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Environmental Protection of International River Basins

PILOT PROJECT
Detailed assessment sources of pollution of potable GW sources supplying the "Novinki" region in the territory of Minsk

Phase 1: Analysis of available geological-hydrogeological information of the well field and evaluation of vulnerability of production groundwater bodies

REPORT
ANALYSIS OF AVAILABLE GEOLOGICAL-HYDROGEOLOGICAL INFORMATION FOR THE WELL FIELD

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With assistance of the
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Content

1 SHORT CHARACTERISATION OF NATURE CONDITIONS AND LEVEL OF GEOLOGY-HYDROGEOLOGY SCRUTINY IN WATER INTAKE "NOVINKI" AREA

1.1 General information

1.1.1 Administrative and geographical location

In relation of administrative and geographical location, the investigative territory is located in NW part of Minsk, as well as in the suburb including villages Zatsen, Tsnyanka, Yakubovichi, Tsna-Yodkovo of Minsk region. High level of developing, building, developed transportation and municipal services are features of the territory. The area is 143 km^2.

1.1.2 Climate

The climate of investigative territory is temperate continental with significant impact of Atlantic sea air. The average annual temperature is $5,5^0$C.

According the quantity of precipitation this area is zone of sufficient moistening. Annual average quantity of precipitation is 650-690 mm.

In the year period the minimum of precipitation quantity is in February (40 mm), maximum – in July (90 mm). Quantity of precipitation is less in the autumn than in the summer, but their duration significantly increases, sometimes the character of duration is lengthy. This period is favorable for infiltration, and for intensive nutrition of ground water.

Average annual air humid is 76-85% what is very high. Maximum air humid is in November-January, minimum is in May-June. Quantity of days with frogs is 60-80 per year, and their maximum is in cold period (October-January).

1.1.3 Orographic and hydrologic conditions

Relief of investigative territory is the result of glacier activity and water flow in Quaternary. North part of Minsk is located in Minsk height that consist of moraine of Sozh glacier (gravel, pebble, boulder loam, clay sand, sand), and relief is swells and hills with altitude 15-30 or 5-15 m. The higher areas are regional zones of active nutrition of ground and surface water. In the SE district the slopes of hills transform to plain, consists of sand and clay deposits of Sozh glacier. Absolut height of earth's surface gradually decreases from 250-230 m to 210-200 m.

Central part of investigative territory is the valley of Svisloch river that is well depleted. Shape of the valley is mildly sloping concave, and channel-shaped

in the upstream of river. Floodplain is indented by former river-bed and broader to downstream.

Channel of Svisloch river is up to 50 m in depth, up to 2 m in depth after Drozdy reservoir, bed is sand. Water velocity of river is 0.2-0.4 m/s, low-water flow is 2.5-4 m^3/day, high-water flow is the bigger. In present, river is fully is regulated in frame of investigative territory. Width of river valley in frame of floodplain (part that is inundated) is mainly up to 250 m. Annual average river flow increases more than 2 times and his distribution is more even as a result of human transformation.

River valley consists of actual and pre-Quaternary limnoglacial and alluvial deposits, seldom paludal, mainly consertal sand that underlaying by fluvioglacial sand and gravel rocks of Sozh glacial retreat. This deposits has well permeability. Their depth is 6-30 m. Morain of Sozh glacier laying down consists of clay sand, loam with gravel and pebble, is degraded in valley, has lens and interlayer. So that alluvial and overlayer sand sometimes lay on intermorainal Dneper-Sozh deposit, formed one hydraulically connected complex of ground water, consisting of fine, medium, coarse and gravel sand with depth up to 60 m.

Tsna river is left tributary of Svisloch.

Relief of investigative territory is characterized by diversity of type and shape, that is result of glaciotectonics processes, glacier accumulation and melt glacial water of Sozh glacier activity, as well as impact of physical and geographical process complex in Neopleistocene and Holocene. According to the formation and morphology the types of investigative territory relief are glacier, fluvioglacial, fluvial, limnoglacial, antropogenic and technogenic.

Nature relief of some area of investigative territory is significantly transformed in the results of human activity. Concaves, hills and plain surface of soil are technogenic form. There are industry and civil building place, roads, sewerage systems, water and gas pipeline, electrical cable connection, beds of reservoir, canals, straightened and performed river channel. Their sizes are various, technogenic performing depth is 9 m.

1.1.4. Level of geology-hydrogeology scrutiny

Geological and hydrogeological study in investigative territory was started in 20-30s of XX century by the staff of research institute VODGEO. They first gave detail description of hydrogeological conditions of Minsk, identified and recommended Dnepr-Sozh fluvioglacial aquifer for municipal water supply, calculated capacity of water intake. Material of this study was base of water intake “Novinki” building with capacity 25 000 m^3/day – first water intake of Minsk, that

was explored from 1932. Systematic and complex study of the territory in the field of geology was started after World War II.

Significant volume of data regarding hydrogeological conditions was obtained during explorative works in 1960-1962 that were carried out for Minsk's drinking water supply. In the end of this works, useful ground water storage of Dnepr-Sozh fluvioglacial aquifer was calculated for Minsk in general and including for Novinki intake.

In 1979-1982, Belarusian hydrogeological expedition carried out the vaste hydrogeological investigation in water intakes working in Minsk. Useful ground water storage of Dnepr-Sozh fluvioglacial aquifer was recalculated. Next recalculation of useful ground water storage of Dnepr-Sozh fluvioglacial and Valday terrigenous complex was in 2010-2012 [9].

Geological survey works in different scale in the investigating territory were carried out since 1960s. In 1963-1987, geological survey works in scale 1:200000 were carried out on this territory by specialists from Minsk geological surveying party of Belgidrotrest. In the result, new data about dead geological structure of the territory (underlying depth of crystalline foundation surface, composition and petrographic features of crystalline rocks, underlaying conditions and lithology of sedimentary cover formation), forecasting assessment of territory for some type of ore and non-ore mineral sources were obtained. For the first time, full set of geological maps in scale 1:200000 was made for investigative territory [1, 2, 4]. The result of hydrogeology scrutiny was identification of 4 main aquifers, that are suitable for drinking water supply.

In 1984-1987 Belarusian hydrogeological expedition carried out the geological survey work in upstream of the Svisloch river in scale 1:50000, results of which was the base for publishing the conditioned geological map in scale 1:50000. Geological structure of Prequaternary sedimentary complex was analyzed. Features of space distribution of full set of non-ore mineral sources field were identified [8].

Together with field survey, the big thematic mapping work was carried out, the aim of which was mapping the hydrogeological maps of Quaternary and Prequaternary deposits with sections, maps of prognostic working fresh ground water store, maps of engineering-geological zoning with sections. Geological maps of Quaternary and Prequaternary deposits in scale 1:200000 and less were publishing. Set of maps for horizons (surface, lithological structure, capacity of main horizon of Quaternary and Prequaternary deposits) was generated.

Ecology state study of geology nature of investigative territory has carried out from 80s. Belarusian research center "Ecology" developed Complex scheme of environmental protection of Minsk city.

In 90s, Belarusian hydrogeology expedition carried out assessment of ground water vulnerability in Minsk district, mapping nature vulnerability of ground water in scale 1:200000. Data on existing and potentially possible source of ground water pollution were collected, ground water quality was assessed in the frame of acting water intake including Novinki [7].

In 1997, geology-ecological study of Minsk in scale 1:200000 was carried out by staff of Belarusian hydrogeology expedition. All collected information permits to assess the ecological state of geological nature of the territory. The main result of study was geology-ecological map in scale 1:200000 [13].

In 2000, CRICUWR carried out the study on assessment of technogenic pollution of ground water intakes on the territory of Minsk. The result contained the characteristic of ground water quality and hydrodynamics conditions of ground water formation [10, 11, 12].

Engineering-geological scrutiny of investigative territory in last ten years is restricted by the work that is due to engineering-geological survey work mainly for civil building by State organization “Geoservice”. In 2008, specialists of the Institute of nature management of National Academy of sciences, State organization “Research and production center for geology” and “Geoservice” published Engineering-geological map of Minsk and outskirts in scale 1:50 000.

Starting from 60s, geological service of the republic carried out the observation on ground water regime in natural and impeded working conditions. Automated information database “Ground water of the Republic of Belarus” is created in State organization “Research and production center for geology”. This database consists of data on fresh and mineral ground water store, municipal water intakes and bore wells. Information includes the data on ground water quality and levels, their resources, water abstraction from working wells of city intakes, wells of regime net that was created by State organization “Research and production center for geology” [6].

2 ANALYSE OF GROUND WATER INTAKE “NOVINKI” WORKING REGIME

“Novinki” intake is located in NW part of Minsk and suburb along the Svisloch valley in distance from 0.5-1.0 km (north part) to 3-4 km (south-east part) from river channel. Intake was built in 1932, constantly and actively works from 1945. Wells was bored on Dnepr-Sozh fluvioglacial and Valday terrigenous aquifers. The distance between wells is 150–850 m. Total length of intake is approximately 10 km.

Depth of wells bored in Dnepr-Sozh fluvioglacial aquifer varies from 33 to 106 m, in and Valday terrigenous aquifer varies from 281 to 293 m.

Till 01.01.2014 total quantity of working wells of intake is 41, 39 of which bored in Dnepr-Sozh fluvioglacial aquifer. The overall details about working wells (well depth, depth of aquifer occurrence, range of filter jamming, flow rate, depression, specific flow rate, static level) are shown in table 1.

Table 1 – Overall details about wells working on Dnepr-Sozh fluvioglacial aquifer

Well №	Well depth, m	Boring year	Depth of aquifer occurrence, m		Range of filter jamming, m		Results of building pumping			Static level, m
			from	to	from	to	flow rate, l/s	depression, m	specific flow rate, l/s	
1б	65,0	1969	15,0	60,4	30,8	45,4	15,0	5,0	3,00	15,0
2в	62,0		43,0	62,0	45,7	60,0	22,2	8,0	2,78	18,0
3б	65,0	1972	41,0	65,0	46,0	63,2	20,0	1,5	13,30	11,0
4	65,5	1960	35,0	60,5	42,0	60,5	9,7	5,3	1,83	14,0
4б	64,0	1983	40,0	64,0	45,5	63,5	19,4	10,0	1,94	5,0
5б	66,0	2006	41,5	65,0	47,0	65,0	38,9	12,5	3,11	15,5
6	70,0	1937	29,8	64,0	39,5	62,0	16,7	8,4	1,99	9,5
7б	55,0	1987	33,0	53,0	35,0	53,0	22,9	8,0	2,87	12,0
8б	46,0	1984	21,0	45,0	30,0	45,0	16,7	6,0	2,08	-
9б	50,0	1974	32,0	46,0	34,8	50,0	13,3	9,5	1,40	14,5
10б	66,0	1972	32,0	63,0	33,3	44,6	20,8	5,0	4,17	16,7
					55,5	61,4				
11	61,5	1934	30,4	60,2			10,0	2,5	4,00	19,1
12б	60,0	1974	39,0	60,0	43,0	58,0	21,4	3,2	6,68	26,0
13б	68,0	1978	28,0	67,0	30,6	35,0	19,4	11,0	1,77	19,0
					54,0	59,5				
14б	56,0	1972	25,0	51,0	25,0	37,6	20,0	4,0	5,00	17,0
					42,6	50,5				
15б	56,0	1978	40,0	55,0	44,2	55,0	11,1	1,0	11,11	30,0
16б	69,0	1983	38,0	69,0	50,0	68,0	10,0	1,0	10,00	23,8
17в	73,0	1983	27,0	70,0	61,0	70,0	19,6	4,0	4,91	22,0
18б	65,0	1969	45,0	65,0	46,0	63,0	18,7	2,5	7,50	25,0
19б	85,1		22,0	81,2	60,0	80,0	16,7	1,5	11,11	28,2
20б	60,0	1972	15,3	60,0	38,0	58,0	22,8	2,5	9,11	12,5
21б	50,0	1972	26,5	48,5	33,5	48,5	15,8	8,5	1,86	6,0
23	66,0	1971	42,0	64,0	43,2	58,5	14,4	6,2	2,33	23,0
24б	106,0	1988	85,0	106,0	87,0	105,0	22,2	32,0	0,69	26,0
25	90,0	1971	55,0	90,0	55,6	61,6	13,3	7,0	1,90	27,0
					72,0	88,0				
26б	94,0	1981	52,0	92,0	69,0	75,0	25,0	15,0	1,67	10,0
					80,0	86,0				
					86,0	92,0				
27б	50,0	1983	41,0	50,0	40,0	49,0	12,8	15,0	0,85	8,5

Well №	Well depth, m	Boring year	Depth of aquifer occurrence, m		Range of filter jamming, m		Results of building pumping			Static level, m
			from	to	from	to	flow rate, l/s	depression, m	specific flow rate, l/s	
29в	70,0	1999	30,0	70,0	50,0	68,0	22,8	10,0	2,28	13,8
30б	55,5	1988	35,0	54,0	40,0	55,0	22,2	8,0	2,78	8,5
31	55,0	1974	17,0	54,0	38,0	52,4	40,0	4,0	10,00	6,2
32б	54,0	1981	42,0	54,0	42,0	54,0	25,0	10,0	2,50	12,0
33	43,0	1974	20,0	42,0	37,2	42,6	28,6	5,2	5,50	7,8
34б	88,0	2001	58,5	86,0	67,2	85,2	25,0	3,0	8,30	6,0
35б	57,0	1987	19,0	57,0	33,0	45,0	25,0	10,0	2,50	8,0
					50,0	53,0				
36	33,0	1975	20,0	31,0	30,0	31,0	22,2	8,0	2,78	2,6
37	34,0	1974	18,0	33,0	21,0	33,0	33,3	4,1	6,67	2,6
39	45,0	1975	29,0	43,0	33,0	43,0	30,6	5,0	6,11	9,0
40	35,0	1974	22,5	33,0	22,6	32,2	25,0	5,0	5,00	5,0
ГП-2б	91		44,5	91	64,5	69,5	14,2	7,0	2,03	42,0

Valday terrigenous aquifer is extended everywhere. Depth of aquifer occurrence varies from 218 to 230 m. Open depth of aquifer rocks is 56.2-78.0 m. Till 01.01.2014 wells №№ 8^a 21^a with flow rate in 1030 m^3/day worked permanently. Their depths are 281.0 and 293 m. The overall characteristics of working wells are shown in table 2.

Table 2 – Overall details about working on Valday terrigenous aquifer

Well №	Well depth, m	Boring year	Depth of aquifer occurrence, m		Range of filter jamming, m		Results of building pumping			Static level, m
			from	to	from	to	flow rate, l/s	depression, m	specific flow rate, l/s	
8a	293,0	1959	218,0	288,0	242,5	287,0	11,7	10,00	1,17	20,0
21a	281,0	1999	222,7	295,0	223,9	239,6	22,22	30,00	0,75	22,1
					260,7	271,8				

2.1 Analysis of hydrodynamic regime of ground water

Dnepr-Sozh fluvioglacial aquifer. During 2000-2013 average flow rate of ground water in "Novinki" intake varied from 49400 m^3/day in 2003 to 56800 m^3/day in 2002. During 2011-2013 water abstraction reduced from 52100 m^3/day to 49670 m^3/day.

Regular observation on working aquifer levels has carried out from 1983. Till present regime net consists of 8 wells (№№ 193, 1198, 203, 209, 217, 2305, 1307, 2976).

According to the regular observation data the maximum reducing of ground water level in 11.0 m were observed from 2007 to 2009 during maximum flow rate. In 2003, during minimum flow rate the minimum reducing of ground water level in 7.7 m was observed. During the last 4 years big variation of levels wasn't observed, ground water levels reducing varied from 9.2 to 10.7 m.

Calculation of specific depression value in observation wells, shown in table 3, shows that intake worked in confined conditions and constant regime of ground water filtration in 2007-2013. Therefore level reducing in working aquifer for relative constant abstraction isn't forecasted. Permissible calculated level reducing, that taken for assessment of ground water resources, is 35.9 m and significantly exceeds the real.

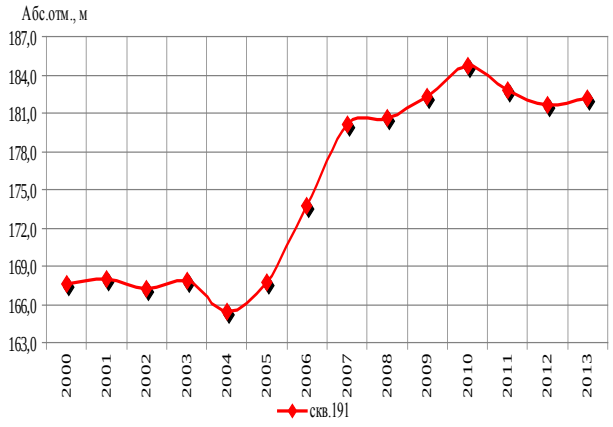
Table 3 – Calculation of specific depression of ground water level in Dnepr-Sozh fluvioglacial aquifer according to observation wells of Novinki intake in Minsk

Year	Depression level (in comparison with initial), m			Specific depression level, S/Q 10^{-3}		
	Well 1307	Well 1198	Well 2676	Well 1307	Well 1198	Well 2676
2007	11,00	0,55	2,23	0,203	0,010	0,041
2008	11,00	0,62	2,33	0,210	0,012	0,044
2009	11,00	0,82	2,73	0,205	0,015	0,051
2010	10,70	0,62	2,43	0,200	0,012	0,046
2011	10,00	0,12	2,33	0,192	0,002	0,045
2012	9,24	-0,08	2,42	0,184	-0,002	0,048
2013	9,42	0,01	2,20	0,190	0,000	0,044

According to the obtained data, specific depression level of ground water in all observation wells is constant, what shows character of ground water regime of Dnepr-Sozh aquifer is steady.

Observation on ground water level of *Valday terrigenous aquifer* is carried out in well 191, that is located near the eastern part of intake.

Analysis of regime observation results showed in 2000-2004, when abstraction was 5500 m^3/day in average, the absolute label of piezometric surface in well 191 was 167.5-168.0 m.



Picture 1 – Diagram of ground water levels changing in observation well № 191 of "Novinki" intake

In 2005-2009 water abstraction was reduced to 3800-4000 m^3/day, and ground water levels increased to 175.0-180.0 m. Due to sudden reducing of abstraction till 1000-200 m^3/day, absolute label of surface increased to 183.0-185.0 m.

In working aquifers ground water level variations directly depend on abstraction value. Ground water level variations in Dnepr-Sozh fluvioglacial aquifer depends also on changing of meteorology and hydrology conditions: precipitation quantity, surface water level fluctuations, temperature etc.

The above mentioned data on state of level surface of working aquifer shows, the real reducing of ground water levels in “Novinki” intake wasn’t exceeded calculated values of permissible reducing, that taken for assessment of ground water resources, till 01.01.2014. This fact confirms abstraction probability in the frame of approval resources.

2.2 Analysis of hydrogeochemical regime of ground water

Ground water quality of “Novinki” intake was assessed on the base of analyses of chemical compounds, organoleptic and physical property of well water, that bored in working Dnepr-Sozh and Valday terrigenous aquifers.

Water sampling and quality control was carried out from working wells by accredited laboratory of “Minskvodocanal”.

Dnepr-Sozh fluvioglacial aquifer. Results of survey showed, the ground water is neutral, soft, medium-hard according to the pH value. Solids content value varies from 149.0 to 709 mg/l, chlorides – from 2.8 to 173.7 mg/l, sulfates – from 4.3 to 112.2 mg/l, nitrates – from 0.2 to 86.5 mg/l, ammonium nitrogen – from 0.05 to 2.05 mg/l, barium – from 0.04 to 0.12 mg/l (table 4).

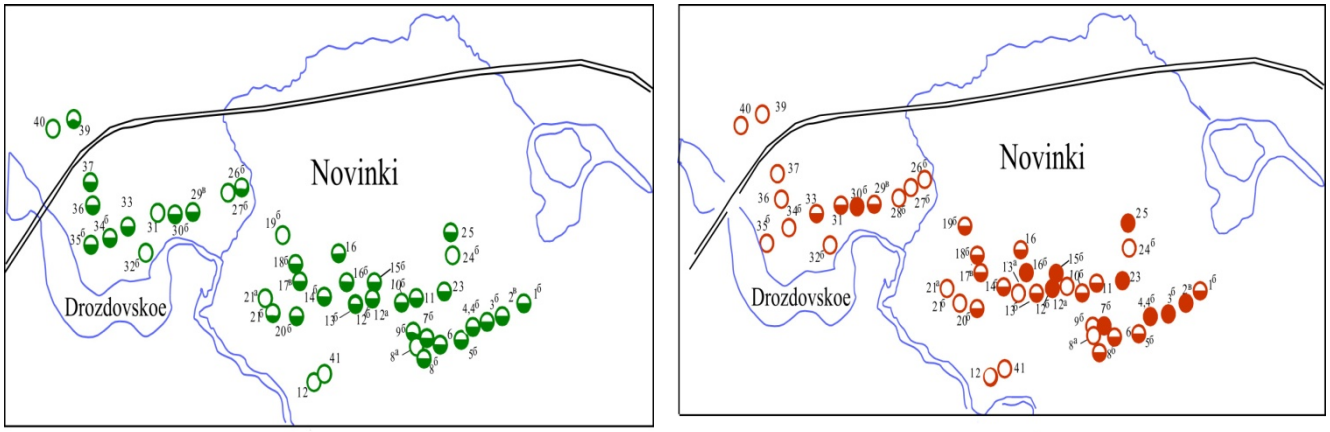
Table 4 – Limits and average value of chemical parameter of ground water quality of Dnepr-Sozh fluvioglacial aquifer in Novinki intake for 2011–2013

Parameter	Measuring unit	MAC	Novinki		
			from	to	average
Turbidity	mg/l	1,5	0,1	**5,0***	0,58
pH	ед.	6-9	7,15	8,23	7,76
Hardness	mEq/l	7	3,2	**8,7***	5,5
Oxidizability	mgO_2/l	5	0,3	3,0	0,96
Solids content	mg/l	1000	149,0	709,0	356,04
Carbonates	mg/l	-	-	-	-
Nitrates	mg/l	45	0,2	**86,5***	33,04
Nitrites	mg/l	3	0,003	0,2	0,193
Chlorides	mg/l	350	2,8	173,7	26,23
Sulfate	mg/l	500	4,3	112,2	25,54
Potassium	mg/l	-	-	-	-
Natrium	mg/l	200	-	-	-
Calcium	mEq/l	-	2,0	5,8	3,65
Magnesium	mg/l	-	-	-	-
Ammonium nitrogen	mg/l	2	0,05	1,47	0,11
Total iron	mg/l	0,3	0,1	**2,05***	0,23
Fluorin	mg/l	1,5	0,05	0,31	0,13
Boron	mg/l	0,5	0,05	0,05	0,05
Barium	mg/l	0,1	0,04	**0,12***	0,063
Manganese	mg/l	0,1	0,01	**0,19***	0,041

Note: * exceeding the MAC

As the results of survey shows, the ground water quality (hardness, nitrates, total iron) often isn't satisfied to requirement of SanPiN 10-124 RB 99 [3]. Especially this is typical to high contain of nitrates.

NO_3^- value exceeds MAC for many wells (№ $2^б$, $3^б$, $4^б$, $7^б$, 23, 25, $15^б$, $12^б$, $15^б$, $16^б$). Furthermore background values of nitrates (wells № $8^б$, 11, $10^б$, $13^б$, $14^б$, 16, $17^б$, $18^б$, $19^б$, $29^б$, 31, 33) and chlorides (wells № $1^б$, $2^б$, $3^б$, $4^б$, $5^б$, $6^б$, $7^б$, $8^б$, $9^б$, 23, 25, 11, $10^б$, $12^б$, $15^б$, $16^б$, $13^б$, $14^б$, $16^б$, $21^б$, $17^б$, $18^б$, $26^б$, $29^б$, $30^б$, 33, $34^б$, $35^б$, 36, 37,39) exceed MAC, what is result of influence of anthropogenic factors (agricultural sources, poultry farm of N.K.Krupskoy).



Picture 2 – Schematic maps of nitrates and chlorides contain in ground water of "Novinki" intake

Microcompounds contain mainly corresponds establish requirement, excluding is high concentration of barium, manganese, and low concentration of fluorine. Organoleptic parameters correspond the requirement, excluding is high value of turbidity.

Valday terrigenous aquifer. Ground water quality establish requirement of SanPiN 10-124 RB 99, solids content value varies from 230 to 298 mg/l, chlorides – from 1 to 4.9 mg/l, sulfates – from 2.7 to 6.3 mg/l, nitrates – 0.2 mg/l, ammonium nitrogen – from 0.05 to .011 mg/l (table 5).

Microcompounds contain varies: fluorine – from 0.5 to 1.26 mg/l, manganese – from 0.01 to 0.02 mg/l, barium – from 0.65 to 1.46 mg/l, barium –

from 0.33 to 0.63 mg/l. High concentration (sometimes exceeds MAC) of boron, barium, total iron is result of nature factor influence [5].

According to the regular hydrogeochemical survey, the ground water quality of main working Dnepr-Sozh fluvioglacial aquifer in "Novinki" intake doesn't correspond establish requirement of SanPiN 10-124 RB 99 for NO_3^-.

Table 5 – Limits and average value of chemical parameter of ground water quality of Valday terrigenous aquifer in Novinki intake for 2011–2013

Parameter	Measuring unit	MAC	Novinki		
			from	to	average
Turbidity	mg/l	1,5	0,3	**4,2***	1,43
pH	ед.	6-9	7,76	8,15	7,93
Hardness	mEq/l	7	2,3	4,3	3,23
Oxidizability	mgO_2/l	5	0,6	1,6	0,97
Solids content	mg/l	1000	230,0	298,0	262,7
Carbonates	mg/l	-	-	-	-
Nitrates	mg/l	45	0,2	0,2	0,2
Nitrites	mg/l	3	0,2	0,2	0,2
Chlorides	mg/l	350	1,0	4,9	2,5
Sulfate	mg/l	500	2,7	6,3	4,02
Potassium	mg/l	-	-	-	-
Natrium	mg/l	200	-	-	-
Calcium	mEq/l	-	1,3	2,5	1,87
Magnesium	mg/l	-	-	-	-
Ammonium nitrogen	mg/l	2	0,05	0,11	0,06
Total iron	mg/l	0,3	0,1	**0,86***	**0,34***
Fluorin	mg/l	1,5	0,5	1,26	0,84
Boron	mg/l	0,5	**0,65***	**1,46***	**1,20***
Barium	mg/l	0,1	**0,33***	**0,63***	**0,43***
Manganese	mg/l	0,1	0,01	0,02	0,012

Note: * exceeding the MAC

Especially this is typical to eastern part of intake and is influence of anthropogenic factors. The more favorable situation with ground water quality is observed in deeply underlying Valday terrigenous aquifer, but there are concentrations of boron and barium that exceed MAC, what is due to influence of nature factors.

2.2.1 Field survey

In order to precise the hydrogeochemical parameters and according to the ToR, on 28th of January 2015 the field survey for 5 more favorable working wells ($4^б$, $7^б$, $12^б$, $15^б$, $16^б$) of "Novinki" intake was carried out. These wells were bored in working Dnepr-Sozh fluvioglacial aquifer.

Samples were analyzed in the branch "Central laboratory" of "Research and productive center of geology" (certificate № BY / 112.02.1.0.0252 on 26th of September 1996 to 10th of March 2016). Na^+, K^+, NH_4^+, Ca^{2+}, Mg^{2+}, B, Ba, $Fe_{total.}$,

Cl^-, SO_4^{2-}, NO_3^-, NO_2^-, F^-, PO_4^{3-}, F^-, oxidizability permanganate, carbonates content were defined. The results (according to the protocol from laboratory) are shown in table 6.

Table 6 – Hydrogeochemical parameter of ground water quality of 5 working wells in Novinki intake (from 28th of January, 2015)

Parameter	Measuring unit	MAC	Well №				
			4б	7б	12б	15б	16б
Natrium	mg/l	200	22,3	102,3	15,9	12,3	10,5
Potassium	mg/l	-	1,7	7,3	1,6	1,3	1,1
Ammonia	mg/l	2,6	<0,1	<0,1	<0,1	<0,1	<0,1
Calcium	mg/l	-	115,5	105,7	95,9	8,7	76,3
Magnesium	mg/l	-	34,4	30,4	27,1	23,1	23,1
Total iron	mg/l	0,3	<0,05	<0,05	<0,05	<0,05	<0,05
Chlorides	mg/l	350	52,2	**179,3**	39,4	35,5	32,5
Sulfate	mg/l	500	94,2	41,6	31,3	23,9	21,8
Nitrates	mg/l	45	**47,1***	**53,2***	**67,4***	**75,1***	**68,4***
Nitrites	mg/l	3	<0,01	<0,01	<0,01	0,02	<0,01
Carbonates	mg/l	-	332,5	332,5	302,0	228,8	219,6
Oxidizability permanganate	mgO_2/l	5	1,0	2,9	2,0	1,4	1,1
Solids content	mg/l	1000	**604,0**	**770**	452	418	376
Fluorides	mg/l	1,5	<0,08	<0,08	<0,08	<0,08	<0,08
Polyphosphate	mg/l	3,5	0,06	0,06	0,06	0,01	0,03
Boron	mg/l	0,5	<0,05	<0,05	<0,05	<0,05	<0,05
Barium	mg/l	0,1	0,093	0,067	0,089	0,067	0,052

Note: * exceeding the MAC

It is fixed that ground water of Dnepr-Sozh fluvioglacial aquifer mainly is hydrocarbonate calcium-magnesium (wells №№ 4б, 12б, 15б and 16б), and chloride-hydrocarbonate sodium-calcium in well 7б.

Ground water quality mainly corresponds to establish requirement of SanPiN 10-124 РБ 99. Excluding are high concentration of nitrates (from 47.1 to 75.1 mg/l), when MAC is 45 mg/l, and high values of solids content (wells №№ 4б and 7б), chlorides (all wells), sulfates (well № 4б) and natrium (wells №№ 7б и 4б) are higher than background values. This is result of influence of anthropogenic pollution sources of ground water.

Water of wells №№ 4б, 7б and 12б is characterized by higher level of anthropogenic pollution for Na^+, Cl^- and SO_4^{2-}, high-hardness. Hardness of well № 4б is 8.6 mEq/l, well № 7б – 7.8 mEq/l, well № 12б – 7.02 mEq/l (MAC is 7.0 mEq/l).

CONCLUSION

Collecting, summarizing and analyzing the landforms, hydrography, geology and geology-hydrogeology data for investigative territory were carried out during this phase. Information about sections of bore wells was analyzed. Lithological composition was studied and aeration zone depth was assessed.

Map of fact information, geology map of Quaternary deposits, hydrogeology map and geology-hydrogeology section in scale 1: 25 000 were created.

The data on level regime and chemical composition and quality of ground water, as working aquifer, as supply aquifer were collected and analyzed.

Based on data on ground water levels, it is fixed, that ground water level fluctuations in working aquifer directly depend on abstraction value and changing of meteorology and hydrology conditions: precipitation quantity, surface water level fluctuations, temperature etc.

Data on state of level surface of working aquifer shows, the real reducing of ground water levels in “Novinki” intake wasn’t exceeded calculated values of permissible reducing, that taken for assessment of ground water resources.

Based on hydrogeochemical data it is fixed, that the ground water quality of main working Dnepr-Sozh fluvioglacial aquifer in “Novinki” intake doesn’t correspond establish requirement of SanPiN 10-124 RB 99 for NO_3^-. This is result of anthropogenic factors influence. The more favorable situation with ground water quality is observed in deeply underlying Valday terrigenous aquifer, but there are concentrations of boron and barium that exceed MAC, what is due to influence of nature factors.

Also sampling of ground water from 5 working wells (№№ $4^б$, $7^б$, $12^б$, $15^б$, $16^б$) in order to hydrogeochemical analyses was carried out. Water was analyzed to define concentration of NH_4^+, PO_4^{3-}, Fe_{ototal}, SO_4^{2+}, Cl^-, NO_2^-, NO_3^-, F^-, B, Ba, solid content, oxidizability permanganate.

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