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Monitoring the quality of drinking water of the regional decentralized water supply

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Abstract. Despite the fact that the Irkutsk region belongs to areas with a large supply of fresh water, the monitoring surveys carried out on the quality of drinking water from decentralized water supply have shown that the inhabitants of the region lack quality drinking water. This is especially true of the population in rural districts and small towns where water supply is mostly not centralized. Studies have revealed a significant excess of standards for sanitary-chemical and microbiological indicators due to the high content of iron, nitrates, magnesium, manganese and sulphates, increased rigidity, the presence of coliform bacteria. The main causes of non-compliance of drinking water with regulatory requirements are identified. Measures to be done to bring the quality of drinking water in line with existing requirements are recommended.

All over the world there is a shortage of clean drinking water. To maintain the normal functioning of the population, drinking water of adequate quality is necessary. Currently, the lack of quality drinking water is one of the main problems. At the same time, pollution of drinking water significantly reduces existing reserves.

The total volume of surface water bodies of the Irkutsk Region is significant and amounts to 180 km^3, there are also large resources of groundwater of about 47,065 thousand m^3. At the same time, residents of rural settlements, where the water supply is mainly decentralized, are not fully provided with high-quality drinking water [1-2]. Therefore, the chosen topic of research is urgent.

The objective of the study is to monitor the quality of drinking water of decentralized water supply. Tasks of the survey include research of indicators of water samples from decentralized water supply, identifying the causes of drinking water quality non-compliance with current standards and recommending measures to bring drinking water quality into compliance with current regulations. The research method is the implementation of local operational observations of the quality of drinking water [3-4].

Based on the materials of the regional report “On the State and Environmental Protection of the Irkutsk Region in 2017” of the Ministry of Natural Resources and Ecology of the Irkutsk Region, 227 monitoring points were used in 34 territories of the region to monitor the quality of drinking water in the decentralized water supply of the Irkutsk Region.

Conducted surveys revealed that during the study period, samples of water samples exceeded hygienic standards, both in terms of sanitary-chemical and microbiological indicators (table 1).

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Table 1. Indicators of water samples of decentralized water supply exceeding hygienic standards.

Indicators	2015		2016		2017	
	Overall, un.	Share, %	Overall, un.	Share, %	Overall, un.	Share, %
Sanitary and chemical	581	26.7	905	37.4	890	38.8
Microbiological	154	7.04	364	11.1	231	9.5
Parasitological	0	0	1	3.7	0	0

Surveys found 6 territories in the region without unsatisfactory hygienic standards; these are the towns of Svirsk and Usolye-Sibirskoye, Ust-Ilimsk, Nizhneilimsky, Slyudyansky and Kazachinsko-Lensky districts (table 2).

Table 2. Ranking of municipalities of the Irkutsk region by the state of drinking water of decentralized water supply systems in 2017.

Municipalities	The share of water samples with an excess of hygienic standards for sanitary and chemical indicators, %	Rank	Share of water samples with excess of hygienic standards for microbiological indicators, %	Rank	The proportion of water samples with excess hygienic standards for parasitological indicators, %
Irkutsk region	38.8	-	9.5	-	-
Irkutsk city	70.2	1	5.3	23	-
Irkutsk district	66.8	3	11.8	13	-
Ol'khon district	33.3	19	33.3	1	-
Shelekhov district	11.1	31	31.1	2	-
Irkutsk district	46.7	9	20.7	6	-
Slyudyansky district	0.0	34	4.5	24	-
Angarsk town and Angarsk district	7.1	32	1.7	31	0
Usolye-Sibirskoye town	5.6	33	0.0	33	-
Usolsky district	21.7	28	7.8	21	-
Ziminsky district	37.5	14	0.0	33	-
Zalarinsky district	22.6	27	14.4	9	-
Balagansky district	0.0	34	11.4	14	-
Nukutsky district	30.4	21	3.4	29	-
Tulun town	31.8	20	2.2	30	-
Tulun district	41.1	13	1.2	32	-
Kuytunsky district	27.3	25	4.0	28	-
Nizhniudinsky district	46.2	10	9.9	17	0
Taishetsky district	21.4	29	4.4	26	-
Kuytunsky district	59.7	6	6.1	22	-
Ust-Ilimsky district	0.0	34	0.0	33	-
Bratsk town	35.0	16	13.3	10	-
Bratsky district	28.1	24	14.6	7	-
Ust-Kutsky district	21.4	29	12.5	11	0
Kazachisko-Lensky district	0.0	34	10.5	16	0
Kirensky district	34.0	18	25.7	3	-
Nizhne-Ilimsky district	0.0	34	0.0	33	-
Svirsk town	0.0	8	0.0	33	-
Cheremkhovo town	66.7	4	11.1	15	-
Cheremkhovsky district	36.5	15	8.7	20	-
Alarsky district	42.2	12	20.9	4	-
Ekhirit-Bulagatsky district	67.5	2	14.4	8	-
Bayandaevsky district	24.1	26	11.8	12	-
Bokhansky district	65.6	5	8.8	19	-
Ust-Udinsky district	34.6	17	4.3	27	-
Kachugsky district	51.0	7	4.5	24	-

Zhigalovsky district	30.0	22	0.0	33	-
Bodaibinsky district	28.6	23	20.8	5	-
Osinsky district	43.2	11	9.0	18	-

The critical situation with high excess of standards in terms of sanitary and chemical indicators of decentralized water supply systems has developed in Irkutsk, Ekhirit-Bulagatsky, Irkutsky districts, Cheremkhovo, Bokhansky, Chunsky and Kachugsky districts with a share of samples, respectively 70.2%, 67.5% 66.8%, 66.7%, 65.6%, 59.7% and 51.7%. The tested standard in the analysed material was significantly increased with the share of samples from a quarter to a third or more in 21 territories. Samples with excess of hygienic standards for microbiological properties with a fraction of samples from a quarter to a third are determined in six locations.

About 10% of the tested samples did not meet the standards for microbiological indicators. The inconsistency in the field of microbiological standards is associated with the content of total coliform (CCB) and thermotolerant coliform bacteria (TCB) in water. Investigations found common coliform bacteria in 48 settlements, and thermotolerant coliformne bacteria was found in 34 ones.

The content of chemicals did not correspond to hygienic standards in 32.8% of tested samples. The decentralized water supply was mainly polluted with iron, nitrates and magnesium (table 3). Iron contamination in 13 territories exceeded the levels of maximum permissible concentrations from 1.1 to 2 and from 2.1 to 5. Exceeding the maximum permissible concentrations from 5.0 for this element was found in 8 administrative entities.

Table 3. The list of territories of the Irkutsk region with a high content of chemicals in drinking water of decentralized water supply, 2017.

The name of the pollutant	Concentration levels of chemicals that do not meet hygienic standards		
	MPC of 1.1 – 2.0	MPC of 2.1 – 5.0	MPC of > 5.0
Iron	Irkutsk district, Usolye-Sibirskoye town, Usolsky district, Zalarinsky district, Ulun town, Tulun district, Nizhneudinsk district, Chunsky district, Ust-Ilimsky district, Kachugsky district, Ust-Udinsky district, Bayandaevsky district, Ekhirit-Bulagatsky district	Irkutsk district, Zalarinsky district, Ulun town, Tulun district, Nizhneudinsk district, Taishetsky district , Chunsky district, Kachugsky district, Zhigalovsky district, Ust-Udinsky district, Bayandaevsky district, Bokhansky district, Ekhirit-Bulagatsky district	Tulun town, Irkutsk district, Kuitunsky, Chunsky, Kaichugsky, Zhigalovsky, Bayandaevsky, Ekhirit-Bulagatsky districts
Magnesium	Svirsk town, Nukutsky, Cheremkhovsky, Taishetsky, Zalarinsky districts		
Nitrates	Irkutsk district, Cheremkhovsky district, Alarsky district, Ziminsky district, Zalarinsky district, Tulun town, Nizhneudinsk district, Taisheysky district, Chunsky district, Bratsk town, Bratsky district, Ust-Udinsky district, Bayandaevsky district, Bokhansky district, Ekhirit-Bulagatsky district	Irkutsk district, Alarsky district, Tulun town, Nizhneudinsk district, Chunsky district, Osinsky district, Ekhirit-Bulagatsky district	Cheremkhovsky and Chunsky districts
Sulphates	Bokhansky, Osinsky districts		
Nitrites		Chunsky district	
Manganese	Irkutsk district, Usolsk district, Zalarinsky district	Irkutsk district, Usolsk district	Irkutsk district

The use of poor quality drinking water leads to the growth of various kinds of diseases associated with suboptimal chemical properties of water [5-7].

Increased water hardness contributes to the development of kidney disease, urolithiasis in the population [8]. Excess iron content in drinking water contributes to the development of diseases of the cardiovascular system. Excess nitrate in water can adversely affect the composition of the blood,

causing such blood diseases as anemia, methemoglobinemia, leading to the development of hypoxia of organs and tissues.

Monitoring studies of the drinking water quality of the non-centralized water supply of the region showed significant excess of hygienic standards in terms of sanitary-chemical and microbiological indicators, the presence of parasitological pollution in 2016.

Conducted surveys revealed that the main causes of poor water quality of decentralized water supply are as follows:

- pollution of underground and surface sources due to the lack of sanitary protection zones;
- lack of a centralized sewage system for existing residential buildings and low-rise construction projects under construction in rural areas, summer cottage and horticultural non-profit partnerships, cottage settlements;
- in some localities, there is a lack of public water supply sites, or inadequate water quality in them, and as a result, the satisfaction of drinking water needs by setting up individual wells from surface water bodies without water treatment, while the water quality does not meet accepted standards.
- natural high content of iron, manganese, magnesium in water, total hardness;
- slow construction of water intake and sewage treatment facilities.

To provide the population with drinking water of appropriate regulatory quality, it is necessary to carry out a set of measures consisting in the development and approval of sanitary protection zones, systematic sanitary inspection of water supply sources and the territory adjacent to water intake facilities, construction of water intake and sewage treatment plants, communications for centralized improvement of residential premises.

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