





## Technical solutions for the development of the water supply system of the rural settlement of Andreevskoye in the Omsk region


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Abstract : Providing the population with high-quality drinking water is one of the state's priorities. The federal project "Clean Water" has become the starting point for developing projects for the reconstruction and construction of water supply systems for populated areas. The rural settlement of Andreyevskoye is located near the regional center, which influences the growth of private construction. This article presents a detailed analysis of existing networks and a long-term plan for the development of the water supply system, taking into account projected water consumption indicators. To ensure the required quality of drinking water for consumers, it is proposed to consider constructing a water pipeline connecting the water supply system to the centralized water supply system of the city of Omsk.

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## 1 INTRODUCTION

Federal Laws of the Russian Federation No. 416-FZ "On Water Supply and Sanitation" and No. 7-FZ "On Environmental Protection" regulate and govern the activities of relevant organizations, whose primary objective is to ensure comfortable and safe living conditions for the population. Their responsibilities include:

- priority of providing the population with drinking water and sanitation services;
- ensuring equal conditions of access for subscribers to water supply and sanitation;
- preservation of a favorable environment, biological diversity and natural resources to meet the needs of present and future generations;
- strengthening law and order in the field of environmental protection and ensuring environmental safety.

The Clean Water federal project has become the starting point for developing projects for the reconstruction and construction of water supply systems for populated areas.

Many areas of the Omsk region face a number of challenges in water supply and sanitation, including deteriorating infrastructure, insufficient capacity of existing systems, seasonal water outages, and the lack of a centralized sewer system in some communities. These factors negatively impact the quality of life, limit the region's socioeconomic development, and pose risks to environmental safety. With increasing demands for comfortable living and stricter sanitary and hygienic standards, the need to modernize and develop utility networks is becoming increasingly urgent.

Developing technical solutions for water supply systems requires a comprehensive approach that considers both the current state of the infrastructure and the development prospects of populated areas. First and foremost, it is essential to conduct a detailed analysis of existing networks, assess water consumption, study hydrogeological conditions, and explore the potential for using alternative water sources. Based on the data obtained, optimal options for reconstruction and construction of new facilities can be proposed, including the implementation of modern water treatment technologies, energy-efficient equipment, and automated control systems.

## 2 OBJECT OF RESEARCH

The subject of this study is the rural settlement of

Andreyevskoye, a municipality in the Omsk region comprising the village of Andreyevka and the settlement of Andreevsky. The area of the settlement is 15,089 hectares, and the permanent population of Andreyevskoye is approximately 2,378 people.

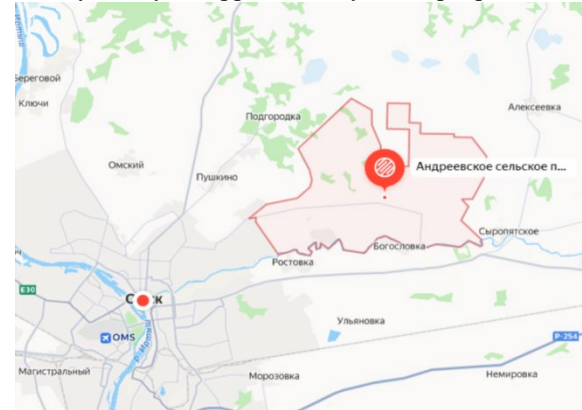


Figure 1: Map of the location of the Andreevskoye settlement.

The source of the centralized water supply for the settlement is groundwater, the characteristics of which are presented in Table 1.

Table 1: Characteristics of groundwater .

Parameters	Units of measurement	Indicators
Depth of occurrence	m	1-2 to 15-20
Pressure value	m	100-120
Filtration coefficient	m/day	0.1 to 40-50
Predominant anions		NSO <sup>z-</sup> , CO <sup>2+</sup> , NSO <sup>3-</sup>
Mineralization	g/l	1.0 -3.0

Facilities of the centralized cold water supply system in the village of Andreevka:

- one complex of water intake structures from an underground source, represented by three water intake wells;
- one water treatment plant located in the center of the village and representing a complex of technological equipment designed for the treatment of drinking water (year of commissioning - 1991);
- one water tower located on the territory of the water intake complex;
- water supply networks with a total length of 11.09 km.

In the village of Andreevsky, the following facilities are part of the centralized cold water supply system:

- structures from an underground source,

represented by four water intake wells, located on the territory of the village;

- two water towers;
- water supply networks with a total length of 2,255 km.

The main indicators and characteristics of the water intake wells of the Andreevskoye SP are presented in Table 2.

Table 2: Characteristics of water intake wells.

Well number	Year of commissioning	Depth, m	Flow rate, m <sup>3</sup> / hour	
			from	to
village of Andreevka				
160000247	1983	84	4	5
160000246	1982	136	7.5	10
160000550	1991	84	4	5

Note: Information on wells in the Andreevsky settlement is unavailable .

### 3 RESEARCH METHODS

The main technical and technological problems of the centralized water supply systems of the Andreevskoye rural settlement are:

- High physical and moral deterioration of technological equipment of the main facilities of cold water supply systems;
- Lack of control systems (automation and dispatching);
- High physical wear and tear of water supply networks, causing significant losses of drinking water during transportation;
- The quality of drinking water does not comply with current sanitary standards in distribution networks; excess turbidity and color are observed.

When determining the future balances for centralized water supply and sanitation systems, determining population growth prospects is a significant factor. Active efforts are underway at the federal and regional levels to increase the attractiveness of rural areas for both population retention and influx. In recent years, the Omsk Region has seen a significant increase in private construction (25.1% compared to last year) outside the city. The rural settlement of Andreyevskoye is one of these attractive areas due to its proximity to urban infrastructure.

In order to determine the actual and projected population size of the Andreevskoye rural settlement, data on the permanent population of the Russian Federation by municipalities for the period

2017-2021, published by the Federal State Statistics Service and the prospective development project of the Andreevskoye rural settlement were analyzed and used.

The actual permanent population figures for the period from 2019 and the results of determining the projected permanent population up to 2036 (Table 4) of the Andreevskoye settlement indicate population growth, which will entail an increase in water consumption.

Table 4: Actual population figures for the rural settlement of Andreevskoye, taking into account the forecast up to 2036, people.

Actual indicators					
2019	2020	2021	2022	2023	2024
2518	2466	2448	2533	2618	2703
Forecast indicators					
2025	2026	2027	2028	2029	2030
2789	2874	2959	3044	3129	3214
					2036
					3725

In order to develop a long-term plan for the development of the water supply system of the Andreevskoye rural settlement, an analysis of the above-mentioned problems was carried out.

Drinking water losses were determined based on the overall balance of water supply and sales in the Andreevskoye settlement, presented in Table 5. Information on water supply balances from the Municipal Unitary Enterprise "SKBU" is presented for October-November 2021.

Table 5: General balance of water supply and sales in the Andreevskoye settlement, m<sup>3</sup>.

Item No.	Name of the indicator	2021
1	Intake (lifting) of source water	13,010
2	Water for technological needs	0
3	Supply of drinking water to water supply networks	13,010
4	Sale of drinking water	6,880
5	Expenditure on the organization's own needs	420
6	Losses of drinking water during transportation through water supply networks	5,710
7	Maximum daily water intake	277
8	Installed capacity (power) of water intake structures	480

9	Reserve (deficit) of water intake facilities' productivity	203
10	Reserve (deficit) of water intake facilities productivity, %	42.2

As can be seen from the table above, actual cold water losses during transportation to the village of Andreevka in October-November 2021 amounted to 5,710 m<sup>3</sup> or 43.9% of the total cold water supplied to the water supply network. Meanwhile, the total actual cold water consumption in the village of Andreevka in October-November 2021 amounted to approximately 6,880 m<sup>3</sup>.

Standards for specific consumption of water supply and sanitation utilities in the Andreyevskoye rural settlement were approved by Order No. 118/46 of the Regional Energy Commission of Omsk Oblast dated September 11, 2014, "On approval of consumption standards for cold and hot water supply and sanitation utilities in the city of Omsk and Omsk Oblast." Depending on the level of amenities in the residential premises, the consumption standard for cold water supply ranges from 0.9 m<sup>3</sup>/month/person to 6.7 m<sup>3</sup>/month/person.

Based on the current volume of water consumption by the population and its dynamics, taking into account the prospects for development and changes in the composition and structure of development, forecast balances of consumption of hot, drinking and technical water for a period of at least 10 years were compiled, taking into account various scenarios for the development of settlements. These are presented in Table 6. To calculate the forecast balances of water consumption, existing data on consumption were adopted and brought up to annual values.

Table 6: Forecast balances of consumption of hot, drinking and technical water in the Andreevskoye settlement, m<sup>3</sup>

Name of the indicator	2026	2027	2028	2029	2030	2036
Intake (lifting) of source water	77040	76797	76570	76360	76163	75238
Water for technological needs	0	0	0	0	0	0
Supply of drinking water to water supply networks	77040	76797	76570	76360	76163	75238
Sale of drinking water	47064	48221	49378	50534	51691	58632

Expenditure on the organization's own needs	2873	2944	3014	3085	3156	3579
Losses of drinking water during transportation through water	27103	25632	24178	22740	21317	13027
Maximum daily drinking water intake	274	274	273	272	271	367
Installed capacity (power) of water intake structures	480	480	480	480	480	480
Reserve (deficit) of water intake facilities' productivity	206	206	207	208	209	113
Reserve (deficit) of water intake facilities productivity, %	42.8	43.0	43.2	43.3	43.5	44.2

## 4 RESULT

One of the significant problems remains the discrepancy between the quality of drinking water supplied to the distribution network and current sanitary standards.

To ensure the required quality of drinking water supply to customers, we propose constructing a water pipeline connecting the Andreyevka water supply system to the centralized Omsk water supply system.

The technical justifications for the main activities and the main characteristics for the implementation of water supply schemes, including the hydrogeological characteristics of potential water supply sources, the sanitary characteristics of water supply sources, as well as the possible change in these characteristics as a result of the implementation of the activities, are presented in Table 7. The total length of the reconstructed networks is 4870 m.

Table 7: Main activities for the implementation of water supply schemes in the Andreevskoye rural settlement

Name of the event	Technical justification	Main technical characteristics of the facility based on the results of

Reconstruction	Ensuring the supply of a certain volume of hot, drinking water of the established quality to subscribers; Reducing water losses during transportation	Du-150 mm, L -500 m
		D-120 mm, L -917 m
		Du-100 mm, L -2164 m
		Du-76 mm, L -1250 m
		Du-50 mm, L 669 m
		D-32 mm, L -230 m
Construction of the VNS	Organization and provision of centralized water supply in areas where it is absent	q = 5 m3/h q=3m3/h q=2m3/h q = 1 m3/h
Construction of water supply networks	Ensuring the supply of a certain volume of drinking water of established quality to subscribers Organization and provision of centralized water supply in areas where	Du-50 mm, L -1740 m
		D-100 mm, L -13445 m
		D-50-100 mm, L -2030 m
Construction of water supply networks in the planned development area of the village of <i>Andreevskoye</i>	Providing water supply to prospective development sites in the settlement	D-50-100 mm, L -34700 m
Construction of water supply networks in the planned development area of the <i>Andreevsky settlement</i>	Providing water supply to prospective development sites in the settlement	D-50-100 mm, L -2100 m
Annual reconstruction of worn-out water supply networks in the amount of 5% of the total length	Ensuring the supply of a certain volume of hot, drinking water of the established quality to subscribers; Reducing water losses during transportation	D-32-150 mm, L -5545 m

To control all major facilities of the centralized water supply system as a single complex, it is recommended to implement an automation and dispatching system. This will monitor the following parameters: pressure developed by each pumping unit; pressure in the pressure main; flow rate of pumped water; water level in the drainage sump; operating pumping units; operating hours of each pumping unit; power consumption; pumping unit

speed during frequency control; and emergency situations.

By implementing the proposed measures, such as reconstructing water supply networks, constructing a water pipeline, implementing an automation system, and connecting to the centralized water supply system of Omsk, the problems of physical and moral deterioration of process equipment, monitoring the technological parameters of the water supply system, reducing drinking water losses, and supplying drinking water of the required quality will be resolved.

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