of plants, animals and human beings.

It is expressed in an assessment of the effects of toxic substances on the equilibrium of ecosystems and their living organisms. Environmental risk assessment requires a good understanding of the properties and effects of many chemicals, their distribution in nature, biodegradability, water solubility, fatty solubility and accumulation in food chains.

1.2 OBJECTIVES AND SCOPE OF THE STUDY

The aim of the present study is to make an ecotoxicological assessment of the operation of pilot telemetry stations for real-time monitoring of the quality of drinking water.

Studies conducted to assess the quality of drinking water are often related to monitoring, modeling and interpretation of data for different physico-chemical indicators.

The purpose of the monitoring stations is to ensure quality management of the risk of contamination of drinking water. Selected points of the water supply network are intended to assemble a set of sensors, the information from which will be merged by telemetry stations and will be transmitted remotely to a central dispatch point.

1.3 TOXICITY OF DRINKING WATER

Substances which, in high concentrations, can cause toxicity and radioactivity to drinking water are: lead, mercury, arsenic, surfactants from detergents, pesticides, mineral fertilizers, etc.)

Heavy metals can be divided into three main groups according to their harmful influence on the human body. These three groups are presented in Chart 1. The most toxic metals are in Group I.

Chart 1 Groups of elements according to their harmfulness.

Group	Element
First group	Hg, Cd, Pb, As, Zn, Ti
Second group	Co, Ni, Mo, Cu, Cr
Third group	Ba, V, Mn, Sr, Al

Lead is considered to be the most widespread toxic metal due to its widespread use in industry. However, mercury, arsenic, cadmium and especially aluminum are just as widespread, if not more, but their 7 toxicity is not so well studied.

1.3.1 *Sources of heavy metal pollution*

Heavy metals in the form of various compounds: oxides, sulphides, carbonates etc. are present in soil, air and water in their natural concentrations. In these amounts, they do not cause any health or environmental problems. However, with the development of human activity, their accelerated penetration into the atmosphere, the water basins and the soil in concentrations higher than the natural ones is observed. This is what causes a distortion of the ecological balance. The main sources of environmental pollution with heavy metals are: metallurgy (processing of raw materials and metal production), metal processing, military industry, fertilizer production, coal burning, waste and sludge from production, motor vehicles, etc. Emissions that emit contaminate air, water and soil. From the air heavy metals fall into the soil, in the open waters and directly in humans through breathing. From the soil heavy metals are absorbed by the plants. As food, they fall into the animals and into man, and then participate in the circle of the biosphere. Another way of getting heavy metals in humans is through their passage from the soil into the open water ponds and underground water, and from them into the drinking water. The use of this water gives rise to health problems. Part of the heavy metals seas and oceans are precipitated, and another part remains dissolved and creates environmental problems. There is no doubt the importance and application of heavy metals in human life. The impact of their ions on humans and the environment is also well studied. It is therefore particularly important to maintain continuous emission control in order not to pollute the environment. Prevention of the fight against heavy metal intoxication can only be achieved through strict control of their content in all potential sources. These sources can be divided into three main groups:

•air;

• water - drinking and industrial;

• food and objects coming into contact with food.

1.3.2 *Major causes of water pollution*

Sources of microbiological contamination of drinking water as well as changes in its chemical composition may be caused by:

- Faecal-urban sewage from settlements that are not completely covered by sewerage networks and treatment plants and are a major source of contamination of surface water bodies with biogenic elements.
- Heavy metal pollution is not only a problem for the quality of river water, but also presents a risk of causing a soil pollution problem around the irrigation channels and for human health;
- Accidental spill releases of untreated industrial waste water as a result of accidents;

- Unregulated discharges of industrial waste water still exist in some areas;
- Increase in wastewater generated by point sources (agriculture, forestry and fisheries, services and households) in the East Aegean region;
- Building up of specific organic pollutants from agricultural practices, livestock farms and fish farms;
- Existence of unregulated landfills for domestic waste, including within the boundaries of flooded terraces of rivers;
- Lack of fertilizer control;

A major source of contamination of drinking water is wastewater and sewage waters. Since the beginning of the Industrial Revolution, factories have been throwing waste products out of their activities into rivers, lakes and seas. This damages not only the local flora and fauna but also the plants and animals hundreds of kilometers away. In addition to production, pollution is also caused by households. Agriculture is another problem area. Artificial manure, increasing harvest yields and pesticides used to eradicate pests, falls directly from soil into groundwater and drinking water.

Determination of the pollution thresholds shall also take into account: the source of the pollutants, the possibilities for their natural formation, their toxicity and the tendency for their dispersion, their persistence and their bioaccumulation potential.

1.4 WATER QUALITY REQUIREMENTS FOR DRINKING WATER

Regulatory documents that concern water quality are:

- ORDINANCE № 12 of 18.06.2002 on the quality requirements for surface water intended for drinking and domestic water supply. Issued by the Minister of Environment and Waters, the Minister of Health and the Minister of Regional Development and Public Works, promulgated, State Gazette, no. No. 63 of 8.06.2002, item 5, item 1, № 530d. Part of APPENDIX 1 of this Ordinance is given in Chart 2:

Chart 2 Requirements for the quality of surface water intended for the abstraction of drinking water

№	Unit and indicator	Category A1		Category A2		Category A3	
		recomm.	mandat.	recomm.	mandat.	recomm.	mandat.
10	mg/l Fe	0.1	0.3	1	2	1	
	mg/l Mn	0.05		0.1		1	
12	mg/l Cu	0.02	0.05	0.05		1	
13	mg/l Zn	0.5	3	1	5	1	5
14	mg/l B	1		1		1	
15	mg/l Be	0.0002					
16	mg/l Co	0.02					
17	mg/l Ni	0.02					
18	mg/l V	0.01					
19	mg/l As	0.01	0.05		0.05	0.05	0.1
20	mg/l Cd	0.001	0.005	0.001	0.005	0.001	0.005

21	mg/l Cr		0.05		0.05		0.05
22	mg/l Pb		0.05		0.05		0.05
23	mg/l Se		0.01		0.01		0.01
24	mg/l Hg	0.0005	0.001	0.0005	0.001	0.0005	0.001
25	mg/l Ba		0.1		1		1

- ORDINANCE No. 9 of 16.03.2001 on the quality of water intended for drinking water purposes Issued by the Minister of Health, the Minister of Regional Development and Public Works and the Minister of Environment and Waters, promulgated, State Gazette, issue no. 30 of 28.03.2001. This regulation defines the water quality requirements for drinking and household purposes. Part of this Ordinance on the permissible values of chemical elements is given in a chart 3.

Chart 3 Water quality requirements for drinking and household purposes.

Indicator	Maximum value	Unit
Sb	5.0	µg/l
As	10	µg/l
B	1.0	mg/l
Hg	1.0	µg/l
Cd	5.0	µg/l
Cu	2.0	mg/l
Ni	20	µg/l
Pb	10	µg/l
Se	10	µg/l
Cr	50	µg/l
Al	200000	mg/l
Fe	200	µg/l
Ca	150	mg/l
Mg	80	mg/l
Mn	50000	mg/l
Na	200	mg/l
Zn	5.0	mg/l

1.5 GENERAL CHARACTERISTICS OF THE WATER SOURCES IN THE TOWN OF DIMITROVGRAD

The quality of all water sources operating in the municipality of Dimitrovgrad is problematic and the levels of contamination of the raw water continuously or periodically exceed the normative permissible. The water sources supplying the town of Dimitrovgrad have very high levels of manganese. The measured maximum concentrations are in the range of 0.2 ÷ 0.3 mg / l at a tolerable 0.05 mg / l or an average of 400%. To solve the problem, in 1994, a drinking water treatment plant -WWTP KRUM was put into operation. The main function of the installation is the removing of manganese in the raw water, achieving consumer-safe levels of water quality indicators for drinking-household needs.

As a result of the multi-annual supply of contaminated water, significant manganese hydroxides have been deposited in the pipes. With sudden changes in the water velocity in the distribution network, they are a threat to the quality of the already purified water, and in addition, they create hydraulic difficulties over the network due to reduced watercourses..

Although in 1994 the WWTP, whose main purpose is the elimination of manganese in the water extracted from the tubular wells, has been put into operation, even under certain hydraulic conditions problems with its increased content are reported. This is due to the fact that as a result of the long-term supply of water in the pipes, deposits of manganese hydroxides have accumulated. In sensitive speed changes, the so-called hydraulic impacts, deposition particles dissolve in the water and there is a risk of an increase in manganese concentration above the normative value of 50 µg / l.

To ensure adequate quality control of the drinking water quality in the city's distribution network, a building of a real-time monitoring system for basic chemical indicators at key points in the water supply network is forseen. The system will consist of 5 control points (CP) installed at pre-selected control points. Their layout is consistent with the characteristics of the entire water supply system so as to ensure the maximum coverage of the city and the cities that are supplied by the urban water supply network of Dimitrovgrad.

1.6 CHARACTERISTICS OF TELEMETRY STATIONS

The installation of the telemetry stations will enable real-time monitoring of basic chemical indicators of water:

- pH
- Oxidative reduction potential ORP
- Residual chlorine

In addition, it is foreseen in the quality control points to measure both the main performance - instantaneous consumption, pressure and temperature.

2 ECOTOXICOLOGICAL ASSESSMENT OF THE ACTIVITY OF THE MONITORING STATIONS TO DETERMINE THE HARMFUL EFFECTS

2.1 RELEVANCE BETWEEN OBSERVED PARAMETERS AND THEIR IMPACT ON THE QUALITY OF DRINKING WATER

2.1.1 *pH*

This is a measure of the amount of hydrogen in the liquid. It does not reflect alkalizing or acidifying chemicals in the liquid and the amount of hydrogen atoms. Water with a pH of less than 6.5 is corrosive, it may contain metal ions such as iron, copper, zinc or manganese and is hazardous to both human health and water supply infrastructure.

2.1.2 *Oxidative reduction potential ORP*

The oxidation reduction potential indicates potential contamination, especially with industrial waste water. Due to the fact that in the presence of a high concentration of metal salts the value of ORP is significant very often the monitoring of this indicator is done to control the pollution of groundwater and surface waters with heavy metals.

2.1.3 *Manganese*

The potential threat of an increased concentration of manganese in water used for drinking as a result of the dissolution of manganese hydroxide deposits from pipes is one of the biggest challenges in terms of providing quality service to consumers. The deviation of this indicator is not of direct health significance even if the norm is exceeded to a certain extent but is very important to the consumer because the increased concentration of manganese changes the organoleptic characteristics of the water very strongly and in some cases the deviations make it even problematic for use for some household needs in households. For this reason, the main priority in the construction of the drinking water quality monitoring system in the water supply network is the provision of a reliable solution for early notification of an increase of the manganese concentration above that specified in the Water Quality Ordinance No. 9 / 16.03.2001, intended for drinking and household purposes.

Measurement of manganese concentration in water is difficult because it is done mainly in laboratory conditions with specialized equipment or on terrain with pre-calibrated portable equipment. For this reason, such equipment is primarily installed in drinking water treatment plants where it is used and maintained by qualified personnel or in dedicated laboratories.

Having this in mind, constant monitoring of the change in the values of the other two parameters to be monitored - pH and ORP - will indirectly give information about the concentration of manganese in the water. The reduction in the oxidation-reduction potential of water reduces the dissolved oxygen in the water as well, which is inversely proportional to the concentration of manganese. At the same time, the change in pH and the concentration of manganese are directly proportional, and the increase of one value is an indication of the increase of the other.

2.1.4 *Residual chlorine*

Chlorine (or chlorine-containing substances) are used to disinfect drinking water due to the fact that it degrades molecules of organic compounds of plant and animal nature and thus destroys all disease-causing micro-organisms. Taking this into account, another key priority of a water quality monitoring system will be to provide reliable data on residual chlorine in the water supply network. For this purpose, it is planned to install a specialized automatic system of sensors and instruments, which every 2.5 minutes will extract water directly from the pipeline through a sampler. The system will use an indicator reagent that will be stained by the free chlorine in the sample pipeline. The end result of the measurement will be available in the on-screen display or remotely in the dedicated monitoring software..

The five residual chlorine monitoring points to be built will enable the WSS operator to maintain its concentration in the required water quality requirements of Ordinance No. 9 / 16.03.2001 for drinking and household purposes of 0.3 - 0.4 mg / l.

2.1.5 *Water quantity*

Separating the water supply network into areas with constant water quantity monitoring and inlet pressure is the most popular method of water loss control. In the presence of already separated zones from the operational point of view it is logically parallel with the water quality monitoring equipment at the selected points to install and measure water quantity measuring devices.

2.2 ASSESSMENT OF THE OPERATION OF THE MONITORING STATIONS AND THEIR IMPACT ON THE QUALITY OF DRINKING WATER AND THE ENVIRONMENT

The Pilot Monitoring System, commissioned, provides real-time data for basic physical, chemical and operational performance. Thanks to strategically selected points, information is provided on - flow, pressure, residual chlorine, oxidation reduction potential, pH and water quantity temperature.

Provided electrical and internet power supply to the shafts where the controllers are installed enables data to be transferred at short intervals without any limitation in the volume of information sent. Continuous flow of information ensures a timely warning of change in some of the observed parameters and a quick response to a potential problem.

Inevitably thanks to the newly introduced information system and monitoring of residual chlorine, the oxidative reduction potential and the pH it provides will significantly improve the quality control of almost all the water supplied by the operator.

2.3 CONCLUSION

The above justifies the need to monitor the quality of drinking water in the water supply network in order to protect public health.

All this will lead to improvement of ecotoxicological indicators and achievement of ecological and socio-economic sustainability in relation to the water supply of the city.

3 CALCULATION OF THE COST OF OPERATION AND MAINTENANCE OF THE MONITORING POINTS SO AS TO ENSURE THE SUSTAINABLE OPERATION OF THE SYSTEM.

In order to ensure the sustainable operation of the real-time monitoring system on the quality of drinking water, constant and proper operation and maintenance of each of the monitoring points is required.

Chart 4 describes the required consumables and activities as well as the cost of operating each of the monitoring points for one year.

Chart 4 Equipment maintenance cost

Activity	Operating value for one monitoring point (BGN/yr)	Number of monitorin points	Total cost of operation of the monitoring system (BGN/yr)
Residual chlorine	1800	5	9000
ORP	1200	5	6000
pH	1200	5	6000
water quantity	400	5	2000
cost connectivity	180	5	900
power consumption	150	5	750
On-site visit by operator	500	5	2500
		total:	27 150 BGN/yr

The total cost of operation and maintenance of the real-time monitoring system on the quality of drinking water is 27 150 BGN/yr.