MINISTRY OF ENERGY OF THE REPUBLIC OF BELARUS
BELENERGO STATE PRODUCTION ASSOCIATION

BELNIPIENERGOPROM
DESIGN AND RESEARCH REPUBLICAN UNITARY ENTERPRISE
(BELNIPIENERGOPROM RUE)

CONSTRUCTION OF A RADIOACTIVE WASTE DISPOSAL AND TEMPORARY STORAGE FACILITY

PRE-DESIGN DOCUMENTATION

Environmental Impact Assessment (EIA)

Report

2184-ППЗ-ОВОС

2026

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Approved by

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Director Central Research Institute for Integrated Use of Water Resources RUE	O.V. Kovzunova		
Director Centre for Geophysical Monitoring of the National Academy of Sciences of Belarus SI	G.A. Aronov		
Director Institute for Environmental Management of the National Academy of Sciences of Belarus	S.A. Lysenko		
Director V.F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus	D.G. Grummo		
Chief Physician Republican Centre for Hygiene, Epidemiology and Public Health SI	A.L. Skuranovich		
Director Belarusian Research and Development Centre ‘Ecology’ State Enterprise	T.G. Tabolich		
Director Belkommunproekt UE	A.V. Chigir		
Director Belenergosetproekt RUE	A.V. Gorosh		

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BELNIPIENERGOPROM RUE
Minsk Belarus

LIST OF ABBREVIATIONS:

ACP	Autonomous Checkpoint
NPP	Nuclear Power Plant
HLW	High-Level Waste
WTU	Water Treatment Unit
AED	**Annual Equivalent Dose**
L/L	**Long-Lived**
LRW	Liquid Radioactive Waste
P	Pollutants
IRS	Ionising Radiation Sources
CIRE	Comprehensive Engineering and Radiation Survey
S/L	Short-Lived
RWPF	Radioactive Waste Processing Facility
IAEA	International Atomic Energy Agency
LLW	Low-Level Waste
SIER	Spent Ion-Exchange Resins
EIA	Environmental Impact Assessment
LLRW	Low-Level Radioactive Waste
SNF	Spent Nuclear Fuel
PSRES	Polesie State Radiation and Ecological Reserve
MPC	Maximum Permissible Concentration
RWDF	Radioactive Waste Disposal Facility
NSRWDF	Near-Surface Radioactive Waste Disposal Facility
RW	Radioactive Waste
ILW	Intermediate-Level Waste
SRW	Solid Radioactive Waste

INTRODUCTION

The use of nuclear energy and ionising radiation sources is inevitably associated with the generation of radioactive waste (hereinafter referred to as RW), which poses a potential hazard to humans and the environment. Ensuring the safety of RW management is a key element of nuclear and radiation safety.

Pursuant to the provisions of the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, dated 5 September 1997, Vienna (entered into force for the Republic of Belarus on 24 February 2003), the Contracting Parties acknowledge that the ultimate responsibility for the safe management of spent nuclear fuel and radioactive waste rests with the State. Each Contracting Party shall take appropriate measures to ensure effective protection of society and the environment against radiation and other hazards at all stages of RW management.

The proposed activity considered herein is the construction of a Radioactive Waste Disposal and Temporary Storage Facility (RWDF).

The purpose of the RWDF is to ensure the RW acceptance, inspection, sorting, processing, conditioning and compliance with waste acceptance criteria for disposal; the disposal of very low-level, low-level and short-lived intermediate-level RW, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 3–5; and the long-term storage of long-lived intermediate-level and high-level RW, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 1 and 2.

This Environmental Impact Assessment (EIA) Report presents an assessment of the environmental impacts associated with the proposed activity, prepared within the framework of the pre-design documentation for the project “Construction of a Radioactive Waste Disposal and Temporary Storage Facility”, on the basis of the approved design brief.

Basis for Design:

Law of the Republic of Belarus No. 208-Z “On Safety Regulation in the Use of Atomic Energy”, dated October 10, 2022;

Law of the Republic of Belarus No. 198-Z “On Radiation Safety”, dated 18 June 2019;

Decree of the President of the Republic of Belarus No. 101 “On the Organisation of the Radioactive Waste Management System”, dated April 12, 2023;

Resolution of the Council of Ministers of the Republic of Belarus No. 128 “On the Radioactive Waste Management Strategy”, dated February 15, 2023;

Resolution of the Council of Ministers of the Republic of Belarus No. 558 “On Approval of the Strategy for the Management of Spent Nuclear Fuel from the Belarusian Nuclear Power Plant”, dated August 22, 2019;

Resolution of the Council of Ministers of the Republic of Belarus No. 668 of October 9, 2023 “On the Implementation of the Law of the Republic of Belarus No. 208-Z ‘On Safety Regulation in the Use of Atomic Energy’, dated October 10, 2022”;

Nuclear and Radiation Safety Rules and Regulations “Near-Surface Disposal of Radioactive Waste. Safety Requirements”, No. 32, dated May 3, 2021;

Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility, approved by Deputy Prime Minister of the Republic of Belarus P.A. Parkhomchik (No. 33/213-194/392), dated September 29, 2023;

Detailed Plan for the Implementation of Items 2.1.4, 4.1.2 and 5.1.2 of the Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility, approved by Deputy Prime Minister P.A. Parkhomchik (No. 33/213-194/392), dated September 29, 2023.

The proposed activity falls within the list of activities and facilities for which an Environmental Impact Assessment (EIA) is mandatory in accordance with Law of the Republic of Belarus No. 399-Z of July 18, 2016 “On State Environmental Expertise, Strategic Environmental Assessment and Environmental Impact Assessment” (Article 7, paragraph 1.4) (facilities engaged in radioactive waste processing, storage and/or disposal, excluding defence and military infrastructure facilities).

In addition, pursuant to Appendix I, Item 3 of the Convention on Environmental Impact Assessment in a Transboundary Context, dated February 25, 1991, the proposed activity (facilities designed exclusively for the production or enrichment of nuclear fuel, the reprocessing of spent nuclear fuel, or the collection, disposal and processing of radioactive waste) is covered by the provisions of the Convention.

The structure and content of this EIA Report have been prepared in accordance with the Regulation on the Procedure for Conducting Environmental Impact Assessment, Requirements for the Content of EIA Reports and Qualifications of EIA Specialists, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 47, dated January 19, 2017.

The Customer for the design works is Belarusian Organisation for Radioactive Waste Management Republican Unitary Enterprise (hereinafter – BelRAO State Enterprise). In accordance with Decree No. 101 of the President of the Republic of Belarus, dated April 12, 2023, and Contract No. 1102-11-25, dated March 14, 2025, concluded with BelRAO State Enterprise, Belnipienergoprom RUE is the developer of the pre-design documentation.

The following organisations have also participated in the EIA process:

1. JIPNR–Sosny Scientific Institution;
2. Bel SRC ‘Ecology’ State Enterprise;
3. Belgiprodor State Enterprise;
4. GEOSERVICE State Enterprise;
5. BELHYDROMET State Enterprise;
6. Republican Centre for Hygiene, Epidemiology and Public Health SI;
7. Institute for Environmental Management of the National Academy of Sciences of Belarus;
8. V.F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus;
9. Minsk Promtransproekt RUE;
10. Belenergosetproekt RUE;
11. Central Research Institute for Integrated Use of Water Resources (TsNIIKIVR RUE);
12. BELKOMMUNPROEKT UE.

In accordance with Law of the Republic of Belarus No. 1982-XII “On Environmental Protection”, dated November 26, 1992, the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus is the authority authorised by the Government to coordinate the implementation of international treaties of the Republic of Belarus in the field of environmental protection and rational (sustainable) use of natural resources, including the transboundary environmental impact assessment process.

The following affected Parties expressed their willingness to participate in the transboundary EIA procedure: Poland, Lithuania, Latvia and Ukraine. The transboundary environmental impact assessment procedure is being conducted in accordance with the Convention on Environmental Impact Assessment in a Transboundary Context, dated February 25, 1991.

1 NON-TECHNICAL SUMMARY

The purpose of the RWDF is:

- to receive, inspect, sort, process and condition radioactive waste (RW) and to ensure its compliance with waste acceptance criteria for disposal;
- to dispose of very low-level waste, low-level waste and short-lived intermediate-level waste, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 3–5;
- to provide long-term storage for long-lived intermediate-level waste and high-level waste, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 1 and 2, as well as radioactive waste resulting from SNF reprocessing.

To achieve these objectives, it is necessary to design and construct a national radioactive waste disposal and temporary storage facility. The following categories of RW are intended for disposal: short-lived intermediate-level waste (ILW-SL), low-level waste (LLW), and very low-level waste (VLLW) generated during the operation and decommissioning of the Belarusian Nuclear Power Plant (BelNPP); previously accumulated institutional waste stored at the Ecores UE's storage facility; and currently generated institutional radioactive waste. The disposal facility will comprise a complex of engineered structures designed to ensure the safe isolation (disposal) of radioactive waste, using modern technologies that provide radiation protection for the public, operating personnel and the environment. The regulatory document of the Republic of Belarus [2] establishes a relationship between the radiation hazard class, radionuclide half-life and disposal method:

ILW-SL and LLW-LL shall be disposed of in near-surface disposal facilities located at depths of up to 100 metres;

LLW-SL and VLLW shall be disposed of in near-surface disposal facilities located at ground level.

In accordance with the applicable regulatory requirements of the Republic of Belarus and taking into account the engineering and geological conditions, a near-surface disposal facility concept has been selected.

Based on the results of geotechnical and environmental surveys and assessments of the natural and man-made environment throughout the territory of the Republic of Belarus, three alternative sites have been selected for the disposal facility:

- Site 1-5, Khoiniki District, Gomel Region;
- Site 2-1, Ostrovets District, Grodno Region;
- Site 3-3, Mstislavl District, Mogilev Region.

The option of not implementing the proposed activity (the "zero option") was also considered. However, it was deemed unacceptable because it would not address the issue of radioactive waste accumulation and management.

The conceptual design of the facility was developed by CPTI (Central Planning and Technological Institute) JSC and comprises 31 buildings and structures.

The RWDF is intended to:

– receive, inspect and sort RW;
– process, condition and bring to acceptance criteria for RW disposal (storage);
– manage disused sealed IRS of Radiation Hazard Scale Categories 1–5;
– dispose of VLLW, LLW (Radiation Hazard Classes IV and III), and ILW (Radiation Hazard Class II) containing radionuclides with half-lives of up to 31 years and meeting disposal acceptance criteria, with no intention of future retrieval;
– dispose of disused sealed IRS of Radiation Hazard Scale Categories 3–5;
– temporarily store HLW (Radiation Hazard Class I), including waste arising from SNF reprocessing, and ILW (Radiation Hazard Class II) containing radionuclides with half-lives exceeding 31 years;

– temporarily store disused sealed IRS of Radiation Hazard Scale Categories 1 and 2.

The principal structures of the facility include RW disposal modules, storage modules, a process building and a waste-processing building.

The waste processing facility is located within the controlled-access area and comprises the following units:

- a SRW sorting and size reduction unit designed to receive very low-level and low-level SRW, and to sort SRW for subsequent processing or direct conditioning;
- a high-pressure compaction unit designed for the treatment of non-combustible SRW of Radiation Hazard Classes III and IV using high-pressure compaction technology;
- a LRW concentration unit intended for treatment of LRW generated during RWDF operation, using a cementation procedure with preconcentration (evaporation) by means of an electric evaporator;
- a cementation unit for processing RW generated during RWDF operation, utilising a cementation procedure with preliminary evaporation;
- an incineration unit intended for the treatment of combustible SRW of Radiation Hazard Classes III and IV, as well as VLLW received at the facility;
- a dedicated area for handling disused IRS and preparing them for disposal.

Potential environmental impacts were assessed for all stages of the RWDF life cycle:

- pre-operational stage (RWDF construction);
- operational stage (RW feed);
- facility-closure and post-closure stages.

It is advisable to divide the potential environmental impact of the proposed economic activity into two main categories: radiation and non-radiation impacts. The magnitude of the impact varies across the proposed activity’s stages (construction, operation, closure, and the post-closure period of the near-surface disposal facility).

Non-Radiation Impact

The maximum non-radiation impact is expected during the RWDF construction phase. Air pollution during construction will be temporary, localised, and negligible. Taking into account the planned environmental protection measures, no additional adverse impacts on surface water or groundwater from water use and wastewater disposal are expected during RWDF construction. The impact on vegetation will be significant but limited to the area occupied by the RWDF site. Overall, the projected impact on vegetation cover should be considered acceptable, provided that reafforestation works and other special environmental protection and remedial measures are implemented. The alternative sites do not contain natural ecosystems or landscapes of conservation value, and each site covers approximately 100 hectares; therefore, the impact on flora and fauna will be minimal.

Given that the proposed facility is located away from the migration routes of large animals and birds and has long been exposed to disturbance factors, the impact on wildlife during the construction phase may be characterised as moderate, provided that environmental protection measures are observed.

During RWDF construction, acoustic impact may be characterised as significant but short-term.

All waste generated during construction activities will be temporarily stored in designated areas and subsequently transferred to a specialised organisation that holds all necessary licences and permits. The RWDF design provides for dedicated areas for the collection and temporary storage of waste prior to its removal from the site. Subject to compliance with environmental protection measures, waste generated during RWDF construction will not adversely affect the environment.

The RWDF sites are located outside populated areas; therefore, the impact on the population will be minimal during both construction and operation.

According to the calculations performed, the maximum ground-level pollutant concentrations at the boundaries of residential areas will not exceed the maximum permissible one-time concentration (MPC OT). Emissions will not adversely affect the environment or the population. Pollutant dispersion calculation demonstrates that the applicable air quality standards for populated areas will be met during the RWDF operational phase.

Adverse impacts on surface water and groundwater associated with water supply and wastewater disposal during RWDF operation may arise from leaks in the water supply system. Provided that environmental protection measures are implemented, such impacts will be minor, localised, and reversible.

The impact on soil cover will be minimal, both in terms of the affected area and the level of impact. Nevertheless, special measures will be implemented to minimise any potential adverse effects on soils during RWDF operation.

After construction is complete, plant communities within the site area will consist mainly of landscaped grass mixtures. Therefore, no significant impact on plant communities is anticipated during RWDF operation.

During operation, noise impacts on the population will remain within permissible limits. Waste generation, collection, temporary storage, and disposal during RWDF operation will not result in deterioration of the environmental situation at the facility or in adjacent areas.

No other type of non-radiation impact that could physically affect the environment or public health is expected during the proposed economic activity.

Radiation Impact

The proposed economic activity has the potential to cause radiation impacts due to direct gamma radiation from packages containing radioactive materials and radioactive releases into the atmosphere through the ventilation systems of the storage facilities and the waste processing facility. All LRW generated during the proposed economic activity will be collected and processed in a safe manner. Therefore, the EIA considers the following sources of impact:

– radiation impact from direct gamma radiation emitted by disposal modules;

– radiation impact resulting from radionuclide releases through the special ventilation systems of the RWDF buildings and facilities;

– radiation impact resulting from discharges from the special sewage system;

– radiation impact resulting from beyond-design-basis and design-basis accidents;

– radiation impact in the event of failure of the protective barriers during the post-operational period.

RWDF radiation safety during normal operation is ensured by keeping the gamma-ray dose rate at heights of 3–4 cm and 1 m above the facility's top shielding layer within established limits.

The adopted biological shielding for the radioactive waste disposal facility for Radiation Hazard Classes II, III, and IV (ILW-SL, LLW, and VLLW) will ensure public radiation safety.

List of References

1. Regulation on the Procedure and Criteria for Classifying Radioactive Waste into Radiation Hazard Classes, approved by Resolution No. 497 of the Council of Ministers of the Republic of Belarus, dated August 21, 2020.
2. Resolution No. 36 of the Ministry for Emergency Situations of the Republic of Belarus, dated June 5, 2023, “On Amendments to Resolution No. 47 of the Ministry for Emergency Situations of the Republic of Belarus, dated September 28, 2010, ‘On Approval of Nuclear and Radiation Safety Rules and Regulations “Safety in Radioactive Waste Management. General Provisions”.
3. “Construction of a Radioactive Waste Disposal and Temporary Storage Facility.” Pre-Design Documentation. Section 1. General Description 01260-000-000-OX Moscow, 2025.

2 GENERAL DESCRIPTION OF THE PROPOSED ACTIVITY

2.1 Information on the Job Requestor

The proposed activity is requested by Belarusian Organisation for Radioactive Waste Management Republican Unitary Enterprise (BelRAO State Enterprise):

1 Kalvariyskaya St., Minsk, 220004

E-mail: official@belrao.by

Tel.: +375 (17) 304-06-02

Fax: +375 (17) 304-06-02

2.2 Developer of the EIA Report

The EIA Report has been prepared by Belnipienergoprom Design and Research Republican Unitary Enterprise:

5a Romanovskaya Sloboda St., Minsk, 220004

E-mail: belnipi@energoprom.by

Tel.: +375 (17) 395-22-77

Fax: +375 (17) 375-53-17

2.3 Purpose and Need for the Proposed Activity

The fundamental safety objective is the protection of people and the environment from the effects of ionising radiation.

The purpose of the proposed economic activity is:

– to ensure the RW acceptance, inspection, sorting, processing, conditioning and compliance with waste acceptance criteria for disposal;
– the disposal of very low-level, low-level and short-lived intermediate-level RW, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 3–5;
– and the long-term storage of long-lived intermediate-level and high-level RW, including disused sealed ionising radiation sources of Radiation Hazard Scale Categories 1 and 2, as well as RW resulting from SNF reprocessing.

The need to construct an RWDF in the Republic of Belarus is driven by the following factors:

1. The volumes of radioactive waste accumulated at the Belarusian NPP and other facilities require new, specific solutions for their safe isolation.
2. In accordance with the requirements of Law of the Republic of Belarus No. 198-Z “On Radiation Safety”, dated 18 June 2019, the storage or disposal of radioactive waste must ensure reliable isolation from the environment, radiation safety in compliance with nuclear and radiation safety regulations, specific sanitary and epidemiological requirements, and the design documentation for radiation facilities. Existing storage facilities are temporary.
3. The construction of RWDF will enable the commissioning of new disposal capacities, while modern technologies will ensure RW safe management, raising the environmental safety level.
4. New technologies have been developed in recent years that provide a higher level of RW managment than earlier solutions. The application of these technologies in the RWDF construction, together with the monitoring system to be installed at the facility, will reduce the risk of potential radionuclide contamination of the surrounding region.
5. The new facility will play an important role in the socio-economic development of the country. The use of modern technologies and the implementation of the defence-in-depth concept, based on a system of multiple barriers that prevent the release of ionising

radiation and radioactive substances into the environment, will reduce the ecological burden on ecosystems and the population. A high level of safety also contributes significantly to the investment and social prospects of the area where the facility is located. The construction and operation of the facility will create additional jobs and raise funds for the region.

The RWDF construction is an integral part of radioactive waste management practice and, includes a number of organisational measures, the key ones being:

– approval by Resolution No. 128 of the Council of Ministers of the Republic of Belarus, dated February 15, 2023, of the regulatory document "Radioactive Waste Management Strategy" [3];
– establishment of a radioactive waste management organisation (hereinafter – BelRAO) [4];
– Plan of Key Organisational Measures for the RWDF Construction [5].

In accordance with the recommendations of the IAEA [6], several stages of the RWDF development programme can be identified and are considered in this EIA Report:

– preparation of an inventory (register) of radioactive waste intended for disposal;
– identification of potential generic (i.e. site-independent) disposal facility concepts;
– initiation of the development of the overall safety assessment report.

2.4 Inventory (Register) of Radioactive Waste in the Republic of Belarus

JIPNR–Sosny Scientific Institution conducted studies [7] to forecast the characteristics of RW intended for disposal or temporary storage, taking into account the proposed waste treatment methods and the types of final RW container forms in accordance with the general waste acceptance criteria for disposal. The study considered RW generated during the operation and decommissioning of the Belarusian NPP; RW received and temporarily stored at Ecores UE's storage facilities; institutional RW; RW resulting from SNF reprocessing at the Belarusian NPP; and RW from prospective facilities.

As a result of the study, there has (have) been:

– recommended waste conditioning methods and final RW container types. An assessment was carried out to determine whether the final RW container characteristics comply with the general waste acceptance criteria for disposal;
– estimated the expected gross volumes, radiation and physicochemical characteristics, and radionuclide composition of RW generated during the operation and decommissioning of Units 1 and 2 of the Belarusian NPP and intended for disposal or temporary storage;
– estimated the expected gross volumes and characteristics of RW currently held in temporary storage at the facilities of the specialised enterprise Ecores UE and intended for disposal or temporary storage. A forecast estimate was also obtained for the expected volumes of RW that will arise from the decommissioning of the specialised enterprise Ecores UE;
– estimated the expected gross volumes, radiation and physicochemical characteristics, and radionuclide composition of institutional RW intended for disposal or temporary storage;
– estimated the expected gross volumes and characteristics of RW arising from SNF reprocessing at the Belarusian NPP and intended for disposal or temporary storage;
– obtained a forecast estimate of RW generation associated with the operation of a research reactor planned for construction in the Republic of Belarus;
– obtained a forecast estimate of RW generation associated with potential future nuclear facilities in the Republic of Belarus (construction of an additional nuclear power plant or expansion of the Belarusian NPP through additional power units);
– obtained an overall estimate of the volumes of all existing and future RW streams in the Republic of Belarus intended for disposal or temporary storage at the RWDF. Table 2.1

presents the resulting estimate of the expected gross volumes of RW intended for disposal or temporary storage, taking into account the final RW container types in accordance with the general waste acceptance criteria for disposal [7].

Table 2.2 presents the expected gross volumes of RW intended for disposal or temporary storage, taking into account the final RW container types in accordance with the general waste acceptance criteria for disposal, generated by potential future nuclear facilities in the Republic of Belarus (construction of an additional nuclear power plant and/or expansion of the Belarusian NPP through additional power units, as well as construction of a research reactor).

The principal RW streams in Belarus are as follows:

– RW from the Belarusian NPP and projected RW from potential future nuclear facilities, comprising VLLW, LLW, and short-lived ILW, accounting for more than 96.95% of the total volume;
– accumulated and institutional radioactive waste managed by the specialised enterprise Ecores UE, accounting for approximately 3.01% of the total volume.

Table 2.1 – Summary Estimate of RW Intended for Disposal and Temporary Storage, Taking into Account Final Waste RW Container Types in Accordance with the General Waste Acceptance Criteria for Disposal [7]

Waste Management Option	Waste Type	Volume, m³
Disposal in a Near-Surface Radioactive Waste Disposal Facility	Class IV, Class III, and Class II RW with T½ ≤ 31 years; IRS of Categories 3–5	46,331.72
Disposal in a Near-Surface Radioactive Waste Disposal Facility or temporary storage, depending on the actual content of long-lived radionuclides*	Class II RW with T½ ≤ 31 years and T½ > 31 years	12,678.6
Temporary storage	Class I, Class II RW with T½ > 31 years; IRS of Categories 1 and 2	13,486.52
* - are determined taking into account the design data of the Belarusian NPP		

Table 2.2 – Expected Gross Volumes of RW from Potential Nuclear Facilities Intended for Disposal and Temporary Storage, Taking into Account Final RW Container Types in Accordance with the General Waste Acceptance Criteria for Disposal [7]

Waste Management Option	Waste Type	Volume, m³
Disposal in a Near-Surface Radioactive Waste Disposal Facility	Class IV, Class III, and Class II RW with T½ ≤ 31 years; IRS of Categories 3–5	69,196.79
Disposal in a Near-Surface Radioactive Waste Disposal Facility or temporary storage, depending on the actual content of long-lived radionuclides*	Class II RW with T½ ≤ 31 years and T½ > 31 years	19,017.9
Temporary storage	Class I, Class RW with T½ > 31 years; IRS of Categories 1 and 2	19,356.37
* - are determined taking into account the design data of the Belarusian NPP.		

2.5 Justification of RW Packaging for the Predictive Assessment of the Impact of the RWDF on the Population and Environmental Components

2.5.1 Problem Definition

During the operation of a nuclear power plant, radionuclides are generated as a result of activation and fission processes. Depending on their origin, they can be divided into three groups: activation products, fission products, and uranium and transuranic alpha-emitting radionuclides.

According to the RW classification system currently in force in the Republic of Belarus, Class II (short-lived), Class III and Class IV RW will be disposed of in the RWDF. These waste classes may contain radionuclides from all three groups listed above.

Class I RW and long-lived Class II RW will be stored in a dedicated facility within the RWDF.

The principal characteristics used to assess the radiological impact of RW are the radionuclide composition and specific and total activities of waste packages.

At this stage, the following key objectives can be identified:

- to determine the radionuclide composition of RW;
- to assess the specific activity of radionuclides contained in RW;
- to select RW packages for the assessment of the radiological impact of the RWDF.

2.5.2 Radionuclide Composition of Radioactive Waste

There were analysed [9] RW data from nine countries (the United States, Belgium, Slovakia, Spain, the United Kingdom, France, Lithuania, Germany, Canada, and the Russian Federation), and a reference list of 14 radionuclides was compiled: ^{3}H, ^{14}C, ^{36}Cl, ^{55}Fe, ^{60}Co, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{93}Zr, ^{94}Nb, ^{99}Tc, ^{129}I, ^{135}Cs, and ^{137}Cs, ^{134}Cs, ^{54}Mn.

The radionuclides on this list can be divided into two groups:

1. Instrumentally measurable marker radionuclides (^{137}Cs, ^{60}Co, and ^{94}Nb);
2. Hard-to-detect radionuclides (^{3}H, ^{14}C, ^{36}Cl, ^{55}Fe, ^{59}Ni, ^{63}Ni, ^{90}Sr, ^{93}Zr, ^{99}Tc, ^{129}I, and ^{135}Cs).

Figure 2.1 presents the distribution of radionuclides by the proportion of NPP RW records in which information on their content was reported during the initial characterisation process.

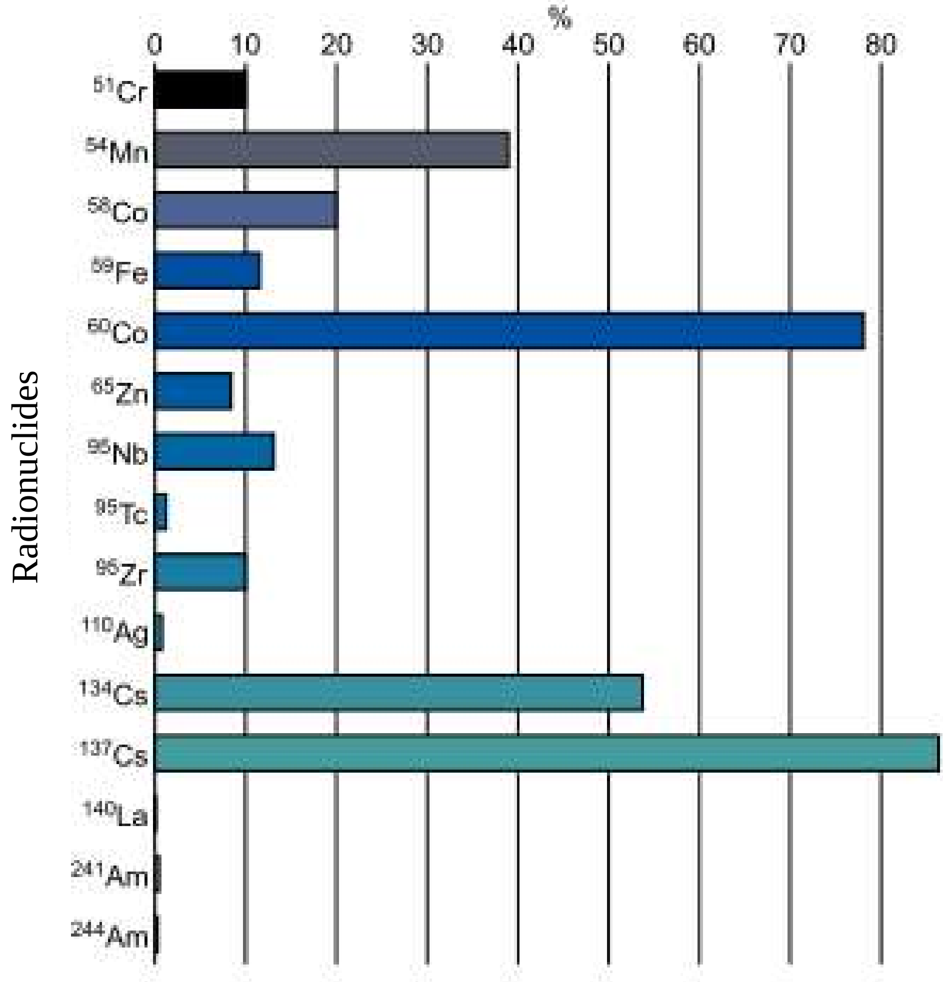

Figure 2.1 – Distribution of Radionuclides by the Proportion of NPP RW for Which Information on Their Content Was Available During Initial Characterisation

The high proportion of radioactive waste containing radionuclides such as ^{54}Mn (Eγ = 834.8 keV), ^{60}Co (Eγ = 1173 and 1332 keV), ^{134}Cs (average Eγ = 698 keV), and ^{137}Cs (Eγ = 662 keV) is explained by the fact that these radionuclides can be readily identified by gamma spectrometry during the initial characterisation of RW packages.

Based on the analysis of literature [10–15], it is assumed that the RW generated at the Belarusian NPP may contain the radionuclides listed in Table 2.3.

Table 2.3 – Radionuclide Composition of RW from the Belarusian NPP

Radionuclide	**Source of information**						
	[8]	[10]	[11]	[9]	[12]	[13]	[14]
^{3}H	+		+	+	+	+	
^{14}C	+	+	+		+	+	
^{36}Cl	+				+		
^{134}Cs		+	+	+	+	+	+
^{137}Cs	+	+	+	+	+	+	+
^{129}I	+	+				+	
^{94}Nb	+	+	+				
^{59}Ni	+	+			+	+	
^{63}Ni	+	+			+	+	

Radionuclide	Source of information						
	[8]	[10]	[11]	[9]	[12]	[13]	[14]
^{240}Pu		+				+	
^{90}Sr	+		+	+	+	+	
^{99}Tc	+	+				+	+
^{93}Zr	+	+					
^{241}Am		+	+		+		+
^{54}Mn			+	+		+	+
^{55}Fe	+	+					
^{60}Co		+	+	+	+	+	
^{235}U			+				
^{239}Pu			+				

2.5.3 Specific Activity of Radionuclides

Reference [13] presents the results of assessments of the specific activities of long-lived radionuclides generated during the operation of VVER-1200 reactor units in various waste streams and materials, including:

– wiping materials, protective clothing and gaskets, and solidified liquid radioactive waste;
– charcoal adsorbers, dirty air filters from ventilation and gas-cleaning systems;
– equipment components (structural materials) of NPU, including steel and concrete.

Using the correlation factor method, correlation factors for long-lived radionuclides in RW were assessed. Based on these assessments, estimates of the specific activity values of long-lived radionuclides in RW were obtained and are presented in Table 2.4.

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Table 2.4 – Specific Activity of Long-Lived Radionuclides in the Most Permanent Media

Radionuclide	Specific Activity, Bq/kg	Volumetric Activity, Bq/m³	Reference Radionuclide	Correlation Factor
Cemented RW derived from activated corrosion products				
^{60}Co	1.11×10^{7}	2.44×10^{10}		
^{137}Cs	4.81×10^{5}	1.06×10^{9}		
^{239}Pu	6.99×10^{1}	1.54×10^{5}	^{137}Cs*	1.45×10^{-4}
^{240}Pu	2.38×10^{1}	5.24×10^{4}	^{137}Cs*	4.95×10^{-5}
^{235}U	1.05×10^{-3}	2.32×10^{0}	^{137}Cs*	2.19×10^{-9}
^{241}Am	2.43×10^{1}	5.34×10^{4}	^{137}Cs*	5.05×10^{-5}
^{99}Tc	8.70×10^{-5}	1.91×10^{-1}	^{137}Cs*	1.81×10^{-10}
^{129}I	1.08×10^{2}	2.37×10^{5}	^{137}Cs*	2.24×10^{-4}
^{94}Nb	8.24×10^{2}	1.81×10^{6}	^{60}Co**	7.42×10^{-5}
^{63}Ni	1.36×10^{5}	2.99×10^{8}	^{60}Co**	1.23×10^{-2}
^{59}Ni	3.94×10^{3}	8.67×10^{6}	^{60}Co**	3.55×10^{-4}
^{14}C	7.88×10^{0}	1.73×10^{4}	^{60}Co**	7.10×10^{-7}
Dewatered IERS				
^{137}Cs	1.00×10^{8}	7.20×10^{10}		
^{239}Pu	1.45×10^{4}	1.05×10^{7}	^{137}Cs*	1.5×10^{-4}
^{240}Pu	4.95×10^{3}	3.57×10^{6}	^{137}Cs*	5.0×10^{-5}
^{235}U	2.19×10^{-1}	1.58×10^{2}	^{137}Cs*	2.2×10^{-9}
^{241}Am	5.05×10^{3}	3.63×10^{6}	^{137}Cs*	5.0×10^{-5}
^{99}Tc	1.81×10^{-2}	1.30×10^{1}	^{137}Cs*	1.8×10^{-10}
^{129}I	2.24×10^{4}	1.61×10^{7}	^{137}Cs*	$2/2\times10^{-4}$
Dewatered IERS in a cement matrix				
^{137}Cs	2.00×10^{7}	4.00×10^{10}		
^{239}Pu	2.90×10^{2}	5.81×10^{6}	^{137}Cs*	1.5×10^{-4}
^{240}Pu	9.90×10^{2}	1.98×10^{6}	^{137}Cs*	5.0×10^{-5}
^{235}U	4.38×10^{-2}	8.76×10^{1}	^{137}Cs*	2.2×10^{-9}
^{241}Am	1.01×10^{3}	2.02×10^{6}	^{137}Cs*	5.0×10^{-5}
^{99}Tc	3.62×10^{-3}	7.24×10^{0}	^{137}Cs*	1.8×10^{-10}
^{129}I	4.48×10^{3}	8.95×10^{6}	^{137}Cs*	2.2×10^{-4}

*^{137}Cs – reference radionuclide in the reactor coolant.
** ^{60}Co – reference radionuclide in structural materials.
*** Specific activity of radionuclides, expressed in Bq/g.
**** Corresponds to the clearance level value. In the Lithuanian EIA, this is the limit value of specific activity corresponding to an annual effective dose of 10 mSv.

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According to RB-154-19, “Recommendations for the Application of the Radionuclide Ratio Method for Determining the Content of Hard-to-Detect Radionuclides in Radioactive Waste from Nuclear Fuel Cycle Facilities”, the following reference hard-to-detect radionuclides are used in the radionuclide vector method: ^{60}Co for corrosion products and ^{137}Cs for fission products. Because the activity of long-lived radionuclides is well below the minimum detectable activity levels, their content in RW can only be determined using the radionuclide ratio method.

Analysis of the results presented in Table 2.4 leads to the following conclusions:

1. Under the current classification system [15], radioactive waste of Radiation Hazard Classes II (short-lived), III and IV is subject to disposal at the RWDF. These categories include short-lived intermediate-level waste, low-level waste and very low-level waste.
2. These waste streams contain long-lived radionuclides at concentrations acceptable for near-surface disposal.

2.5.4 RW Packages

Based on the analysis of radioactive waste generated in the Republic of Belarus, the following container types are recommended for disposal (storage):

- a special container for Class I RW;
- NZK-150-1.5P reinforced-concrete container for packaging Class II RW with a half-life exceeding 31 years, intended for temporary storage;
- NZK-150-1.5P reinforced-concrete container for packaging Class II RW with a half-life of up to 31 years, intended for disposal at a Near-Surface RWDF (NSRWDF) (if the gamma exposure rate from a loaded NZK-150-1.5P container exceeds 2 mSv/h, such waste shall be placed in a KZH-2ks container);
- NZK-150-1.5P reinforced-concrete container for packaging combustible Class III and IV RW intended for disposal at an NSRWDF;
- NZK-IER reinforced-concrete container for packaging dewatered SIERs of Radiation Hazard Classes III and IV intended for disposal at an NSRWDF;
- NZK-150-1.5P container with a metal liner for packaging RW contaminated with ^{226}Ra, not exceeding Radiation Hazard Class II, intended for disposal at an NSRWDF;
- KRAD-1.36 metal container for packaging Class III and IV RW intended for disposal at an NSRWDF, excluding combustible SRW (if the gamma exposure rate from a loaded KRAD-1.36 container exceeds 2 mSv/h, such waste shall be placed in an NZK-150-1.5P container);
- specialised KMZ-RNI-RADON package for packaging disused sealed IRS intended for disposal and temporary storage.

For assessing radiation impacts on the population in the event of accidents at the RWDF, the NZK-150-1.5P container is recommended as the reference package.

The characteristics of RW packages used for the radiation impact assessment are presented in Table 2.5.

The waste acceptance criteria for disposal are set out in Resolution No. 47 of the Ministry for Emergency Situations of the Republic of Belarus, dated July 16, 2019.

Table 2.5 – Radionuclide Composition, Specific Activity, and Activity of RW Containers Used for the Assessment of Radiation Impact on the Population of the Republic of Belarus in the Event of Accidents at the RWDF [19]

RW Type	RW Class	Package Type	RW Volume per Package, m³	RW Density (Bulk Density), kg/m³	RW Weight per Package, kg	Radionuclide Composition	Specific Activity, Bq/kg	RW Activity per Package, Bq
Solidified LRW	II (s/l), III	NZK-150-1.5P	1.5	2000	3000		1.27×10^{7}	3.49×10^{10}
						^{60}Co	1.11×10^{7}	3.30×10^{10}
						^{137}Cs	4.81×10^{5}	1.44×10^{9}
						^{239}Pu	6.99×10^{1}	2.10×10^{5}
						^{240}Pu	2.38×10^{1}	7.14×10^{4}
						^{235}U	1.05×10^{-3}	3.15×10^{0}
						^{241}Am	2.43×10^{1}	7.29×10^{4}
						^{99}Tc	8.7×10^{-5}	2.61×10^{-1}
						^{129}I	1.08×10^{2}	3.24×10^{5}
						^{94}Nb	8.24×10^{2}	2.47×10^{6}
						^{63}Ni	1.36×10^{5}	4.08×10^{8}
						^{59}Ni	3.94×10^{3}	1.18×10^{7}
						^{144}C	7.88×10^{0}	2.36×10^{4}
Dewatered IRS	II (s/l), III	NZK-150-1.5P	1.3	850	1100		1.0×10^{8}	1.10×10^{11}
						^{137}Cs	1.0×10^{8}	1.10×10^{11}
						^{239}Pu	1.45×10^{4}	1.60×10^{7}
						^{240}Pu	4.95×10^{3}	5.45×10^{6}
						^{235}U	2.19×10^{-1}	2.41×10^{2}
						^{241}Am	5.05×10^{3}	5.56×10^{6}
						^{99}Tc	1.81×10^{-2}	2.00×10^{1}
						^{129}I	2.24×10^{4}	2.46×10^{7}

2.6 Protective Barrier System

The RWDF modules are constructed on a previously prepared foundation. In addition to bearing geological formations, the foundation incorporates an engineered safety barrier made of clay-based materials, the thickness of which depends on the specific conditions of the selected site (the required thickness is determined, among other factors, on the basis of long-term safety assessments). After the reinforced-concrete disposal modules are constructed, waterproofing and engineered safety barriers made of clay-based materials are installed along the module walls. The thickness of these barriers is determined by engineering calculations. The clay-based material is placed in uniform layers along the entire length of the walls and compacted with the air rammer. Once the safety barrier system is in place, the reinforced concrete disposal module is isolated from the host geological environment, and the system prevents radionuclide dispersal into the host rocks. In the event of hypothetical operational disturbances, the clay-based barriers either prevent or significantly retard radionuclide dispersal into the environment.

The properties and features of engineered safety barriers based on natural clay materials have been extensively studied. Numerous scientific publications have been published on this subject, industry standards have been developed, and practical operating experience has been gained.

The engineered barrier system of the RWDF includes:

- RW package and its individual components (RW form, container);
- a natural clay-based buffer material (barrier clay material) used to fill voids within disposal cells;
- load-bearing and enclosing reinforced-concrete structures of the RWDF cells;
- the bottom liner of the disposal module;
- a clay sealing layer along the perimeter of the module, forming the side barrier;
- the cover system of the disposal module (constructed upon closure of the RWDF);
- a vegetative layer with soil and plant cover;
- drainage systems.

The design and composition of the bottom and cover barrier systems will be determined during the design documentation development stage, taking into account the geological conditions of the selected site.

The engineered barriers of the RWDF are designed to perform their safety functions after facility decommissioning, within the scope specified by the project, for the service life established and justified in the RWDF design, without the need for maintenance or repair.

2.7 Buildings and Structures of the RWDF

The proposed facility is designed as an integrated complex of buildings and structures, functionally interconnected and located within a single site boundary. The layout of buildings and structures has been developed taking into account functional zoning of the site, engineering interconnections between facilities, the possibility of routing underground and above-ground utility trunks, access to existing transportation infrastructure, compliance with regulatory separation distances between facilities and utilities, fire clearances, and provision of vehicle access to all buildings and structures within the site.

The RWDF industrial site is configured as a rectangle. The set of buildings and structures is identical across all alternative sites under consideration.

To ensure safe operation and maintenance of the facility, the project includes an off-site hard-surfaced bypass road.

The preliminary dimensions of the RWDF site, measured along the perimeter structure, are 691.0 m × 538.0 m.

The general layout, including designated functional areas, is provided in Appendix A.

The following functional areas are planned:

The *Administrative and Amenity Area* is located adjacent to the main access roads to the RWDF site, connecting the facility with RW-generated enterprises. This area spans the entrance area and part of the territory within the site perimeter. The following buildings, structures, and facilities are planned for the facility-adjacent territory:

- Administrative and amenity building (No. 1.1);
- Visitor parking area P1 with charging stations for 32 vehicles;
- Standing area P2 for special-purpose vehicles with 4 parking spaces;
- Six SKAT-type charging stations (No. 25/1);
- Protective shelter (No. 20/1);
- Municipal waste collection area (No. 3/1) for three containers;
- Standing area P5 for construction equipment, with 4 parking spaces (located near Access Control Checkpoint No. 18/3).

Within the perimeter fence:

- Combined amenity building (No. 1.2);
- Protective shelter (No. 20/2);
- Special-purpose area (No. 30);
- Passenger vehicle parking area P3 with 17 parking spaces.

The *Security Buffer Area* is located along the RWDF perimeter and performs protection and security functions.

The RWDF has three separate access points along the perimeter, each equipped with access control checkpoints (Nos. 18/1, 18/2, and 18/3 on the general layout), inspection areas (Nos. 24/1–24/3), and inspection areas for special-purpose vehicles and construction equipment (Nos. 10/1 and 10/2).

The following buildings and structures are within the Radioactive Waste Disposal and Temporary Storage Area:

- Process building (No. 2);
- Dewar flask shelter for liquid nitrogen storage (No. 4);
- Vehicle and equipment decontamination facility (No. 9);
- RW processing facility (No. 17);
- RW disposal modules (Nos. 15/1–15/10);
- Storage area for RW from SNF reprocessing (No. 22);
- SRW storage facilities (Nos. 23/1–23/4).

The following buildings and structures are planned for the *Logistics Support Area*:

- Forklift garage (No. 5);
- Materials storage shelter (No. 6);
- Materials storage yard (No. 7);
- Heavy equipment storage area (No. 8);
- Mobile fuel station area (No. 11);
- Special-purpose vehicle garage (No. 19).

The following buildings and structures are planned to be located within the *Electrical Engineering Area*:

- Transformer substation (No. 12);
- SKAT-type charging stations (No. 25/2);
- Battery energy storage system (BESS) (No. 26);
- Area for diesel generator units (No. 28);
- Parking area P4 with charging stations for six special-purpose vehicles;
- Municipal waste collection area (No. 3/2) for seven containers.

The following buildings and structures are planned to be located within the *Auxiliary (Water Treatment) Area*:

- Industrial and firefighting water supply pumping station with storage tanks (No. 14);

– Water treatment plant area (No. 21) with storage tanks;
– Electric boiler house (No. 31).

The following buildings and structures are planned to be located within the *Wastewater Treatment Area*:

– Local surface water run-off treatment facility (No. 13) with associated buildings and structures;
– Domestic wastewater treatment plant (No. 16);
– Sludge dump for WTP backwash water (No. 29).

To ensure the operation and maintenance of the proposed facilities, including access for heavy and oversized vehicles, the project includes the construction of internal access roads.

A description of the buildings and structures of the proposed facility as potential sources of environmental impact is provided in Section 6.

Monitoring wells for groundwater sampling will be installed around the facilities and along the site perimeter.

2.8 RW Transportation Flow Chart

RW Containers are delivered to the RWDF for temporary storage, as follows:

- Class I RW containers;
- Class II RW containers with long-lived radionuclides, packaged in reinforced-concrete containers of the NZK-150-1.5P and NZK-IRS types;
- Disused sealed IRS of Categories 1 and 2 according to the radiation hazard scale, packaged in KMZ-RNI-RADON reinforced-concrete containers.

Class I RW containers are delivered through the access control checkpoint (ACC) by specially equipped vehicles (self-propelled heavy-duty transport platforms).

Class II RW containers with long-lived radionuclides are delivered to the process building, where the incoming inspection of RW containers is carried out, and then transferred to the SRW storage facility.

Class II RW containers with short-lived radionuclides, as well as Class III and Class IV RW containers, are delivered to the process building in NZK-150-1.5P, NZK-IRS, KMZ-RNI-RADON reinforced-concrete containers, and KRAD-1.36 metal containers by specialised transport vehicles. There, incoming inspection and acceptance control of RW containers intended for disposal or temporary storage are carried out, except for RW resulting from SNF reprocessing. Temporary storage of RW containers that have not yet passed incoming inspection may be provided in specially designated areas of the process building, according to the respective RW class. The process building is equipped with all necessary engineering systems and equipment to ensure compliance with sanitary and radiation protection requirements during RW treatment operations.

After inspection, Class II (short-lived), Class III, and Class IV RW containers are transferred from the process building by forklift either to disposal modules for final disposal or to SRW storage facilities for temporary storage. Registration of RW received for disposal and storage is carried out within the process building.

Specialised handling equipment is used during transportation and handling operations associated with the delivery of Class I RW containers to the unloading area.

RW Transportation and Handling

RW transportation and delivery will be carried out by road and rail along routes approved in advance and in strict compliance with the legislation of the Republic of Belarus.

RW packages will be delivered to the RWDF as follows:

– Class I radioactive waste packages will be transported on a self-propelled, heavy-duty platform with independently controlled axles. On public roads, the platform is towed by a tractor unit; within the RWDF site, it moves under its own power. This platform will be used to transport waste containers across the facility to the storage area access gates. The loaded platform will enter the unloading area through swing gates, where the waste containers will be unloaded using an overturning spreader beam and an overhead crane. Following unloading, the containers will undergo incoming inspection. Based on the inspection results, they will be transferred and placed in their designated storage locations. If a delivered container fails to meet the established acceptance criteria, a decision will be made on its further handling.

– Class II, III, and IV radioactive waste packages will be transported in dropside trucks fitted with protective tarpaulin covers.

Waste packages will be unloaded using an overhead crane and forklifts. Following unloading, all vehicles will undergo radiation monitoring.

If contamination exceeds permissible limits, vehicle decontamination will be carried out.

Incoming RW packages delivered to the RWDF will be inspected for the following parameters:

– package weight (volume);
– availability and completeness of accompanying documentation;
– package integrity and serviceability of lifting and fastening elements;
– presence, content, and visibility of package labelling;
– compliance of certification data with the acceptance criteria applicable to radioactive waste intended for disposal at the RWDF;
– radiation dosage rate at the package surface (measured at a distance of 10 cm from the outer surface) and at a distance of 1 m from the package surface;
– presence of removable radioactive contamination on the outer surface of the package.

Class III and IV radioactive waste, as well as disused sealed IRS of Categories 1–5 according to the radiation hazard scale, may also be transferred to the radioactive waste treatment facility.

The Radioactive Waste Treatment Facility (RWTF) will provide acceptance, processing, repackaging, and conditioning of radioactive waste to ensure compliance with waste acceptance criteria for disposal.

Solid radioactive waste will be delivered to the RWTF as pre-sorted combustible waste, non-combustible compactable waste and non-combustible non-processable RW. Combustible SRW will be delivered to the RWTF in returnable containers or 200-litre drums without pre-compaction.

Non-combustible compactable waste will be delivered in returnable containers without pre-compaction, or in non-returnable 200-litre drums after pre-compaction.

Non-combustible non-processable SRW will be delivered in returnable containers or in non-returnable 200-litre drums.

The RWTF may also receive both secondary non-combustible LRW from its own operations and non-combustible LRW from external sources (including radionuclide-contaminated surface water runoff collected at the RWDF site) for processing at the concentration plant, followed by cementation.

Combustible LRW may also be received for treatment at the incineration facility. Disused sealed IRS will be delivered to the RWTF in returnable transport containers, standard manufacturer shielding containers, or KMZ-RNI-RADON containers.

During the incineration of combustible SRW, Class II RW may be generated in the form of ash residue.

Labour Force and Work Pattern

The RWDF will operate on a single-shift schedule for 264 days per year.

The duration of work shifts will be 7 or 8 hours, depending on working conditions.

The workforce required for the RWDF operation is estimated at around 200 employees, taking into account the commissioning of all construction phases.

Description of the Construction Work Process

The organisational and engineering diagram provides for two construction phases: the preparatory phase and the main construction phase.

During the preparatory phase, activities are carried out to ensure the systematic deployment of construction and installation works and the coordinated operation of all construction participants.

To organise the construction site, the following activities will be carried out during the preparatory phase:

- establishment of a geodetic base, installation of towers, and site grading;
- construction of temporary on-site and access roads;
- preparation of storage areas for construction materials and structures;
- implementation of temporary groundwater-lowering measures, where necessary;
- installation of temporary facilities for construction personnel;
- installation and connection of temporary utility networks for the construction period. Temporary utility connections will be made from the permanent utility networks designed for the facility.
- provision of temporary telephone communication services.

The main construction phase includes the execution of works related to the construction of buildings and structures within the RWDF site. Construction is planned to be implemented in stages with the completion of start-up facilities.

The construction of substructures (footing excavation, foundation, and backfilling) will be carried out using conventional methods and standard construction machinery and equipment.

2.9 Conclusion

Disposal is the final stage of the RW life cycle and ensures reliable isolation of the biosphere from the radiation impact of radionuclides contained in the waste.

The specific objectives of disposal are:

- confinement of RW within the RWDF;
- isolation of RW from the accessible biosphere;
- minimisation of all potential consequences of inadvertent human intrusion into the RWDF;
- minimisation of radionuclide migration from the RWDF to the accessible biosphere;
- ensuring minimal radiological consequences in the event of radionuclide release into the accessible biosphere resulting from beyond-design-basis accidents at the RWDF.

The primary objective of RW disposal is the long-term protection of people and the environment, including the period after decommissioning of the RW disposal facility [4]. During this period, radionuclides may migrate and disperse within the accessible biosphere, potentially leading to public exposure.

According to regulatory requirements [17] and the IAEA’s recommendations, disposal facilities must provide reasonable assurance that long-term public doses and risks will not exceed the dose limits or risk constraints established as design criteria [18]:

1. The dosage limit for members of the public in all planned exposure situations is an effective dose of 1 mSv per year. This dosage limit and its associated risk are regarded as criteria that must not be exceeded.

2. To ensure compliance with this dosage limit, the RWDF is designed so that the calculated dose or risk to a member of the public who may be exposed in the future due to natural processes affecting the disposal facility does not exceed an effective dose of 0.3 mSv per year or a risk constraint of the order of 10^{-5} per year.
3. The radionuclide composition, specific activity values, and RW package type have been determined to assess the radiation impact on the population of the Republic of Belarus in the event of accidents at the RWDF.

List of References

1. IAEA Safety Fundamentals No. SF-1, Vienna, 2007.
2. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, adopted by the International Atomic Energy Agency on September 5, 1997; entered into force on June 18, 2001 (on February 24, 2003 – for the Republic of Belarus).
3. Strategy for Radioactive Waste Management, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 128, dated February 15, 2023. National Legal Internet Portal of the Republic of Belarus, February 21, 2023, No. 5/51387.
4. Decree of the President of the Republic of Belarus No. 101, dated April 12, 2023.
5. Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility (RWDF), approved by Deputy Prime Minister of the Republic of Belarus P.A. Parkhomchik on September 29, 2023, No. 33/213-194/392.
6. Design Principles and Approaches for Radioactive Waste Repositories, IAEA Nuclear Energy Series No. NW-T-1.27, Vienna, 2024.
7. Research Report: Determination of the Characteristics of Radioactive Waste Intended for Disposal/Temporary Storage, Taking into Account Expected Treatment Methods and Final Waste Package Types in Accordance with the General Waste Acceptance Criteria for Disposal: Waste Generated During Operation and Decommissioning of the Belarusian NPP; Waste Received and Stored at Ecores EU’s Storage Facilities; Institutional RW; RW from SNF Reprocessing at the Belarusian NPP; RW from Proposed Facilities; RW Generated During Disposal of Weapons, Military and Special Equipment. Stage 3: Assessment of Expected Volumes, Radiological and Physicochemical Characteristics, and Radionuclide Composition of RW Intended for Disposal/Temporary Storage, Taking into Account Expected Treatment Methods and Final Waste Package Types in Accordance with the General Waste Acceptance Criteria for Disposal: Institutional Waste (RW generated from the use of IRS in medicine, industry, and science); RW from SNF Reprocessing at the Belarusian NPP. Forecast Assessment of Expected RW Generation from the Operation of Proposed Nuclear Facilities in the Republic of Belarus (Construction of an Additional Nuclear Power Plant or Expansion of the Number of Power Units at the Belarusian NPP) and from the Research Reactor Planned for Construction in the Republic of Belarus. Summary of Results (Final Report). Contract No. 24/07-1 dated April 02, 2024. JIPNR–Sosny Scientific Institution, Minsk District, 2025.
8. NP-055-04: Radioactive Waste Disposal. Safety Principles, Criteria and Basic Safety Requirements, approved by Resolution No. 8 of the Federal Service for Environmental, Technological and Nuclear Supervision on October 19, 2004.
9. T.A. Aleksandrova, P.A. Blokhin, A.A. Samoilov, A.V. Kurindin, Analysis of Data on the Radionuclide Composition of Radioactive Waste in the Context of Long-Term Safety Assessment of Its Disposal. Radioactive Waste Journal, No. 2 (3), 2018.
10. Repository for Short-Lived Very Low-Level Waste. EIA Report. LEI S/14-PI.05.02.02.01.0001/EIAR-DRr/R:5. Nuclear Engineering Problems Laboratory, Version 5, Issue 1, July 15, 2009.
11. Comprehensive EIA of the Ignalina NPP Decommissioning Process. LEI EIA Report, Nuclear Engineering Laboratory, S/14-2184.24.26/EIAR/R:1, Revision 1, November 12, 2025.
12. 01260-000-000-OH “Construction of a Radioactive Waste Disposal and Temporary Storage Facility.” Pre-Design Documentation. Section 1. General Description. Moscow, 2025.

13. Research Report: Activity 3. Improvement of Radioactive Waste and Spent Nuclear Fuel Management Technologies. Stage 3.1.1. Preparation of Data on the Characteristics and Volumes of Belarusian NPP Radioactive Waste Intended for Disposal (Storage) at a Radioactive Waste Disposal Facility Considering NPP Decommissioning; Analysis of Compliance of SRW Characteristics with General Disposal Acceptance Criteria; Justification of Conditioning Methods (Container Selection); Justification of Disposal (Storage) Methods Based on Waste Characteristics and Regulatory Requirements for the Natural Conditions of the Radioactive Waste Disposal Facility Site, using alternative reference technologies and existing projects; Justification of Technological Solutions for radioactive waste management at the radioactive waste disposal facility and the selection of the corresponding equipment. State Program “Knowledge-Intensive Technologies and Equipment” for 2016–2020, Subprogram 6 “Scientific Support for Nuclear Power Development in the Republic of Belarus.” Contract No. 2016/2-29 dated March 30, 2016. Minsk, 2016.
14. D.A. Sharov, A.S. Korotkov, A.A. Zagorodnikh, I.I. Gribanov, On the Formation of Lists of Radionuclides to Be Controlled in Nuclear Power Plant Radioactive Waste. Radioactive Waste Journal, No. 4 (33), 2025.
15. Regulation on the Procedure and Criteria for Classifying Radioactive Waste into Radiation Hazard Classes, approved by Resolution No. 497 of the Council of Ministers of the Republic of Belarus, dated August 21, 2020.
16. GOST R 51824-2001. Non-Returnable Shielding Casks for Radioactive Waste Made of Concrete-Based Structural Materials.
17. Hygienic Standard “Criteria for Assessing Radiation Impact”, approved by Resolution No. 37 of the Council of Ministers of the Republic of Belarus, dated January 25, 2021 (as amended by Resolution No. 829, dated November 29, 2022).
18. Specific Safety Requirements No. SSR-5: Disposal of Radioactive Waste. IAEA Safety Standards for Protecting People and the Environment. Vienna, 2011.
19. Environmental Impact Assessment Materials. Section 11. Assessment of Radiation Impact on the Population of the Republic of Belarus in the Event of Accidents at the RWDF Located at Alternative Sites. Book 3. Justification of Design-Basis and Beyond-Design-Basis Accident Scenarios During RWDF Operation Based on Radiation Impact Assessment Results for Site 2-1. Modelling and Assessment of Accident Consequences for the Population at Site 1-5. Assessment of Population Demographics and Morbidity in 2025 in Administrative Districts Associated with Sites 1-5, 2-1, and 3-3. 2184-PP3-EIA 11.3, Volume 7.11.3. Republican Centre for Hygiene, Epidemiology and Public Health, Minsk, 2026.

3 LEGAL ASPECTS OF THE PROPOSED ECONOMIC ACTIVITY

3.1 General Environmental Requirements

The Constitution of the Republic of Belarus establishes the fundamental principles of the country's environmental policy, defining both the rights of citizens and the responsibilities of the state and society in the field of environmental protection.

General environmental requirements in the Republic of Belarus constitute a set of mandatory rules and restrictions aimed at minimising the adverse impact of economic activities on the environment and public health. The principal legal act establishing these requirements is Law of the Republic of Belarus No. 1982-XII "On Environmental Protection", dated November 26, 1992.

The main regulatory legal acts establishing environmental protection requirements applicable to the proposed economic activity and the facility under consideration include:

- Subsoil Code of the Republic of Belarus No. 406-Z, dated July 14, 2008;
- Land Code of the Republic of Belarus No. 425-Z, dated July 23, 2008;
- Water Code of the Republic of Belarus No. 149-Z, dated April 30, 2014;
- Forest Code of the Republic of Belarus No. 332-Z, dated December 24, 2015;
- Law of the Republic of Belarus "On Waste Management" No. 271-Z, dated July 20, 2007;
- Law of the Republic of Belarus "On Atmospheric Air Protection" No. 2-Z, dated December 16, 2008;
- Law of the Republic of Belarus "On Protection of the Ozone Layer" No. 56-Z, dated November 12, 2001;
- Law of the Republic of Belarus "On Flora" No. 205-Z, dated June 14, 2003;
- Law of the Republic of Belarus "On Fauna" No. 257-Z, dated July 10, 2007;
- Law of the Republic of Belarus "On Specially Protected Natural Areas" No. 150-Z, dated November 15, 2018;
- as well as other regulatory and technical legal acts detailing the requirements established by laws and codes.

The legal and organisational framework for preventing adverse impacts of environmental factors on human health, with the aim of ensuring sanitary and epidemiological well-being, is established by Law of the Republic of Belarus No. 340-Z "On Sanitary and Epidemiological Well-Being of the Population", dated January 7, 2012.

The legal basis for protecting the population and territories from natural and man-made emergencies is set out in Law of the Republic of Belarus No. 141-Z "On Protection of Population and Territories from Natural and Man-Made Emergencies", dated May 5, 1998.

Among the principal international treaties governing environmental protection and natural resources management in relation to the construction, operation, and decommissioning of the proposed facility are the following:

- the United Nations Framework Convention on Climate Change (UNFCCC) dated May 9, 1992 (New York), which entered into force for the Republic of Belarus on August 9, 2000;
- the Kyoto Protocol to the United Nations Framework Convention on Climate Change dated December 11, 1997, which entered into force for the Republic of Belarus on November 24, 2005;
- the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management dated September 5, 1997, which entered into force for the Republic of Belarus on February 24, 2003;
- the Vienna Convention for the Protection of the Ozone Layer dated March 22, 1985, which entered into force for the Republic of Belarus on September 22, 1988;
- the Montreal Protocol on Substances that Deplete the Ozone Layer dated September 16, 1987, which entered into force on January 1, 1989;

- the Convention Concerning the Protection of the World Cultural and Natural Heritage dated November 16, 1972 (Paris), which entered into force for Belarus on January 12, 1989;
- the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) dated February 25, 1991, which entered into force for the Republic of Belarus on February 8, 2006;
- the Convention on Long-Range Transboundary Air Pollution dated November 13, 1979 (Geneva) and protocols thereto, which entered into force for Belarus on March 16, 1983;
- the Convention on the Protection and Use of Transboundary Watercourses and International Lakes dated March 17, 1992 (Helsinki) and the Protocol on Water and Health to the Convention dated June 17, 1999 (London);
- the Convention on Biological Diversity dated June 5, 1992 (Rio de Janeiro), which entered into force for the Republic of Belarus on December 29, 1993;
- the Cartagena Protocol on Biosafety to the Convention on Biological Diversity dated January 29, 2000, which entered into force for Belarus on September 11, 2003.

3.2 Radiation Safety Requirements

Given the specific nature of the proposed economic activity, the following radiation safety requirements applicable to the design of the RWDF are considered separately:

- Law of the Republic of Belarus No. 198-Z “On Radiation Safety”, dated June 18, 2019;
- Law of the Republic of Belarus No. 208-Z “On Safety Regulation in the Use of Atomic Energy”, dated October 10, 2022;
- the Rules and Regulations on Nuclear and Radiation Safety “Radioactive Waste Disposal. Safety Principles, Criteria and Basic Safety Requirements”, approved by Resolution No. 7 of the Ministry for Emergency Situations of the Republic of Belarus, dated January 20, 2012;
- the Rules and Regulations on Nuclear and Radiation Safety “Safety in Radioactive Waste Management. General Provisions”, approved by Resolution No. 47 of the Ministry for Emergency Situations of the Republic of Belarus, dated September 28, 2010;
- the Rules and Regulations on Nuclear and Radiation Safety “Siting of Nuclear Material Storage Facilities, Radioactive Waste Storage Facilities, and Radioactive Waste Disposal Facilities”, approved by Resolution No. 48 of the Ministry for Emergency Situations of the Republic of Belarus, dated August 18, 2022;
- the Rules and Regulations on Nuclear and Radiation Safety “Safety of Radiation Facilities. Requirements for the Structure and Content of the Safety Analysis Report for Radioactive Waste Management Facilities”, approved by Resolution No. 64 of the Ministry for Emergency Situations of the Republic of Belarus, dated December 13, 2010;
- the Rules and Regulations on Nuclear and Radiation Safety “Safety in the Management of Solid Radioactive Waste”, approved by Resolution No. 50 of the Ministry for Emergency Situations of the Republic of Belarus, dated September 30, 2025;
- the Hygienic Standard “Criteria for Radiation Impact Assessment”, approved by Resolution No. 37 of the Council of Ministers of the Republic of Belarus, dated January 25, 2021.

The design also takes into account the requirements of relevant IAEA safety standards, particularly SSR-5 “Disposal of Radioactive Waste”, which have been incorporated into the national regulatory framework.

3.3 Environmental Impact Assessment (EIA) Procedure

The EIA procedure in Belarus is strictly regulated and constitutes a mandatory stage in the design of an RWDF.

The EIA process involves the Customer, the EIA Developer, the public, territorial bodies of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, local executive and administrative authorities, as well as specially authorised state bodies responsible for supervising and controlling the implementation of the proposed project solutions.

Transparency is one of the fundamental principles of the EIA procedure, ensuring the right of interested parties to participate directly in the decision-making process during project discussions and guaranteeing consideration of public opinion regarding the environmental impacts of the proposed activity.

The EIA covers the following stages of the proposed economic activity implementation:

1. Preparation and approval of the EIA programme;
2. Conducting international procedures in cases where the proposed activity may have transboundary environmental impacts;
3. Preparation of the EIA Report;
4. Conducting public consultations on the EIA Report, including consultations with affected parties where there may be transboundary impacts (subject to confirmation of participation);
5. Advising affected parties on comments and proposals received regarding the EIA Report in cases of potential transboundary impacts;
6. Revision of the EIA Report when changes are introduced into the design documentation, including revisions based on comments and proposals received during public consultations and from affected parties, provided that such comments and proposals comply with legal requirements, including mandatory technical normative legal acts in the field of environmental protection;
7. Conducting public consultations on the revised EIA Report if any of the following conditions arise and were not considered in the original EIA Report:
    - an increase of more than 5% in the maximum pollutant emission limit per unit of time (tons/year and/or grams/second) compared with the values specified in the original EIA Report;
    - an increase of more than 5% in the average annual flow rate (volume) of wastewater (cubic metres per year) and/or in permissible pollutant concentrations in wastewater discharged into surface water bodies (milligrams per cubic decimetre) compared with the values specified in the original EIA Report;
    - an increase of more than 5% in the volume of production waste intended for disposal at waste disposal facilities, compared with the values specified in the original EIA Report;
    - an increase of more than 5% in the land area allocated to the project compared with that specified in the original EIA Report;
8. Approval of the EIA Report by the Customer, including environmental safety requirements and conditions to be incorporated into the project design;
9. Submission for State Environmental Review of the developed design documentation for the proposed activity, taking into account the design conditions established during the EIA process to ensure the environmental safety of the proposed activity, together with the approved EIA Report and the materials from public consultations on the EIA Report, including the results of international procedures where applicable (in the event of potential transboundary environmental impacts of the proposed activity);
10. Submission of the approved EIA Report to the Ministry of Natural Resources and Environmental Protection in cases where the proposed activity may have transboundary environmental impacts.

Based on the conclusions of the State Environmental Review of the pre-design documentation and the results of public consultations, the Council of Ministers of the Republic of Belarus makes the final decision on the project implementation.

4 ALTERNATIVE OPTIONS FOR SITING AND IMPLEMENTATION OF THE PROPOSED ACTIVITY

4.1 Alternative Options for the Implementation of the Proposed Activity

The radioactive waste management practice recommended by the IAEA is based on a direct relationship between the RW class (specific activity and half-life) and the disposal method.

The IAEA has developed Safety Guide GSG-1, “Classification of Radioactive Waste” [1], which sets out a general radioactive waste classification scheme based on long-term safety considerations. The classification system proposed in the guide facilitates the exchange of information and experience both within and between countries. The guide defines the conceptual boundaries between radioactive waste classes and provides recommendations on their designation from the perspective of long-term safety.

A conceptual illustration of the waste classification scheme is shown in Figure 4.1. The vertical axis represents the activity content of the waste, and the horizontal axis represents the half-lives of the radionuclides contained in the waste.

The classification is based on two key radionuclide characteristics: specific activity and half-life.

The higher the specific activity and the longer the half-life, the more reliable the isolation of radioactive waste from the biosphere must be (e.g., through geological disposal).

The key feature of a repository is the disposal area itself. Depending on the waste being disposed of, this feature can range from near-surface trenches or concrete vaults, sub-surface vaults, chambers, silos or boreholes, to deep geological disposal systems that include excavated chambers or drifts. Deep borehole disposal systems can also be considered. Figure 4.2 provides a schematic overview of the various disposal options available for different waste classes [2]. The presentation in Fig. 4.2 and the use of depth to discriminate between waste classes are consistent with the IAEA classification system.

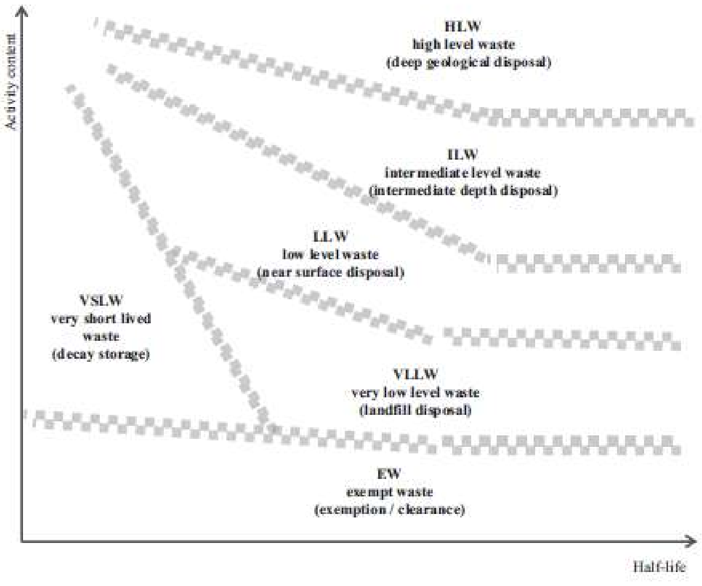


Fig. 4.1 – Conceptual illustration of the waste classification scheme

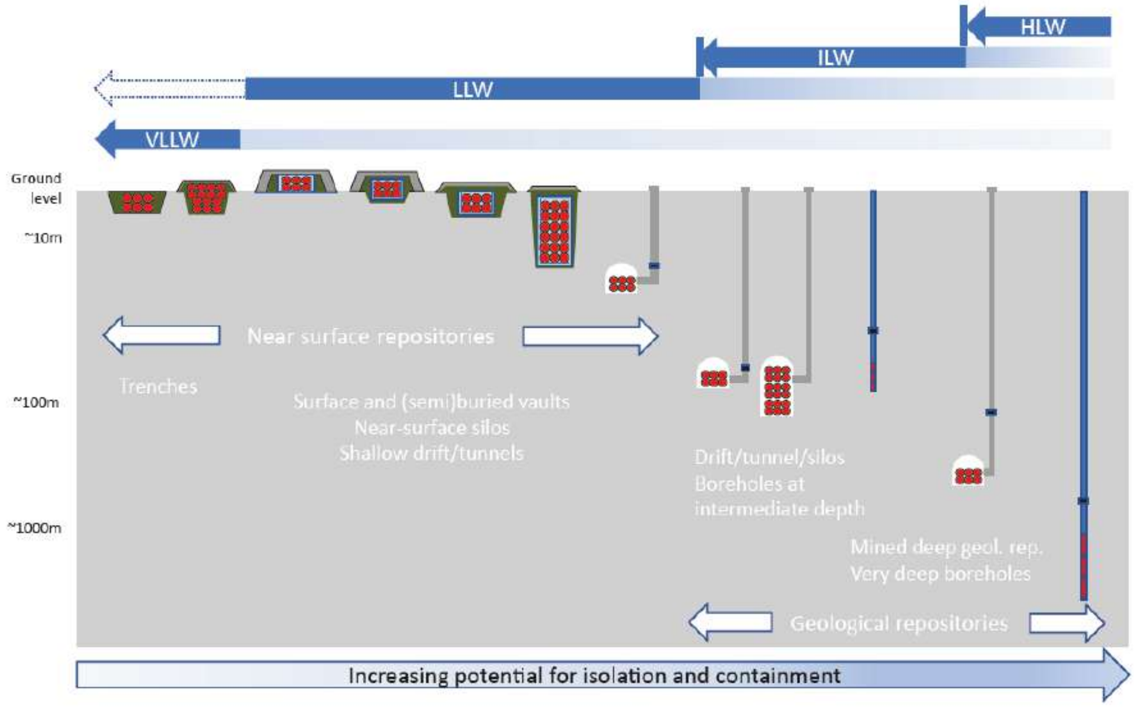


Fig. 4.2 – Schematic illustration of the range of disposal options, from surface to deep, currently considered or implemented for different classes of radioactive waste

The radioactive waste classification adopted in the Republic of Belarus is based on the assignment of RW to radiation hazard classes. The criteria for such classification are presented in Table 4.1 [3].

Table 4.1 – Criteria for Classifying Radioactive Waste into Radiation Hazard Classes

Radiation Hazard Class	Criteria for Classifying Radioactive Waste into Radiation Hazard Classes							
	Radioactive Waste Category	Gamma Dose Rate at a Distance of 0.1 m from the Surface of Radioactive Waste, mSv/h	Surface Radioactive Contamination Level, particles/(cm²·min)		Specific Activity, Bq/g			
			Beta-emitting Radionuclides	Alpha-emitting Radionuclides	Tritium*	Beta-emitting Radionuclides (excluding tritium)	Alpha-emitting Radionuclides (excluding transuranic radionuclides)	Transuranic Radionuclides
Solid Radioactive Waste								
I	High-Level	> 10	$> 10^7$	$> 10^6$	$> 10^7$	$> 10^7$	$> 10^6$	$> 10^5$
II	Intermediate-Level	0.3 – 10	$10^4 – 10^7$	$10^3 – 10^6$	$10^8 – 10^{11}$	$10^4 – 10^7$	$10^3 – 10^6$	$10^2 – 10^5$
III	Low-Level	0.03 – 0.3	$10^3 – 10^4$	$10^2 – 10^3$	$10^7 – 10^8$	$10^3 – 10^4$	$10^2 – 10^3$	$10^1 – 10^2$
IV	Very Low-Level	0.001 – 0.03	$500 – 10^3$	$50 – 10^2$	$\leq 10^7$	$\leq 10^3$	$\leq 10^2$	$\leq 10^1$
Liquid Radioactive Waste								
I	High-Level	–	–	–	$> 10^8$	$> 10^7$	$> 10^6$	$> 10^5$
II	Intermediate-Level	–	–	–	$10^4 – 10^8$	$10^3 – 10^7$	$10^2 – 10^6$	$10^1 – 10^5$
III	Low-Level	–	–	–	$\leq 10^4$	$\leq 10^3$	$\leq 10^2$	$\leq 10^1$

* For radioactive waste generated at nuclear energy facilities.

Resolution No. 47 of the Ministry for Emergency Situations of the Republic of Belarus, dated September 28, 2010 [4], establishes the relationship between the radiation hazard class, the half-life of radionuclides, and the applicable disposal method, as shown in Table 4.2.

Table 4.2 – Relationship Between Waste Class and SRW Disposal Method

Radiation Hazard Class	**SRW Category**	**Disposal Method**
Class I	High-Level	Disposal in deep geological formations
Class II	Intermediate-Level	SRW, including solidified LRW, of Radiation Hazard Class II containing radionuclides with a half-life of no more than 31 years, shall be disposed of in near-surface radioactive waste disposal facilities at depths of up to 100 m, without prior storage for decay heat reduction. SRW containing radionuclides with a half-life greater than 31 years shall be disposed of in geological repositories without prior storage for decay heat reduction.
Class III	Low-Level	SRW, including solidified LRW, of Radiation Hazard Class III containing radionuclides with a half-life greater than 31 years, shall be disposed of in near-surface radioactive waste disposal facilities at depths of up to 100 m, without prior storage for decay heat reduction. SRW, including solidified LRW, of Radiation Hazard Class III containing radionuclides with a half-life of no more than 31 years, shall be disposed of in near-surface radioactive waste disposal facilities at ground level, without prior storage for decay heat reduction.
Class IV	Very Low-Level	Shall be disposed of in near-surface radioactive waste disposal facilities at ground level, without prior storage for decay heat reduction [4].

Table 4.3 presents a qualitative overview of the design concepts of various types of near-surface radioactive waste disposal facilities, highlighting their inherent advantages and disadvantages [5].

Table 4.3 – Comparative Characteristics of RWDF Designs

Advantages	Disadvantages
Above-ground	
Relatively low capital expenditures to build an RWDF (compared with sub-surface RWDFs) Less stringent requirements for site geological conditions Simple transportation flow chart for RW package emplacement	Exposure to seasonal temperature fluctuations Large land area required Complex multilayer cover system design Need for cover system maintenance Sensitivity to external impacts (especially during the operational loading period)
Partially In Ground	
Relatively low capital expenditures to build	Shares the same disadvantages as the above-

an RWDF (compared with sub-surface RWDFs) Less stringent requirements for site geological conditions Simple transportation flow chart for RW package emplacement Smaller cover system dimensions compared with above-ground facilities	ground option, plus: - Additional excavation works required - More complex design of gravity drainage systems for disposal cells - Potential flooding due to groundwater-level fluctuations (resulting in additional hydrogeological requirements for the site)
Sub-surface	
Environmental stability Absence of seasonal temperature fluctuations Presence of a natural geological safety barrier Smaller surface land area occupied (for the surface facilities of the disposal site) Capability to accommodate the most hazardous intermediate-level RW containing long-lived and weakly sorbing radionuclides (due to the geological safety barrier)	High capital construction expenditures Specific requirements for site geological conditions Special requirements for hoisting equipment

The information presented on alternative radioactive waste disposal options leads to the following conclusions:

- Regulatory documents of the Republic of Belarus and the IAEA recommendations support the use of near-surface disposal for isolating short-lived intermediate-level, low-level, and very low-level radioactive waste.
- The near-surface disposal option is economically justified and compatible with the engineering and geological conditions for RW disposal in the Republic of Belarus.

4.2 No-Action Alternative

The no-action alternative should be considered as postponing the final disposal of VLLW, LLW, and short-lived ILW to a later date.

This alternative is unacceptable for the following reasons:

1. There is objective necessity to establish a radioactive waste disposal facility to ensure the safe management of very low-level, low-level and intermediate-level RW generated after the commissioning of the nuclear power plant [6]. The storage facility for VLLW, LLW, and ILW at the Belarusian NPP was designed for a 10-year period; therefore, the accumulated radioactive waste will need to be removed from storage taking into account the rate of their formation.
2. In 2019, a comprehensive engineering and radiation survey of the decommissioned and conserved radioactive waste storage facilities operated by Ecores UE was conducted [6].

The survey showed the following:

1. The residual service life of the underground structural components of the first- and second-generation storage facilities ranges from 18 to 27 years. These engineering constructions serve as the primary engineered barrier preventing the release of radionuclides contained in radioactive waste into the environment. The service life of the storage facilities may be extended based on the results of periodic CIRE and safety assessments.
2. The mothballed storage facilities should be decommissioned before the expiration of the service life. Therefore, it is necessary to carry out the retrieval of radioactive waste from these facilities in stages, followed by its processing into forms that meet the acceptance criteria for disposal at a radioactive waste disposal facility.

Thus, in case of postponing the decision regular monitoring of the condition of radioactive waste storage facilities and packages is required to detect degradation processes in time and secure the time needed to implement corrective measures.

However, this method is not rational because, after a certain period, it will still be necessary to empty the radioactive waste storage facilities at the Belarusian NPP and the specialised facilities operated by Ecores UE, properly process and condition the radioactive waste, package and transfer it for final disposal.

4.3 Alternative Site Locations for the Proposed Activity

The safety of an RWDF is ensured primarily through the proper selection of its site. When selecting a site for an RWDF and assessing its suitability, consideration must be given to factors that affect the facility's safety, social acceptability, and economic feasibility in the context of the socio-economic development of the Republic of Belarus.

Site selection is a long-term process that includes the following stages [8]:

- concept development and planning;
- area survey;
- site characterisation;
- site suitability confirmation.

4.3.1 Concept Development and Planning Stage

Section 4.1 provides the justification for selecting near-surface disposal as the preferred option for the final isolation of ILW-SL and LLW-LL and VLLW radioactive waste. This option will be implemented by constructing a near-surface radioactive waste disposal and temporary storage facility in the Republic of Belarus.

The facility is planned for commissioning in 2030, with subsequent expansion as required.

The principal organisational and technical measures required to commission the RWDF within the established timeframe are set out in the *Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility* [9] and include:

- general organisational activities;
- organisation and implementation of the Environmental Impact Assessment (EIA);
- development of the regulatory framework for RWDF construction;
- permitting activities;
- design and construction works;
- human development in radioactive waste management.

The site selection process for the RWDF was carried out in three stages:

Stage 1 – Analysis of available archival materials and unpublished reports on natural and anthropogenic conditions across the territory of the Republic of Belarus. Areas for which the available information indicated the absence of exclusionary or unfavourable factors for RWDF siting were identified (areas within an approximate radius of 30 km were considered). Potential candidate sites were then selected within the preferred areas identified at this stage.

Stage 2 – Reconnaissance survey of the candidate sites to confirm the presence or absence of exclusionary factors. Sites where exclusionary factors were identified during field investigations were either eliminated from further consideration or reclassified as reserve sites.

Stage 3 – Implementation of a comprehensive set of investigations and site characterisation studies at the candidate sites in accordance with the Programme [10], followed by their characterisation, comparative assessment, and selection of alternative sites.

4.3.2 Area Survey Based on Available Unpublished Reports and Archival Data

The Radioactive Waste Management Strategy [11] states: “At the first stage of the siting process, a broad area is considered and screened to identify locations suitable for further investigation against the siting criteria for a radioactive waste disposal facility. These criteria include exclusionary factors and adverse conditions set out in Resolution No. 48 of the Ministry for Emergency Situations” [12].

The objective of this stage is to identify regions within the Republic of Belarus that offer the most favourable conditions for siting an RWDF.

The main tasks for this stage are as follows:

- to analyse available unpublished reports and archival data on natural and anthropogenic factors that may affect the long-term safety of the RWDF throughout the territory of the Republic of Belarus;
- to conduct a comparative assessment of candidate areas based on natural and anthropogenic factors and to identify preferred areas that meet the applicable safety requirements and criteria;
- to minimise the time and financial resources required to identify and justify areas suitable for RWDF siting.

The safety requirements and siting criteria that shall be applied during the evaluation of areas and the selection of a site for a radioactive waste storage or disposal facility are set out in Resolution No. 48 of the Ministry for Emergency Situations and are presented in Table 4.5 below.

Table 4.5 – Safety Requirements and Criteria for the Selection of an Area and Site for an RWDF

No.	Factor / Criterion
	Exclusionary Factors
1	Areas where the siting of a storage or disposal facility is prohibited by laws, including legislation on environmental protection and the sustainable use of natural resources.
2	Sites located directly on active faults or within geodynamical active areas.
3	Sites where the intensity of the maximum credible earthquake exceeds 8 points on the MSK-64 scale.
4	Areas affected by karst or thermokarst processes.
5	Areas subject to disastrous floods or inundation.
6	Areas that may be flooded by a dam-break wave from upstream reservoirs due to the failure of dams upstream of the storage (disposal) facility.
7	Areas exposed to mudflows, snow avalanches, active landslides, or other hazardous slope processes.
8	Slopes with gradients of 15° or steeper.
9	River floodplain terraces and reservoir shores with an abrasion scarp edge migration rate of more than 1 m/year.
10	Areas underlain by structurally or dynamically unstable soils, permafrost non-rock soils, or soils with a deformation modulus below 20 MPa.
11	Mining excavations whose stability cannot be ensured throughout the operational and decommissioning period of a sub-surface storage facility or throughout the closure period of a sub-surface disposal facility.
12	Rock formations in which, in the event of an accident at a sub-surface storage or disposal facility, the stability and integrity of the host rock cannot be maintained.
	Adverse Factors
1	Areas of exploited artesian basins and areas of intensive interaction between groundwater and surface water.

No.	Factor / Criterion
2	Tornado-prone areas and areas exposed to strong winds (hurricanes).
3	Areas containing major mineral deposits that have been explored or where mining activities are being conducted.
4	Areas where the storage (disposal) facility would be located upwind of industrial or residential areas.
5	Sites where the intensity of the maximum credible earthquake is between 6 and 8 points on the MSK-64 scale.
6	Sites where differential tectonic movements have been identified during the Quaternary period, but which are not located on active faults.
7	Fracture zones.
8	For above-ground or ground-level storage (disposal) facilities: sites where groundwater occurs at a depth of less than 3 m below the established grade, provided that the soil layer thickness exceeds 10 m and the filtration coefficient is 10 m/day or greater.
9	For above-ground or ground-level storage (disposal) facilities: areas within thunderstorm cells, i.e. areas where the probability of intense thunderstorm activity is significantly higher than in surrounding areas.
10	Areas containing abandoned mine workings and other underground excavations, except for those suitable for use as a sub-surface storage (disposal) facility.
11	Areas containing facilities (including military facilities) where fires or explosions could release toxic substances or cause other impacts, such as air shock waves, missiles, and secondary fire hazards.
12	Areas with a high probability of externally initiated fires that could endanger a storage (disposal) facility.
13	For sub-surface storage (disposal) facilities: rock masses in which horizontal stresses exceed vertical stresses by a factor of 2.5 or more.
14	Areas where the projected average population density during the operational period of the storage (disposal) facility and the decommissioning period of nuclear material storage facilities, including fresh and spent nuclear fuel storage facilities, exceeds 100 persons/km² within the emergency planning zone for compulsory evacuation.
15	Areas containing social care institutions and healthcare facilities.
16	Areas subject to erosion or flooding.
17	Sites affected by hazardous geological or engineering-geological processes and phenomena, including erosion, subsidence, landslides, weathering, and related processes.
18	A near-surface disposal facility shall not be located on a site exhibiting clear evidence of active surface geological processes (e.g. erosion, subsidence, landslides, or karst development).

At this stage, the following tasks were accomplished:

1. An analysis of archival materials and unpublished reports covering the geological, hydrological, seismological, geophysical, and demographic conditions of the entire territory of the Republic of Belarus was conducted. A total of 472 primary sources on natural and anthropogenic factors were reviewed in accordance with the requirements of the applicable regulatory documents.
2. A comprehensive characterisation of natural and anthropogenic factors across the territory of the Republic of Belarus was conducted. Natural hazards were assessed for events with a recurrence interval of once every 10,000 years. Maps at a scale of 1:500,000 were prepared, showing areas preliminarily excluded and priority areas for the siting of a radioactive waste disposal facility.

3. Based on maps forming GIS layers, a spatial analysis of the territory of the Republic of Belarus was conducted, resulting in the preparation of:
- a hydrological map indicating candidate areas;
- a map of excluded territories and candidate areas prepared by the Scientific and Production Centre for Geology;
- a hydrogeological map showing excluded territories and candidate areas;
- a geological and geophysical map showing excluded territories and candidate areas;
- a geological and geomorphological map showing excluded territories and candidate areas;
- a climatic map indicating areas with unfavourable conditions;
- a general geographic map;
- a seismotectonic map showing excluded territories and candidate areas;
- a geological map showing excluded territories and candidate areas;
- a map describing the anthropogenic characteristics of the territory of the Republic of Belarus.

Based on a comparative cross-analysis of the identified factors, 20 candidate areas were selected.

To ensure the long-term safety of the RWDF, particular attention is paid to hydrological and hydrogeological conditions when selecting a site.

The selection of alternative sites was based on the results of a comprehensive programme of investigations and surveys, including engineering and hydrogeological surveys carried out in 2024 in accordance with the *Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility in the Republic of Belarus*, approved by the Deputy Prime Minister of the Republic of Belarus on September, 29 2023 (No. 33/213-194/392).

The pre-design documentation considers the following alternative sites within the territory of the Republic of Belarus, all of which meet the established site selection criteria:
- Site 1-5 (Khoiniki District, Gomel Region);
- Site 2-1 (Ostrovets District, Grodno Region);
- Site 3-3 (Mstislavl District, Mogilev Region).

List of References

1. IAEA Safety Standards Series No. GSG-1. Classification of Radioactive Waste: General Safety Guide. Vienna, 2014.
2. IAEA Nuclear Energy Series No. NW-T-1.27. Design Principles and Approaches for Radioactive Waste Repositories. Vienna, 2024.
3. Regulations on the Procedure and Criteria for the Classification of Radioactive Waste by Radiological Hazard Class, approved by Resolution No. 497 of the Council of Ministers of the Republic of Belarus, dated August 21, 2020.
4. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 36 dated June5, 2023 On Amendments to Resolution No. 47 “Approval of Nuclear and Radiation Safety Rules and Regulations ‘Safety in Radioactive Waste Management. General Provisions’, dated September 28, 2010”.
5. D.I. Pavlov, V.T. Sorokin, A.S. Barinov, A.V. Dyomin, and D.V. Sychenko, Scientific, Technical and Design Basis for the Development of Near-Surface Disposal Facilities for Low- and Intermediate-Level Radioactive Waste. Radioactive Waste Journal, No. 4 (17), 2021.
6. Technical Report on the Results of the Comprehensive Engineering and Radiation Safety Audit of Conserved and Surplus Radioactive Waste Storage Facilities operated by Ecores

UE. State Atomic Energy Corporation ‘Rosatom’, Nuclear Fuel Cycle Logistics Centre JSC, Moscow, 2019.

7. Seventh National Report of the Republic of Belarus on Compliance with the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. Minsk, 2020.
8. Nuclear and Radiation Safety Rules and Regulations “Radioactive Waste Disposal. Safety Principles, Criteria and Basic Safety Requirements”, approved by Resolution No. 7 of the Ministry for Emergency Situations of the Republic of Belarus, dated January 20, 2012 (as amended by Resolution No. 38 of the Ministry for Emergency Situations of the Republic of Belarus dated June 5, 2018).
9. Plan of Key Organisational Measures for the Construction of a Radioactive Waste Disposal Facility, approved by Deputy Prime Minister of the Republic of Belarus P.A. Parkhomchik, No. 33/213-194, dated September 29, 2023.
10. Construction of a Class 3 and Class 4 Radioactive Waste Disposal Facility and a Long-Term Storage Facility for Class 2 Radioactive Waste. Implementation of a Comprehensive Survey and Research Programme to Substantiate the Preferred Site within Priority Areas. Comprehensive Survey and Research Programme. Belnipienergoprom RUE, Minsk, March 1, 2024.
11. Strategy for Radioactive Waste Management, approved by Resolution No. 128 of the Council of Ministers of the Republic of Belarus, dated February 15, 2023. National Legal Internet Portal of the Republic of Belarus, February 21, 2023, 5/51387.
12. Resolution No. 48 of the Ministry for Emergency Situations of the Republic of Belarus, dated August 18, 2022. Nuclear and Radiation Safety Rules and Regulations “Siting of Nuclear Material Storage Facilities, Radioactive Waste Storage Facilities and Radioactive Waste Disposal Facilities”.

5. ASSESSMENT OF THE CURRENT ENVIRONMENT CONDITIONS

5.1. Atmospheric air including the climate and meteorological conditions

5.1.1. Atmospheric air

Area of location of Site 2-1

The parer considers Site 2-1, which is located in the Ostovets district, in close proximity to the Belarusian NPP (~ 7 km) on the left bank of the Vilia River.

According to the data of the Grodno Regional Centre for Hydrometeorology and Environment Monitoring Branch Office of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, the background concentrations of pollutants in the atmospheric air at the Aveny Village of the Ostrovets District of the Grodno Region as of June 2025 are below the specified maximum allowable concentration (MAC).

In the district under review, the atmospheric air monitoring is carried out within the framework assurance of the safe functioning of the Belarusian NPP at the operation stage. The observations of the atmospheric air conditions are carried out according to the following indices: solid particles (undifferentiated dust/aerosol), sulphur dioxide, carbon monoxide, nitrogen dioxide and ammonia. Additionally, meteorological parameters (air temperature, atmospheric pressure, relative humidity, wind speed and direction) and weather conditions are measured. The observations are carried out in a discrete mode 4-5 times a month from March-April to September-October. Every year, 32 measurements are performed. No exceeding of the specified specified MAC is observed.

According to the State Atmospheric Air Cadastre, an increase in emissions of pollutants into the atmosphere from stationary sources of emissions is observed in the Ostrovets District that indicates the development of the industrial sector. The contribution of the Ostrovets district to the emissions of hydrocarbons from stationary sources in the Grodno Region increased from 0.5% (2019-2020) to 3.2% (2023) [1].

Area of location of Site 3-3

The paper considers Site 3-3, which is located in the Mstislavl district of the Mogilev Region.

According to the data of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, the background concentrations of pollutants in the atmospheric air at the Volovniki Village of the Mstislavl District of the Mogilev Region as of January 2026 are below the specified maximum allowable concentrations.

The analysis of atmospheric air sampling data in December 2025 [2] showed that the actual concentrations of pollutants did not exceed the maximum occasional allowable concentration, but the concentrations of some substances exceeded the background values.

The contribution of the Mstislavsl district to the emissions of pollutants from stationary sources in the Mogilev region during the period under review ranged from 0.1% (2019) to 2.9% (2022).

Area of location of Site 1-5

The paper considers Site 1-5, which is located in the south-eastern part of Belarus in the territory of the Khoiniki district of the Gomel Region near the Polessky State Radiation and Ecological Reserve.

According to the data of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, the background concentrations of pollutants in the atmospheric air at the Novoselki Settlement of the Khoiniki District of the Gomel Region as of January 2026 are below the specified maximum allowable concentrations.

The analysis of atmospheric air sampling data in February 2026 showed that the actual concentrations of pollutants did not exceed the maximum occasional allowable concentration, but the concentrations of some substances exceeded the background values. In general, the state of atmospheric air near the Novoselki Settlement of the Khoiniki district of the Gomel region complies with the accepted standards: no exceeding of the maximum occasional allowable concentration [3] were recorded.

According to the information of the State Atmospheric Air Cadastre for the period 2018-2022 in the Khoiniki district, the maximum amount of carbon dioxide emissions into the atmospheric air was observed in 2018 (about 1.71 thousand tons).

5.1.2. Climatic conditions

Area of location of Site 2-1

At the area of Site 2-1 (Grodno Region), three representative meteorological stations under the jurisdiction of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection were selected taking into account their location, scope of observations and duration of the series of observed characteristics:

– Vileika Meteorological Station (54.5° N, 26.9° E);

– Lyntupy Meteorological Station (55.1° N, 26.3° E);

– Oshmyany Meteorological Station (54.4° N, 25.9° E).

For a more complete consideration of the climatic conditions, the data on the Vilnius meteorological station received in the international exchange were used:

– Vilnius Meteorological Station (54.6° N, 25.1° E).

The assessment of the climatic parameters according to data of the Vilnius Meteorological Station is presented based on available data.

The selected stations are located in similar climatic conditions and fully reflect the regional climate features in the Ostrovets district.

The climate of the region is characterised as temperate continental with pronounced seasonality. A high spatial uniformity of average annual and seasonal temperatures has been established, but a stable thermal gradient has been revealed: the north-western part (Lyntupy) is cooler, especially in summer, compared with the central part (Vileyka, Oshmyany).

The annual temperature range of air (about 23-24°C) and soil (about 26-28°C) confirms the significant continentality of the climate. The extreme temperature indices (absolute minima and maxima) show great spatial variability, indicating local factors affecting the intensity of frost and heat.

The dates of stable seasonal transitions are as follows: the autumn temperature transition from 0°C downward occurs on average on November 21-24, and the spring one on March 21-25. The average duration of the cold period with stable negative temperatures is about 120 days.

The seasonal course of atmospheric precipitation with a summer maximum (July) and a winter minimum (February-March) has been revealed. The precipitation regime is characterised by a high frequency of days with low to moderate precipitation and rare, but potentially extreme downpours (up to 70-100 mm/day). The snow cover persists for an average of 104-114 days with an average height of 24 cm. The absolute maxima of snow height are 52-72 cm and those of the water reserve in snow are 132-195 mm.

The wind regime is characterised by stable seasonal dynamics and the predominance of winds in the western and southern quarters, reflecting the dominance of western air mass transport. The cold season is more windy.

The wind speed at an altitude of 10 meters has a pronounced annual course. The wind speed in summer is lower than that in winter, its values in the warm season in the area of Site 2-1 vary between 2.0 and 2.6 m/s, in the cold season the average wind speed increases to 3 m/s.

The repeatability of wind directions is determined by the predominance of westerly air mass transport. In winter, the prevailing wind direction is south–westerly (45-50%), the frequency of south-easterly winds is noticeably lower (15-20%), the total frequency of easterly and north-easterly directions is estimated to be 15-20%. In summer, the winds of the north-west and west directions prevail (about 50%); the frequency of winds of the eastern quarter is about 30%.

The wind speed is stable at an altitude of 100 m: it is 1.7-1.9 m/s in the cold season (winter and autumn) and 1.0-1.2 m/s in the warm one (spring in summer). As the altitude increases and the influence of the underlying surface decreases, the wind speed increases gradually and reaches 3.3-3.5 m/s at an altitude of 300 m in winter and autumn, and 2.0-2.2 m/s in spring and summer. Further, the wind speed at an altitude of 500 m increases to 4.4-4.9 m/s in the cold season and to 2.7-2.9 m/s in the warm one. As the altitude exceeds 700 m, the wind speed increases and then changes slightly while varying within about 4.9-5.8 m/s in winter and autumn, and within 3.0-3.5 m/s in spring and summer.

Figure 5.1 shows the average annual wind rose in the area of the site under review.

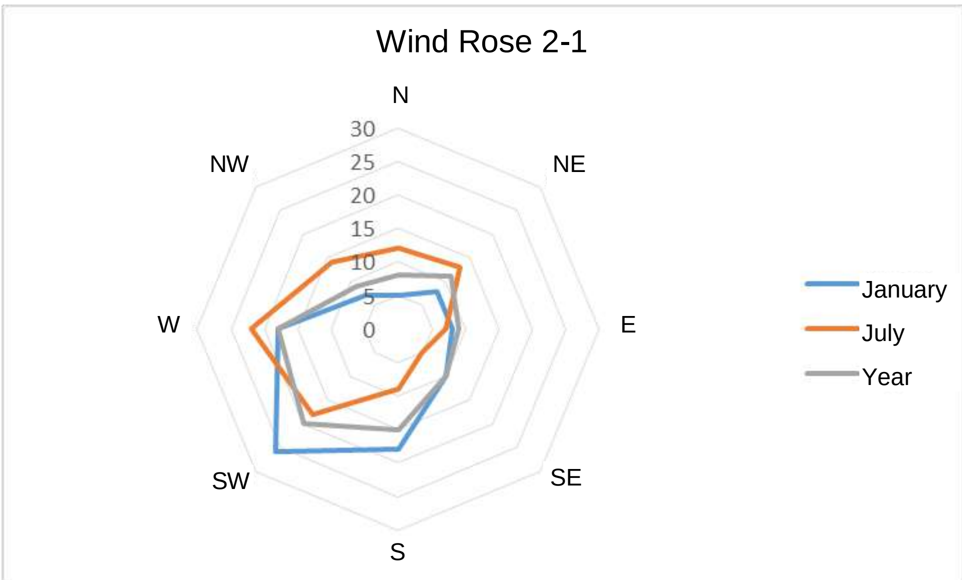


Figure 5.1. – Average annual wind rose

The thermal regime of the atmosphere is characterised by the following values. In the area of Site 2-1, the average air temperature for the winter season at 100 m is 2.5°C and decreases with increasing of the altitude down to minus 3.6°C at an altitude of 300 m and minus 4.1°C at an altitude of 500 m; then the gradient decreases significantly and the temperature at an altitude of above 700 m in winter is minus 4.3-4.5°C. In spring and autumn, the air temperature has comparable values; at a level of 100 m its seasonal values vary between 7.9 and 8.1°C, at an altitude of 300 m – between 6.8 and 7.0°C and at an altitude of 500 m – between about 5.5 and 5.9°C. Above 700 m, the gradient increases and the air temperature decreases faster, dropping to 4.0°C at altitudes of 700 m and 2.6°C at altitudes of 900 m. In autumn, the gradient is more stable; at similar altitudes, the air temperature ranges from 4.1 to 5.0°C. In summer, the air temperature naturally decreases from 18.6 °C at an altitude of 100 m to 17.3 °C at an altitude of 300 m and further to 15.8°C at an altitude of 500 m, 14.2°C at an altitude of 700 m and 12.6°C at an altitude of 900 m.

Disruption of the temperature distribution with altitude causes the formation of inversion layers, which are of great ecological importance, since they determine the conditions for the dispersion of pollutants.

In the area of Site 2-1, the **raised and ground inversions** are recorded.

Raised inversions are 3 times more common than ground inversions (68.8% and 22.8%, respectively). The raised inversions are most often formed in winter under the anticyclone conditions (clear, windless weather). Their repeatability in winter relative to the total number of observations is 80.2%; in the transitional seasons (spring and autumn) the raised inversions are noted in 66.6% and 73.3% of cases, respectively; in summer their number is smallest, 55% on average per season.

Ground inversions have an inverse intra-annual distribution. The ground inversions is observed prevalently in summer – in 30% of the total number of observations; in the transitional seasons, they are 26.5% in spring, 21.9% in autumn and 12.7% in winter.

The differences in thickness of the ground inversions and raised ones are not large, the annual difference is 3 m (191 and 194 m, respectively). Seasonally, the thickness varies in ground inversions; it has the highest value being 190 m in summer and autumn; in winter the thickness is about 181 m. The thickness of the raised inversions varies little throughout the year, and ranges from 193 to 196 m seasonally.

The intensity of ground inversions in the cold season is 3.2-3.6°C and in raised ones – 2.0-2.1°C. In summer, the intensity is one-third lower and is estimated to be 2.1°C in the ground inversions and 1.6°C in the raised ones.

Throughout the year, the atmospheric stability classes B, C, and D prevail, which are favourable for the dispersion of impurities and account for about 83% of the total number of cases, with the highest values occurring in autumn and winter at about 86% each. The recurrence rates of unfavourable stability classes (E and F) are no more than 12% for the seasons of the year, and the maximum is in the summer period – about 7% per year, and the minimum is noted in winter – about 4%.

Area of location of Site 3-3

At the area of Site 3-3 (Mogilyov Region), three representative meteorological stations under the jurisdiction of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection were selected taking into account their location, scope of observations and duration of the series of observed characteristics:

– Gorki Meteorological Station (54.3° N, 30.94° E);
– Slavgorod Meteorological Station (53.5° N, 31.0° E);
– Mstislavl Meteorological Station (53.41° N, 27.33° E).

The selected stations are located in similar climatic conditions and fully reflect the regional climate features in the area of Site 3-3.

The wind regime is characterised by seasonal speed variability and clear vertical gradient. The maximum speeds observed in winter are from 2 m/s at the surface to 5.3 m/s at an altitude of 950 m. In summer, the speeds are minimal: from 1.1 m/s to 2.9 m/s at the same levels. At the same time, the relative increase of the wind with altitude remains almost constant throughout the year. The most intense increase of the speed occurs in the ground layer of 0-310 m (in winter, the increase is 1.5 m/s), while in the layer of 730-950 m, the gradient decreases sharply (in winter, the increase is only 0.2 m/s).

The prevailing wind directions change with altitude and seasonally that indicates the effect of wind turning with altitude. Near the surface, the southern and western points have significant repeatability in different seasons. As the altitude increases, frequency of western and south-western directions increases too. In winter, the westerly wind (WSW) dominates at an altitude of 900 m, with the frequency of 40% and speed of 8 m/s. In summer, westerly directions also prevail at the same altitudes (28%), but with significantly lower speeds (4 m/s).

Figure 5.2 shows the average annual wind rose in the area of the site under review.

Figure 5.2. – Average annual wind rose

The temperature regime is characterised by a significant seasonal amplitude at the surface being 22.5°C (from minus 3.1°C in winter to 19.4°C in summer), which smooths out with altitude; the amplitude at 950 m is 18.2°C. The magnitude of the vertical temperature gradient between 0 and 950 m depends strongly on the season. The maximum values close to the standard adiabatic gradient are observed in summer at minus 0.64°C/100 m and in spring at minus 0.56°C/100 m. In winter, the gradient is slightly negative (minus 0.18°C/100 m), which indicates the conditions close to isothermic behaviour and frequent occurrence of inversions.

The regime of temperature inversions has a pronounced seasonal dynamics. Ground inversions are most frequent in summer, their frequency is 46.9%; they are most intense in spring and summer. Their maximum average thickness is also 210.5 m in summer. On the contrary, the maximum raised inversions occur in winter: the repeatability is 43%, the intensity is 1.9°C and the thickness is power 380.5 m. Their minimum values are observed in summer, their frequency is 5.4% and the intensity is 0.7°C. The average annual frequency of the ground inversions is about 33% that is higher than that for raised inversions (22.6%); however, the average thickness of raised inversions (320 m) is more than 1.7 times larger than that of ground ones (187 m).

the neutral stratification (class D) prevails on average for a year (55%). Stable conditions (classes E+F) are in second place in terms of repeatability (18.7%) that creates a regular risk for the accumulation of pollutants. The seasonal distribution is contrasting: in winter, the neutral class D is absolutely dominant (74.7%), while in summer the recurrence of the most stable, dangerous class F (22.3%), associated with nighttime radiation inversions, reaches its maximum despite the high proportion of unstable classes (A+B+C = 32.2%).

The area of site 3-3 is characterized by a temperate continental climate with pronounced spatial differentiation of the main meteorological elements in the direction from south-west to north-east, which is manifested in an increase in continentality and severity of conditions. The average annual air temperature varies from 5.1°C (Gorki MS) to 7.0°C (Mstislavl MS) that forms a thermal gradient of 1.9°C. The differences in the average temperature of the coldest month (January) are also 1.9°C (from minus 7.7°C to minus 5.8°C), and the warmest (July) is 1.3°C (from 17.8°C to 19.1°C). The absolute annual temperature amplitude as a key index of continentality, increases sharply towards the north-east: from 68.7°C in Mstislavl to 78.2°C in Gorki. The duration of the period with an average daily temperature below 0°C varies from 111 days in the south-west to 133 days in the north-east, and the average number of days with a thaw over the winter (December-February) ranges from 39 to 31, respectively. The average annual soil surface temperature maintains a similar gradient: from 8.6°C to 6.4°C, with extreme summer surface heating above 50°C and winter cooling to minus 41°C. The typical depth of soil freezing in the eastern part of the region is about 60 cm, with extreme values up to 140-150 cm.

The humidification regime is characterised by average annual precipitation amounts from 631 mm to 708 mm with an increase to the north. The annual course has a summer maximum (July, 84.6–87.6 mm) and a winter minimum (February, 33-43 mm). The absolute monthly maximum reached 274.6 mm, and the daily maximum – 97 mm. The average number of days with precipitation of more than 0.1 mm is 158-174, while the days with precipitation of more than 10 mm are observed 15-20 times a year. The relative humidity has an annual minimum of 65-74% in spring and a maximum of 86-91% in winter, and the absolute moisture content (partial pressure of water vapour) in summer (15.2–16.1 hPa) is 3.5–4 times higher than that in winter (3.6–4.8 hPa).

The wind regime is characterised by significant spatial heterogeneity: the average annual speed varies from 2.5 m/s to 3.8 m/s (the regional average is 3.2 m/s). The seasonal course is clearly marked with a winter maximum (3.4–4.5 m/s) and summer minimum (2.0–2.9 m/s). The absolute maxima of the wind speed reach 24-26 m/s, and gusts – 30-32 m/s. During the cold season, southerly winds prevail (the total frequency is 51-54%), in summer, the westerly and north-westerly convection increases (31-36%).

Atmospheric phenomena have a moderate frequency: fogs are observed 48-54 days a year (duration 250-270 hours), thunderstorms – 26-29 days, ice – 11-14 days during the cold period, snowstorms - 3-5 days (with extremes up to 20-28 days). Hail and dust storms are extremely rare (less than 1.4 days per year).

Area of location of Site 1-5

At the area of Site 1-5 (Gomel Region), three representative meteorological stations under the jurisdiction of the Republican Centre for Hydrometeorology, Radioactive Contamination Control and Environmental Monitoring State Institution of the Ministry of Natural Resources and Environmental Protection were selected taking into account their location, scope of observations and duration of the series of observed characteristics:

– Mozyr Meteorological Station (52.0° N, 29.2° E);

– Vasilevichi Meteorological Station (52.3° N, 29.6° E);

– Bragin Meteorological Station (51.8° N, 30.3° E);

The selected stations are located in similar climatic conditions and fully reflect the regional climate features in the area of Site 1-5.

Based on the results of the performed analysis of the vertical structure and seasonal variability of meteorological parameters (wind speed and direction, air temperature, inversion characteristics and atmospheric stability classes) for the area of site 1-5 for the period 2000-2025, the following was ascertained. According to the data of the three meteorological stations, the surface layer is characterised by an annual average wind speed with the maximum in winter and spring and the minimum in summer. In January–February, the average speeds reach the highest values of 2.9–3.6 m/s. The minimum average speeds are observed in July–August (2.0–2.4 m/s). The absolute maximum wind speed for the entire observation period reached 20-26 m/s, and the wind gusts associated with convective phenomena (squalls) can reach 34 m/s. The estimated maximum wind speed with a probability of exceeding 0.01% (once every 10,000 years) varies from 34 to 51 m/s.

In winter and autumn, winds from the southern quarter and the western direction prevail, their total share is 45-49%, which is typical for Atlantic cyclones bringing warm and humid air. In spring, the circulation is rearranged and the frequency of the northern, north-eastern and eastern points increases to 21-38%. In summer, westerly and north-westerly winds reach their maximum development by up to 38%, which is caused by the predominance of westerly transport with weakened barometric gradients and the development of convective processes.

There is a pronounced seasonal variability at all altitudes from 100 to 900 m. Maximum speeds are observed in winter (up to 5.1–8 m/s at an altitude of 900 m), minimum speeds – in summer (up to 2.8–5 m/s at 900 m), and transitional values – in autumn and spring. The vertical velocity gradient is also subject to seasonal fluctuations.

The vertical distribution of wind directions follows patterns as well. In the lower layer, up to 300-400 m, southern and even south-eastern rhumbs can be observed, especially in spring and summer. Above 400-500 m, the wind adjusts and westerly and south-westerly directions begin to prevail at all levels. In winter, the predominance of western and south-western convection can be traced from a height of 100 m and increases with an increase to 60-64% at altitudes of 490-690 m. In summer, the lower levels show a noticeable proportion of north-westerly winds caused by cool air intrusion, but the upper levels are again dominated by the western component. In autumn, the winter regime is restored with a rapid increase in the frequency and speed of westerly and south-westerly winds.

There is significant variability in the wind regime throughout the year, with a predominance of westerly and south-westerly winds during the cold season and an increase in the role of north-westerly and westerly points during the warm season.

Figure 5.3 shows the average annual wind rose in the area of the site under review.

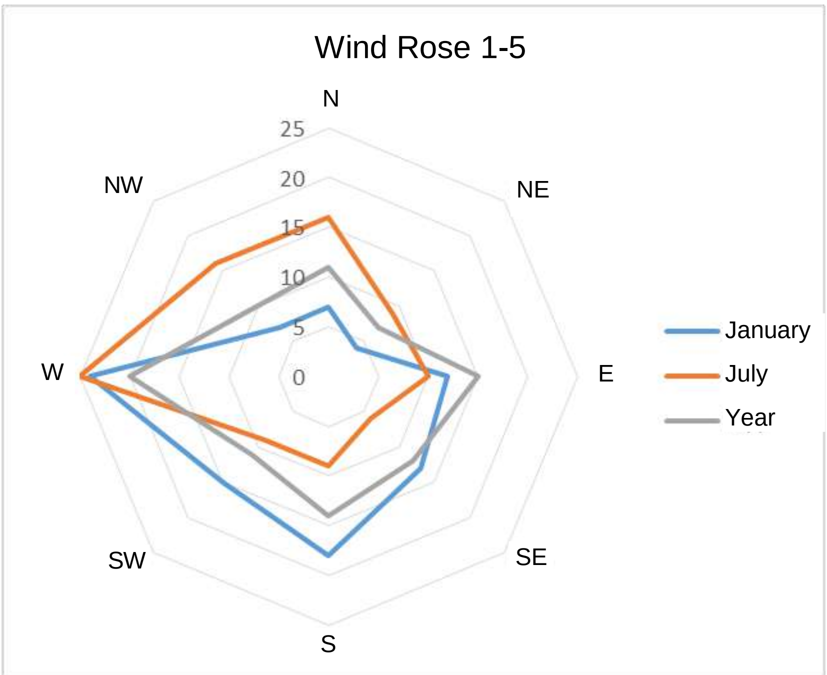


Figure 5.3. – **Average annual wind rose**

The analysis of vertical profiles of the air temperature revealed the characteristic patterns of the thermal regime in the atmospheric boundary layer of the area of site 1-5. For all seasons of the year, there is a decrease in temperature with altitude corresponding to tropospheric conditions; however, the intensity of this drop and the absolute values of temperatures vary significantly depending on the season. The winter profile is flattest, the air temperature decreases slightly – from minus 3.1°C at an altitude of 100 m to minus 4.7°C at an altitude of 900 m, and the vertical gradient is lowest in the annual cycle and is about 0.2°C per 100 m of elevation. In spring, active warming of the underlying surface begins, and the profile changes dramatically. At the lower level of 100 m, the temperature reaches +8.8°C, at an altitude of 900 m it remains low (+3.5°C), and the temperature difference between the lower and upper levels is 5.3°C. The summer profile is characterised by maximum heating of the entire air column: at an altitude of 100 m, the temperature reaches +20.1°C, at 900 m it is +14.1°C, and the vertical gradient remains significant, with a difference of 6°C. In autumn, temperatures naturally decrease compared to summer, at the ground it is +8.4°C, at an altitude of 900 m it is +4.4°C, and the gradient is estimated to be 4.0°C at 800 m, which is less than that in summer, but higher than that in winter. The earth's surface cools faster than the high layers of air, but radiation cooling has not yet reached its maximum, and this profile is typical for the period of transition to the winter regime.

The frequency of ground inversions is distributed relatively evenly throughout the year with small fluctuations. In winter, it is 22%, in spring it increases to 24%, in summer it remains at the same level of 24%, and in autumn it reaches a maximum value of 26% with the average annual frequency of 24%.

The reverse distribution is typical for raised inversions: the maximum frequency is 61% in winter, which is more than twice the summer values. In spring, the frequency decreases to 33%, in summer it reaches a minimum of 21%, in autumn it increases again to 50%, and the average annual frequency is 41%.

The maximum thickness of ground inversions is observed in winter and reaches 510 m. In spring, the thickness is sharply reduced to 310 m, in summer it reaches a minimum of 280 m, in autumn it rises again to 320 m, and the average annual thickness is 360 m. The raised inversions are characterised by different seasonal dynamics. In winter, their thickness also reaches the maximum of 470 m, in spring it decreases to 320 m, in summer a minimum of 260 m is reached, in autumn it increases to 380 m, and the average annual thickness, like that of ground inversions, is 360 m.

The intensity of ground inversions reaches a maximum of 4°C in winter due to strong cooling of the underlying surface and presence of the snow cover, decreases to 3°C in spring, reaches a minimum of 2.6°C in summer, increases again to 2.8°C in autumn, and its annual value is 3.4°C. The intensity of raised inversions is also characterised by a winter maximum of 3.2°C, due to advective processes and air subsidence in anticyclones; in spring it decreases to 1.7°C, in summer it reaches a minimum of 1.1°C, and in autumn it increases to 2°C.

The analysis of the stability classes of the atmosphere has shown that in winter there is a predominance of stable conditions. The total share of classes E (weakly stable) and F (moderately stable) reaches 83.5%, while class E makes up the vast majority (78.4%), which is associated with long nights, low influx of solar radiation and snow cover. The neutral class D occurs in 10.7% of cases in winter and unstable classes are practically not represented (about 5.9% in total). In spring, the share of unstable classes increases to 11.3% due to an increase in the height of the sun and warming of the underlying surface, the share of stable classes decreases (E – 53.5%, F – 26.8%), but their total contribution remains high, 80.3% due to the persistence of nocturnal inversions. The summer season is characterised by the maximum development of instability; the sum of classes A, B and C reaches 13.4%, while class A (highly unstable) has the highest annual frequency of 4.1% due to intensive warming and active thermal convection during the daytime. At the same time, in summer there is a high proportion of class F – 35.1%, the maximum for the year, which is explained by frequent clear nights with effective radiation, leading to the formation of intense ground inversions at night and in the morning. In autumn, there is a reverse transition to the winter regime, the instability weakens, the sum of classes A, B, C is 5.5% with the minimum class A for the year being 0.8%, and the share of class E increases to 67.3%, approaching the winter values. In the annual distribution of stability, the predominant class is E (60.8%), the second major is class F (21.9%), the neutral stratification is class D (8.5%) and the sum of unstable classes is only 9.6%.

The average annual air temperature is 6.9°C, the coldest month is January with the average temperature of minus 5.7°C, and the warmest is July with the temperature of +18.8°C. The winter period is characterised by a stable temperature below 0°C, but December is noticeably warmer than January and February. The summer season is warm, with average temperatures above +17°C. During the mid-seasons, there is a gradual change in temperature, in spring there is an intensive increase from minus 0.1°C in March to +14.1°C in May, and in autumn there is a gradual decrease from +12.8°C in September to +1.2°C in November. The frost-free period with stable average temperatures above 0°C lasts from April to October. The average daily temperature range widens from 6°C in winter to 11.5°C in summer that reflects the increased role of radiation factors in the warm period with fine weather. The absolute maximum of air temperature is 36.5–38.1°C, the absolute minimum varies from minus 37.0 to minus 35.0°C.

The temperature regime of the soil surface differs from the air regime by a higher annual amplitude. The average monthly temperature of the coldest month (January) is minus 6.1°C and that of the warmest one (July) is +23.0°C, which corresponds to the annual amplitude of 29.1°C. The average annual temperature of the soil varies from +7.9 to +8.6°C, which exceeds the air temperature by about 1–1.7°C. The absolute maximum temperature of the soil reaches +60.3°C and occurs in the summer months, when the surface can warm up to 55-60°C in direct sunlight. In winter, the average minimum soil temperature drops to minus 10.5... minus 10.1°C, and the absolute minimum reached minus 42...minus 37°C. The average maximum freezing depth during the winter is 51–62 cm, and the absolute maximum depth can reach 104–150 cm.

The humidification regime of the territory is characterised by a summer maximum and winter minimum of precipitation. The lowest precipitation is observed in February (33 mm) and January (35 mm) that is caused by the predominance of anticyclonic weather and low moisture content of cold air. A gradual increase begins in March, and a sharp increase occurs in May–June, with the largest amount in July (86 mm). The summer maximum is caused by the development of convective activity and passage of atmospheric fronts accompanied by heavy rainfall. The average annual precipitation in the region is 613 mm. The average precipitation intensity ranges from 0.74 to 0.77 mm/min, but the values can reach 2.22 and 1.69 mm/min, which corresponds to very heavy downpours. In terms of phase composition, the liquid precipitation prevails: about 53% of the precipitation time, the solid precipitation makes up 39% and the mixed precipitation makes up 8%.

The snow cover is characterised by an average maximum height of 52-57 cm and a duration of 84-88 days, which corresponds to the period from early December to late February – early March. In the snowiest winters, the duration of occurrence can increase to 88-97 days.

The humidity of the air has an annual course with a maximum in the cold period and a minimum in the warm period. The highest relative humidity is observed in November–January at 85-88% and is caused by low temperatures, which bring the partial pressure of water vapour closer to saturation. The minimum relative humidity is 66% in May. The average annual relative humidity is 77%. The partial pressure of water vapour changes synchronously with the air temperature. The minimum values were recorded in January–February – 3.9 hPa, the maximum – in July - 15.1 hPa, the annual amplitude is 11.2 hPa, the average annual value is 8.7 hPa.

The total annual evaporation is 523 mm, which corresponds to 85% of the annual precipitation of 613 mm. The remainder forms the total runoff and infiltration. The river runoff being an integral index of the interaction of precipitation, evaporation, and groundwater supply is characterised by a pronounced spring flood with a maximum average monthly flow rate of 980 m^3/s in March and a low-water level in summer and autumn period with a minimum of 217 m^3/s in August.

5.2 Surface water bodies and subsoil water

5.2.1. Surface water bodies

The distance of the sites under consideration to watercourses and water bodies of potentially transboundary importance is shown in Table 5.1.

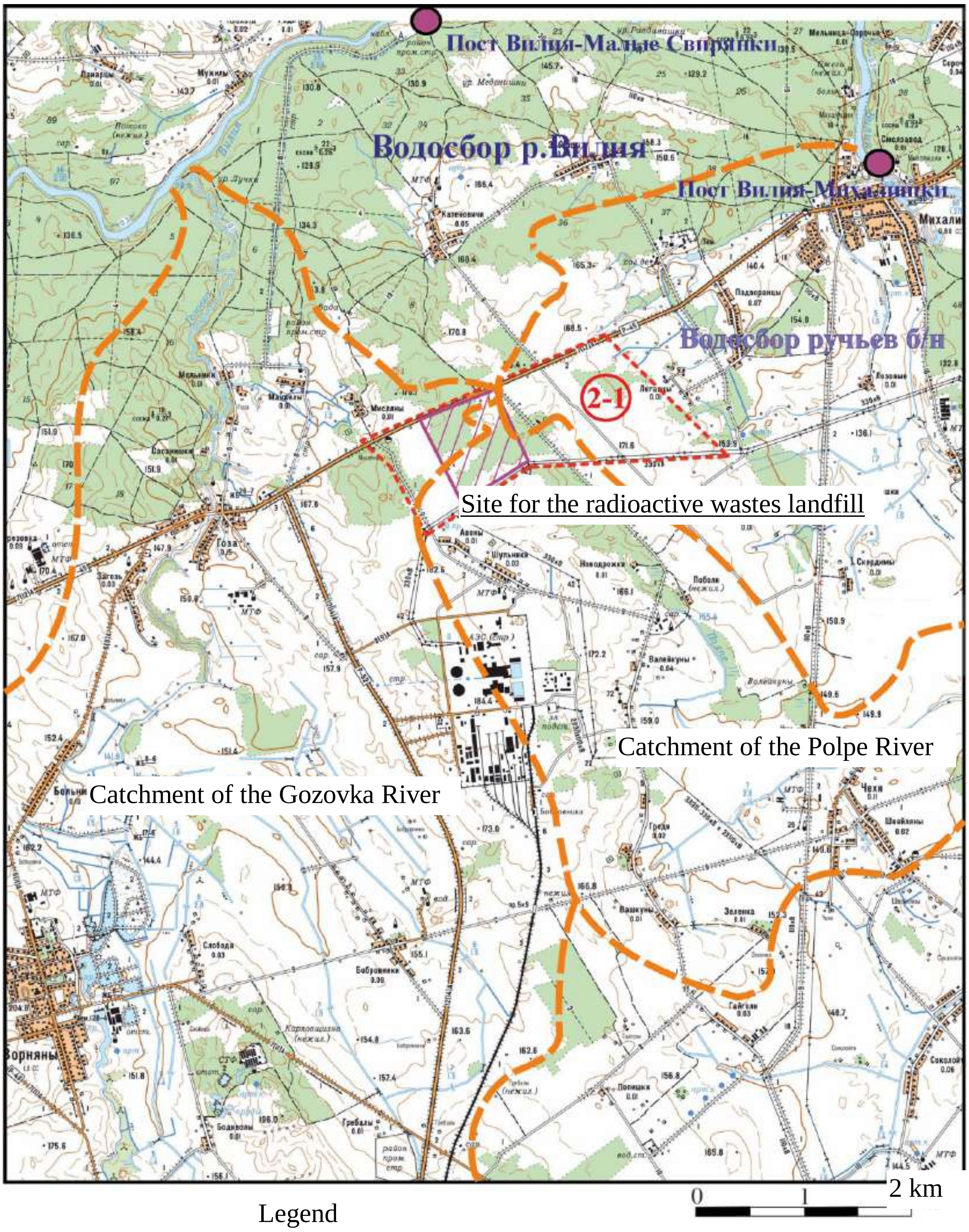
Table 5.1 – Distance from the sites under consideration to watercourses and water bodies of potentially transboundary importance

Neighbouring states	Linear distance from the site to the neighbouring state frontier along the transboundary water bodies	Name of the transboundary water body	distance from the site to the neighbouring state frontier along the channel of the bater body	Assessment of the transboundary conditions	
				Existence of the transboundary aspect***	Existence of the transboundary impact
Site No.1-5, Khoiniki District					
Ukraine	40 km	Pripyat River	71 km	officially exists	none
Russia	57 km	Dnieper River	-*	officially exists	none
Poland	425 km	Western Bug River	--**	officially exists	none
Lithuania	374 km	Vilia River	–	officially exists	none
Latvia	462 km	Western Dvina River	–	officially exists	none
Site No.2-1, Ostrovets District					
Ukraine	328 km	Dnieper River	–	officially exists	none
Russia	306 km	Lovat River	–	officially exists	none
Poland	252 km	Narev River	–	officially exists	none
Lithuania	20 km	Vilia River	25 km	officially exists	none
Latvia	145 km	Western Dvina River	–	officially exists	none
Site No.3-3, Mstislavl District					
Ukraine	205 km	Sozh River	434 km	officially exists	none
Russia	21 km	Sozh River	–	officially exists	none
Poland	524 km	Narev River	–	officially exists	none
Lithuania	387 km	Vilia River	–	officially exists	none
Latvia	325 km	Western Dvina River	–	officially exists	none

Note:
* - the neighbouring state is situated upstream the watercourse of the transboundary water body;
** - absence of communication with the transboundary water body via hydrographic network;
*** - aspect in connection of the existence of a transboundary water body.

Area of location of Site 2-1

There are no surface water bodies within the boundaries of Alternative Site 2-1, but the territories adjacent to the site are the catchment areas of the basins of the following surface water bodies: the Vilia River, its left tributaries. The Gozovka River and the Polpe River as well as unnamed streams whose outlets and runoff hollows are concentrated to the north, west, and east of the site. Alternative Site 2-1 in relation to water bodies is located at the junction of their watersheds, at a distance of 8-10 km from the channel of the Vilia River and 2.0-2.5 km from the channels of the Gozovka and Polpe rivers (Figure 5.4).



Legend

Location of the hydrological post of the NSEM

Alternative Site boundary and number

Boundaries of catchments of surface water bodies

Location of the radioactive wastes landfill site

Figure 5.4 – **Schematic map of the situational location of the Alternative Site 2-1**

The characteristics of water quality in the Vilia River at the river stations of the posts are presented by summarising the surface runoff monitoring data by the National System for Environmental Monitoring for the period 2020-2024 is shown in Table 5.2.

Table 5.2 – Water quality characteristic in the Vilia River according to the hydrochemical indices (data of the National System for Environmental Monitoring for 2020-2024)

Index	Vilia River, Vilia-Mikhalishki River Station		
	average	max	min
Suspended substances, mg/dm^3	6.32	17.6	1.2
Total iron, mg/dm^3	0.190	0.242	<0.03
Copper, mg/dm^3	0.002	0.0018	<0.001
Zinc, mg/dm^3	0.0083	0.013	<0.005
Phosphate ion, mg/dm^3	0.038	0.041	0.0254
Ammonium ion, mgN/dm^3	0.08	0.1	0.056
Nitrate ion, mgN/dm^3	2.67	7.8	0.1
Nitrite ion, mgN/dm^3	0.015	0.017	0.014
Petroleum products, mg/dm^3	0.084	0.016	0.001
Synthetic surfactants$_{anion}$, mg/dm^3	0.01525	0.05	<0.0025
Dissolved oxygen, mgO_2/dm^3	10.58	11.3	10.5
Biological oxygen demand in 5 days, mgO_2/dm^3	3.168	4.2	2.4
Chemical oxygen demand$_{Cr}$, mgO_2/dm^3	31.55	33.18	26.2

The ecological status of the Vilia River is currently classified as good, because the water in the Vilia River is characterised as water of second-class quality according to hydrobiological and hydrochemical indices (according to the materials of the National System for Environmental Monitoring).

As regards its chemistry, the water in the Vilia River is fresh and related to the bicarbonate-calcium type. The content of the main hydrochemical indices of the water composition in the Vilia River is seasonally characterised by the following concentrations: calcium – 53-64 mg/dm^3, magnesium – 2-35 mg/dm^3, bicarbonate ion - 183-224 mg/dm^3, sulphate ion – 18.9-30.0 mg/dm^3 and chloride ion – 10-16 mg/dm^3.

The reaction of water in the Vilia River basin has actual values of the hydrogen index pH = 6.8-8.5 and is characterised as neutral to slightly alkaline. The water is colourless, low turbidity, which indicates the absence of natural colloidal impurities (from peat, silt, humic and other organic substances that determine the turbidity of water). The amount of suspended solids in the water of the Vilia River and its tributaries, depending on the season, ranges from 1.2 to 17.6 mg/dm^3.

The surface waters in the Vilia River basin are not aggressive. Based on the values of the redox potential Eh > + (250-350), the water in the river is characterised by weakly oxidising conditions. The gas and oxygen regime of the water remains satisfactory throughout the year. The average annual dissolved oxygen content varies from 5.3 to 11.9 mg O_2/dm^3. Based on the presence of small concentrations of biogenic substances (nitrite ion, ammonium ion), the content of other gases being characteristic of natural waters (carbon dioxide, nitrogen) is lowest and does not exceed the limits of natural solubility of 10-13 mg/dm^3 for nitrogen and 3-4 mg/dm^3 for carbon dioxide. Hydrogen sulphide is not detected in the river water. The river water density corresponds to the standard physical parameters: about 1,000 kg/m^3 at a temperature of about 4°C.

The maximum water temperature for the month of July is 28.3°C, the average water temperature for July-August is about 24.2°C. The minimum water temperature for December-January is 0 to +1.1°C. The average annual water temperature in the Vilia River and its tributaries is 11.6°C.

The content of specific pollutants according to hydrochemical indices in the bottom sediments of the Vilia River for the period of research did not exceed the threshold values established by Environmental Rules and Regulations 17.01.06-001.

The radiation monitoring of surface waters in the Vilia River basin is carried out using the transboundary measuring point of the National System for Environmental Monitoring at the Vilia River near the Bystritsa Village in the area of the Belarusian NPP. According to the materials of the National System for Environmental Monitoring, the current radiation situation and content of radionuclides in the Vilia River at the gauge line of the Bystritsa Village for the years 2019-2024 remain stable.

The main areas of use of the water body include:

- utility and drinking water system;
- meeting the needs of industrial enterprises and their use in the cycle of supplying the Belarusian NPP with technical water;
- recreation and fishing.

There are no hydraulic structures or devices in the area of Site 2-1.

Area of location of Site 3-3

According to the hydrological zoning of Belarus, the concurrent District No. 3, the Mstislavl one, is located within the Upper Dnieper hydrological region IIb. There are no surface water bodies within the boundaries of Alternative Site 3-3, but the territories adjacent to the Site are the catchment areas of the Chernaya Natopa River basin, its left tributary Chernotopka River, the right tributary of the Mertvitsa River as well as left tributary of the Mertvitsa River – the Sorochinka River. Alternative Site No. 3-3 in District No. 2, the Mstislavl one, in relation to water bodies, is located at the junction of the watershed between the Chernaya Natopa River and its left tributary, the Chernotopka River, at a distance of 0.8 km from the Chernaya Natopa riverbed and 1.0 km from the Chernotopka riverbed (see Figure 5.5). The Sorochinka and Deaditsa Rivers are located on the opposite, right-hand side of the Chernaya Natopa River catchment area, at a distance of about 2 km.

There are no hydrological posts of the National System for Environmental Monitoring in the Mstislavl district and no routine hydrological observations are carried out.

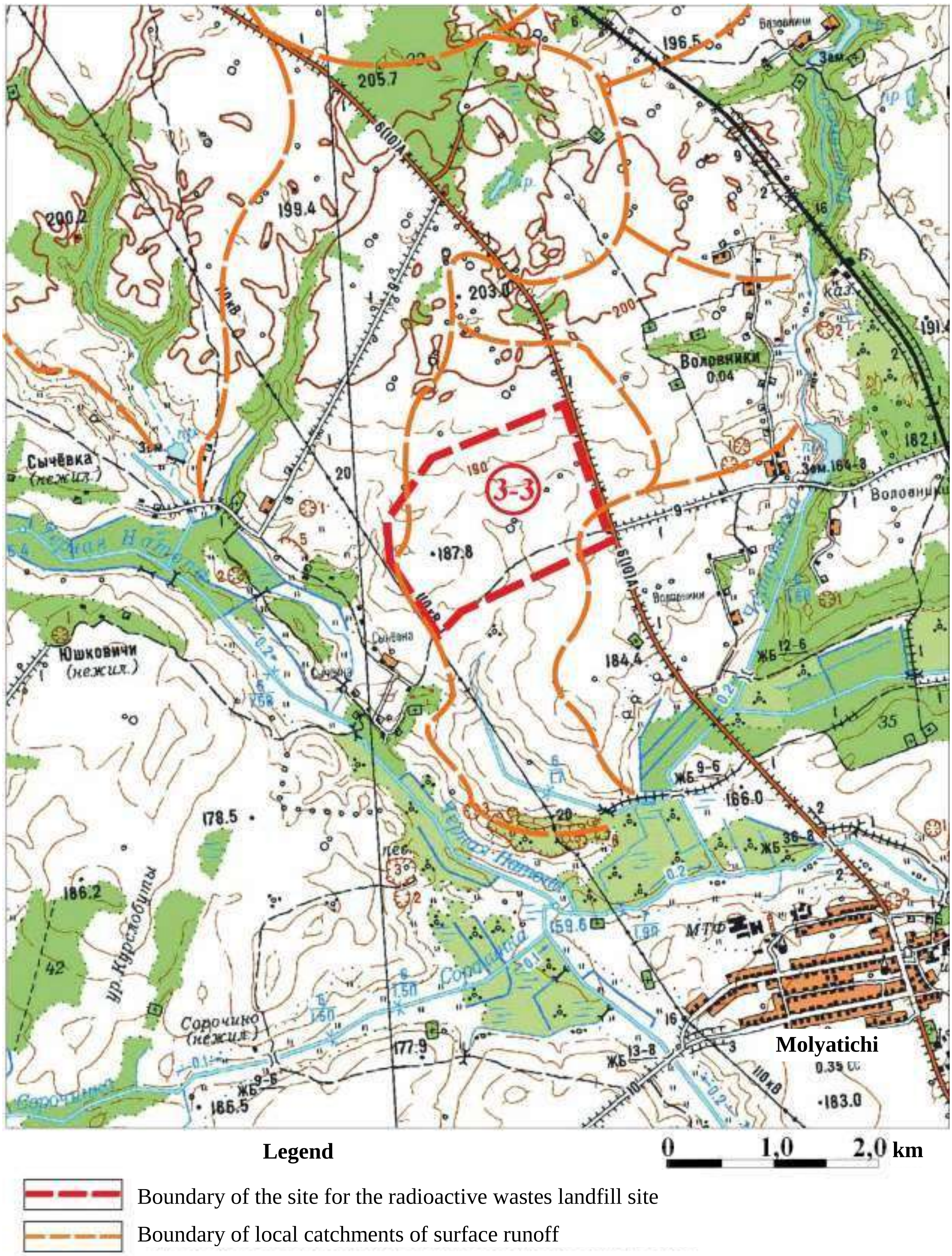


Figure 5.5 – Schematic map of location of the Alternative Site 3-3

The results of studies of the hydrochemical composition of water in the Chernaya Natopa River showed that from the list of the main hydrochemical indices of river water quality, only the biological oxygen demand in 5 days was at the level of 1.02 MAC.

The main hydrochemical indices characterising the water quality in the Chernaya Natopa River at the gauge line of the Molyatichi Village are shown in Table 5.3.

Table 5.3 – **Characteristics of the water quality in the Chernaya Natopa River**

Index	Chernaya Natopa River at the gauge line of the Molyatichi Village
Suspended substances, mg/dm^3	4.5
Dissolved oxygen, mgO_2/dm^3	7.6
Total iron, mg/dm^3	0.235
Copper, mg/dm^3	0.0006
Zinc, mg/dm^3	0.008
Phosphate ion, mgN/dm^3	0.04
Ammonium ion, mgN/dm^3	0.039
Nitrite ion, mgN/dm^3	0.009
Petroleum products, mg/dm^3	0.01
Synthetic surfactants$_{anion}$, mg/dm^3	<0.025
Biological oxygen demand in 5 days, mgO_2/dm^3	6.1
Chemical oxygen demand$_{Cr}$, mgO_2/dm^3	16.7

The Chernaya Natopa River is characterised by the 2nd class of water quality in terms of hydrochemical indices, which may make it possible to classify the ecological condition (status) of the river as no more than good.

The reaction of water in the Chernaya Natopa River basin has actual values of the hydrogen index pH = 7.5-8.3 and is characterised as neutral to slightly alkaline.

The surface waters in the Chernaya Natopa River basin are not aggressive. Based on the values of the redox potential Eh > + (150-250), the water in the river is characterised by weakly oxidising conditions.

At the present time, the volumetric activity of caesium-137 and strontium-90 in the Chernaya Natopa River and in the area of Alternative Site 3-3 currently significantly lower than the norms established by the Hygienic Standard “Radiation Risk Assessment Criteria” (in version No.829 dated November 29, 2022), according to which the levels of caesium-137 and strontium-90 shall not exceed above 10 Bq/dm^3.

The main areas of use of the water body include:

- agriculture and soil reclamation;
- recreation and fishing.

There are no hydraulic structures or devices in the area of Site 3-3.

Area of location of Site 1-5

According to the hydrological zoning of Belarus, the concurrent Khoiniki District is located within the Pripyat hydrological region VI b. The situational location of the concurrent Site 1-5 is shown in Figure 5.6.

Site 1-5 is located in the downstream reaches of the left-hand watershed of the Vit River basin, at a distance of about 5 km south-east of the riverbed.

Generally, the river valley is weakly pronounced; in the downstream reaches it merges with the floodplain of the Pripyat River. The slopes of the valley are smooth, 2-3 m high. The floodplain is swamped everywhere, with an average width of up to 800 m.

The riverbed is canalized, except for the mouth part. The river banks are mainly peaty, they rise above the water's edge by 0.3-1.3 m. The water depth in the river during the low-water period is 0.3-0.8 m, and the maximum is no more than 1.8 m. The width of the riverbed in the middle and downstream reaches is 10-26 m, the water flow velocity is 0.2–0.4 m/s and reaches 1.0 m/s during the high water. During the low-water period, the riverbed sections with low slopes and flow velocities are overgrown with aquatic vegetation.

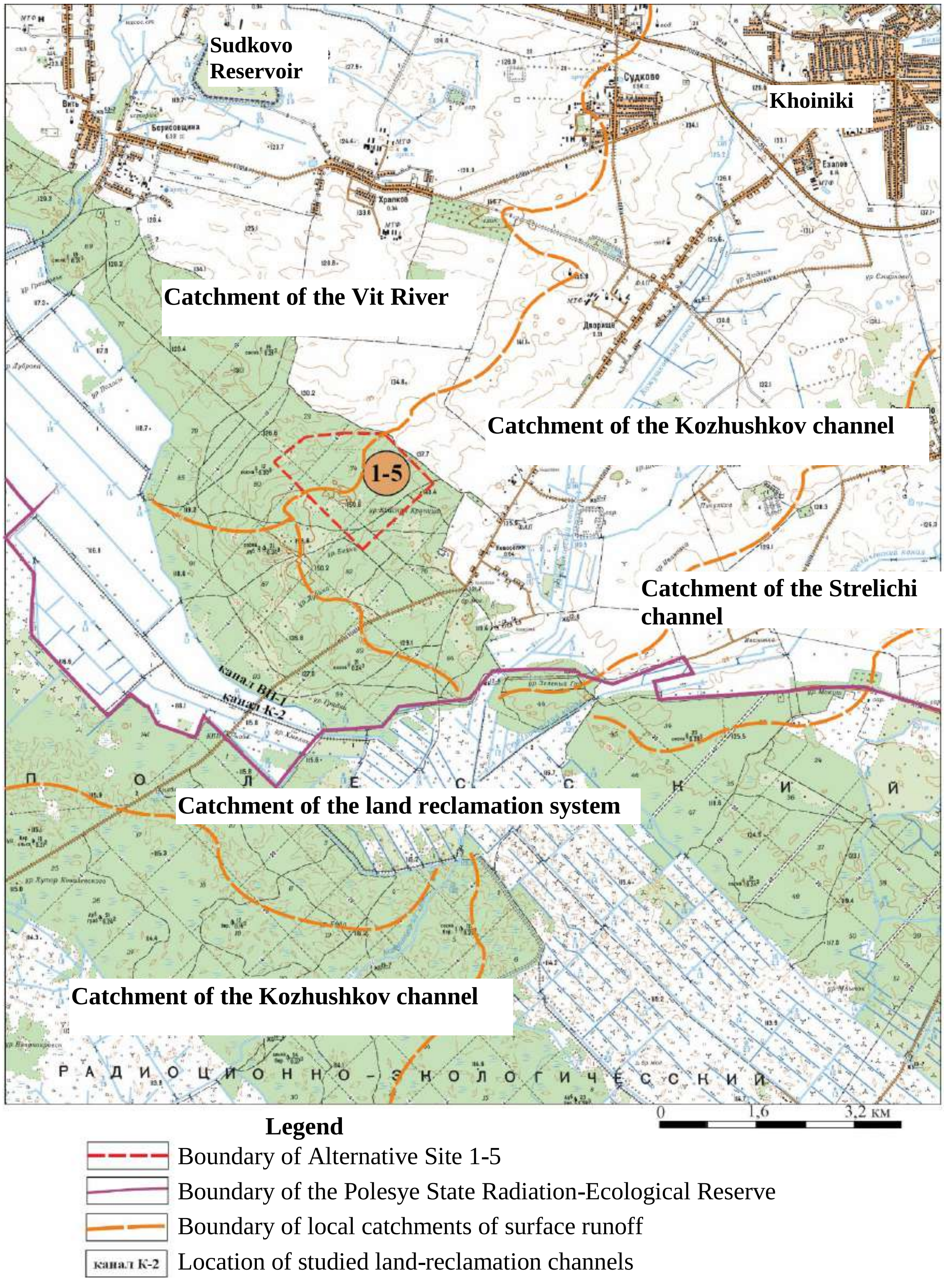


Figure 5.6 – **Schematic map of the hydrographic network of surface water bodies in District No.1, the Khoiniki one, Alternative Site 1-5**

The maximum duration of the period with ice events for the Vit River is up to 90 days, and the average freezing period is mid–December. The ice in the river is broken up at the end of March, the average duration of ice flow is usually 3-4 days, and the total duration of high water is 40-45 days.

As regards its chemistry, the water in the Vit River is fresh and related to the bicarbonate-calcium type. The content of the main hydrochemical indices of the water composition in the Vit River is seasonally characterised by the following concentrations: calcium – 50-125 mg/dm^3, magnesium – 2-35 mg/dm^3, bicarbonate ion - 129-229 mg/dm^3, sulphate ion – 6.3-65.3 mg/dm^3 and chloride ion – 10-23 mg/dm^3.

The characteristics of the water quality in the Vit River is given according to the main hydrochemical indices, which are the main normalized substances and given in Table 5.4.

Table 5.4 – **Characteristics of the water quality in the Vit River**

Index	Vit River at the gauge line of the Borisovshchina Village
Suspended substances, mg/dm^3	16.4
Dissolved oxygen, mgO_2/dm^3	8.6
Total iron, mg/dm^3	0.54
Copper, mg/dm^3	0.0035
Zinc, mg/dm^3	0.014
Phosphate ion, mgN/dm^3	0.07
Ammonium ion, mgN/dm^3	0.061
Nitrite ion, mgN/dm^3	0.018
Petroleum products, mg/dm^3	0.27
Synthetic surfactants$_{anion}$, mg/dm^3	<0.043
Biological oxygen demand in 5 days, mgO_2/dm^3	17.0
Chemical oxygen demand$_{Cr}$, mgO_2/dm^3	75.5

The results of studies of the hydrochemical composition of water in Vit River showed that from the list of the main hydrochemical indicators affecting the quality of river water in December 2025, the biological oxygen demand in 5 days was at the level of 2.8 MAC, chemical oxygen demand$_{Cr}$ – 2.5 MPC, petroleum products – 5.4 MAC and phosphate ions – 1.06 MAC.

The reaction of water in the Vit River basin has actual values of the hydrogen index pH = 6.8-8.5 and is characterised as neutral to slightly alkaline. The water has a characteristic light brown colour, opalescent transparency and increased turbidity, which indicates the presence of natural colloidal impurities (from peat, silt and humic substances, which determine the increased content of chemical oxygen demand$_{Cr}$ and biological oxygen demand in 5 days). The amount of suspended solids in the water of the Vit River and its tributaries, depending on the season, ranges from 12 to 30 mg/dm^3.

The surface waters in the Vit River basin are not aggressive. Based on the values of the redox potential Eh > + (250-350 mV), the water in the river is characterised by weakly oxidising conditions. The gas and oxygen regime of the water remains satisfactory throughout the year. The average annual dissolved oxygen content varies from 5.3 to 11.9 mg O_2/dm^3. Based on the presence of small concentrations of biogenic substances (nitrite ion, ammonium ion), the content of other gases being characteristic of natural waters (carbon dioxide, nitrogen) is lowest and does not exceed 10-13 mg/dm^3 for nitrogen and 3-4 mg/dm^3 for carbon dioxide. The river water density corresponds to the standard physical parameters: about 1,000 kg/m^3 at a temperature of about 4°C.

At the present time, the specific activity of caesium-137 and strontium-90 in the Vit River and in the area of Alternative Site 1-5 currently significantly lower than the norms established by the Hygienic Standard “Radiation Risk Assessment Criteria” (in version No.829 dated November 29, 2022), according to which the levels of caesium-137 and strontium-90 shall not exceed above 10 Bq/dm^3.

The maximum water temperature for the month of July is 23.7°C, the average water temperature for July-August is about 20.3°C. The minimum water temperature for December-January is 0 to +1.1°C. The average annual water temperature in the Vit River and its tributaries is 10.4°C.

The integral water pollution index for the Vit River as of December 2025 was 1.8 that also corresponds to the 3rd class of water quality of a surface water body: moderately polluted water.

The main areas of use of the water body include:

- land reclamation;
- nature conservancy zone.

There are no hydraulic structures or devices in the area of Site 1-5.

5.2.2 Subsoil waters

Area of location of Site 2-1

In accordance with the geological structure and lithological features of the water-bearing soils, aquifers of Quaternary, Neogene and Devonian deposits are distinguished up to the studied depth of 108.0 m.

The aeration zone is represented by loamy sands, rarer – by morainic loams and sandy soils with various granulometric compositions. The thickness of loamy sands and loams varies from 2.6 m to 21.4 m.

The layer represented by loamy sands and loams with a thickness of more than 12.5 m is distributed in the central part of the Site, where groundwater is characterised by a higher degree of protection. The layer with a thickness of less than 8.5 m is distributed in the north-western and north-eastern parts of Site 2-1, where the groundwater is less protected.

The sporadic-distribution waters are associated with thin layers and lenses of mainly fine and medium sands in the clay layer of the aeration zone. During the engineering and geological surveys, the levels were recorded at depths of 2.0-3.0 m from the earth's surface (absolute marks 172.32-173.07 m). They are formed due to infiltration of atmospheric precipitation. The discharge occurs due to water migration or infiltration into the underlying horizons. According to the data of water infusions into pits and wells, the filtration coefficients of clayey soils of the aeration zone in the adjacent territory are 0.0005-0.0224 m/day (the average value is 0.0067 m/day), and according to laboratory work, the filtration coefficients of samples of undisturbed structure (monoliths) of morainic loamy sand at the site of survey on a scale of 1:10,000 vary within 0.0004-0.036 m/day (the average value is 0.0076 m/day) and confirm the reliability of the values of filtration coefficients according to laboratory data. The filtration coefficients of sandy soils of terminal morainic deposits according to the data of infusions, depending on the lithological composition, vary from 0.16 to 18.81 m/day, and according to laboratory data at the site they are 0.12-9.80 m/day. During the high water and heavy rains, the perched water can appear on the roof of argillaceous deposits in the aeration zone.

The aquifer of the Sozh finite morainic deposits (gtIIsž) (groundwater) is widespread throughout Site 2-1. The horizon is mostly unconfined; in some areas it has a confined nature. The head reaches 12.0 m. According to the survey on a scale of 1:10,000 at Site 2-1, the horizon lies at a depth of 9.8 m. Static (piezometric) levels are set at a depth of 9.8 m – 13.4 m. The absolute marks of static (piezometric) levels are 162.88 m – 164.77 m. The groundwater flow is directed towards the Vilia and Gozovka Rivers to the north-west. The stream gradient is 0.0016. Site 2-1 is located on a watershed. The horizon is recharged by infiltration of atmospheric precipitation, the discharge occurs due to water migration into the underlying horizons and lateral drainage into surface watercourses (Vilia River, Gozovka River). The water-bearing soils are represented by medium, fine and silty sands, rarer coarse and gravelly ones, sometimes clayey ones with thin layers of loamy sand and gravelly soil. They are characterised by a "motley" lithological composition, lack of restraint in plan and section. The thickness of the water-bearing soils is 0.1-16.7 m. The aquifer at the Site has been tested by cluster pumping test. The flow rate of wells is 7.1-8.6 m^3/hour with a decrease in the level by 3.2-5.0 m; the coefficient of permeability is 222-322 m^2/day and the filtration coefficient is 29.2-43.5 m/day. The lower watertight stratum of the horizon consists of moraine loamy sands and loams of the Sozh horizon, with a thickness of 26.6–32.3 m. The aquifer is used in rural areas for domestic drinking water supply through wells.

Dnieper and Sozh aqueoglacial water-bearing complex (f,lgIId-sž). The first pressure water horizon from the surface is pervasive at Site 2-1 and penetrated at depths of 47.5-52.8 m. The water-bearing soils are represented by silty, fine and medium-sized sands, and sometimes clayey sands with loamy sand interlayers. The thickness of the water-bearing complex is 4.1-21.7 m. At the site of survey on a scale of 1:10,000, the horizon was tested by pumping from well No. 23d equipped for monitoring. The piezometric level in the well was set at a depth of 28.39 m (the absolute mark was 147.61 m). The head value was 19.1 m. The well flow rate was 1.8 m^3/hour with a decrease in the level by 9.47 m (the specific flow rate was 0.2 m^3/hour). The coefficient of permeability was 38 m2/day, and the filtration coefficient was 9.3 m/day. The water-bearing soil consists of medium sand with a thickness of 4.1 m. The upper watertight stratum of the horizon is the Sozh moraine, the lower is the moraine of the Dnieper horizon. The thickness of the upper watertight stratum is 26.6-32.3 m. The flow direction is north, towards the Vilia River. The stream gradient is 0.004. In adjacent territories, the coefficient of permeability is 37-413 m2/day, and the filtration coefficient is 3.2-40.6 m/day. The flow rate of well No. 9c at the BelNPP site was 9.2 m^3/hour with a decrease in the level by 11.64 m. The horizon is supplied by water migration from the overlying groundwater horizon and a lateral inflow; the discharge occurs due to drainage of the Vilia River and water migration into the underlying horizons. The horizon is widely used for water supply of settlements and livestock farms.

The Berezinsky-Dneprovsky aqueoglacial water-bearing complex (f,lgIbr-IId) is distributed locally at a depth of 72.2-85.3 m. The water-bearing soils consist of fine and medium sands with a thickness of up to 2.2 m.

The sporadic-distribution waters are associated with thin layers and lenses of medium, fine, and silty sands up to 4.9 m thick in the clay moraine deposits of the Sozh, Dnieper and Berezina horizons.

The Brinev terrigenous aquifer (N1br) is penetrated with wells at a depth of 90.7-92.6 m. The water-bearing soils are fine sands with a thickness of 10.1-10.8 m.

The Narova aqueoglacial water-bearing complex (D2nr) is penetrated with wells at a depth of 98.8-103.4 м. The sediments are represented by clay marl, marl and clay. The penetrated thickness is 3.6-9.8 m.

Area of location of Site 3-3

In accordance with the geological structure and lithological features of the water-bearing soils, aquifers of Quaternary and Pre-Quaternary deposits are distinguished up to a depth of 100 m.

The perched water is penetrated with well No.10 at a depth of 3.3 m (the absolute mark is 168.07 m) in medium sands deposited on the roof of the Sozh moraine. The thickness of the water-bearing soils is 2.2 m.

During the wettest periods of the year, the appearance of a perched waters is also possible in other areas in the sandy deposits of the roof of the Sozh moraine.

The *sporadic-distribution waters* are associated with thin layers and lenses of silty, fine, medium and gravelly sands in the argillaceous deposits of the Sozh horizon. The waters have a confined and unconfined nature. The static (piezometric) levels are set at a depth of 3.4-14.2 m, at absolute elevations of 167.97-176.26 m. The head reaches 4.1 m. They are distributed locally. The thickness of the water-bearing soils is 4.1 m.

According to the laboratory measurements, the sand filtration coefficients vary between 0.09-14.0 m/day, and, according to geophysical research, they are 2.4-5.9 m/day.

The waters are formed due to infiltration of atmospheric precipitation. The discharge occurs due to water migration or infiltration into the underlying horizons. The water temperature is about 8°C. As regards their chemistry, the waters have mainly bicarbonate magnesium-calcium composition, they are fresh with a dry residue of 183.0-579.0 mg/dm^3, pH 7.3-8.0 (slightly alkaline), from mild to moderately harsh.

They are non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures.

Dnieper and Sozh aqueoglacial water-bearing complex (f,lgIId-sz). It is pervasive and has confined and unconfined nature, it is unconfined in wells No.21, 22, 25, 27; 2A, 4, 14. The piezometric (static) levels are set at a depth of 3.2-15.6 m (the absolute mark is 167.39-176.91 m).

The depth of the roof of the horizon on the Site varies from 5.9 to 22.1 m. The pressure head is 7.7 m.

The water-bearing soils of the complex are sands ranging from silty to coarse, often clayey, mostly fine and medium ones. In a number of wells, there are layers of silty loams and loamy sands in the sands.

According to the laboratory definitions, the sand filtration coefficients are 0.05-2.00 m/day, according to the geophysical research, they are 0.1-12.1 m/day. The complex is characterised by the anisotropy of filtration properties in the vertical and horizontal directions.

According to the data of the cluster pumping test on adjacent territories (Kamenka quarry), the filtration coefficients of fine and silty sands are 0.1-7.9 m/day (the average value is 5 m/day) and that of medium sands is 21.3 m/day. The complex thickness is 7.4-23.6 m.

According to the laboratory measurements, the filtration coefficients of loamy sands and loams protecting the aquifer from pollution are 0.0002-0.0032 m/day with an average value of 0.0016; according to the geophysical research data, the weighted average filtration coefficients of the upper watertight stratum, taking into account the sand layers, are 0.149-0.395 m/day. Filtration properties are characterised by anisotropy. The horizon is recharged by infiltration of atmospheric precipitation and due to overflow of water from the overlying horizons (perched water and sporadic-distribution waters) and lateral inflow; it is discharged due to water migration into the underlying horizon and lateral flow.

The water flow direction is south, towards the Chernaya Natopa River. The slope is 0.002-0.006. The top watertight stratum consists of loamy sands and loams of the Sozh moraine.

The predicted level is assumed to be 1 m higher than that recorded during the survey.

*Berezina-Dnieper aqueoglacial water-bearing complex (*f,lgIbr-IId). It lies at a depth of 35.2-50.8 m and has a confined nature. The piezometric levels were set at a depth of 13.7-19.5 m, the absolute mark is 157.67-160.64 m.

It has not been penetrated with well No.19, in which the Dnieper moraine lies on terrigenous Upper Cretaceous deposits.

The water-bearing soils consist of fine, medium and coarse sands, often clayey, with layers and lenses of silty loams. According to the geophysical research data, the sand filtration coefficients are 0.3-36.2 m/day.

The top watertight stratum is the Dnieper horizon moraine. The complex thickness is 1.6-13.2 m.

The Upper Cretaceous Cenomanian carbonate-terrigenous water-bearing complex (K_{2s}) is penetrated at a depth of 37.6-53.0 m. The water-bearing soils consist of marl and chalk. In the upper part of the complex, terrigenous deposits are distinguished: fine and medium sands with a thickness of 3.2-8.8 m. The thickness of the complex is 3.2-12.8 m and that of carbonate deposits is 3.2-10.6 m.

There is no information about the level mode on the Site.

According to the data of cluster pumping test from the aquifer in the adjacent territory (Kamenka quarry), the water-bearing soils (chalk) are characterised by a filtration coefficient of 1.31-2.46 m/day. At the same time, the pressure gradient in the upper part of the complex (the change in absolute mark from piezometric levels in depth) is 0.138 and 0.05 in the rest.

The Lower Cretaceous terrigenous water-bearing complex (K_{1-2}) is penetrated at a depth of 49.4-56.6 m. The water-bearing soils consist of medium and fine glauconite-quartz, sometimes clayey sands with interlayers of silt loamy sands. The thickness of the water-bearing soils is 1.4-12.4 m. There is no information about the site's horizon levels. The sand filtration coefficients according to geophysical research data are 0.6-21.4 m/day.

The Jurassic terrigenous water-bearing complex (J_{2k}) is penetrated at a depth of 64.4-68.4 m. The water-bearing soils consist of interlayers of silty sands in loamy sands and loams with a thickness of 3.2-4.8 m.

There is no information about the horizon levels. According to the geophysical research data, the sand filtration coefficients are 0.14-2.50 m/day.

The Site is located in the recharge zone of subsoil waters with a noted downward movement of subsoil waters – migration from the upper levels to the underlying ones. The absolute marks of water levels in the upper levels are always higher than in the underlying ones.

Area of location of Site 1-5

In accordance with the geological structure and lithological composition of the soils at Site 1-5 to the studied depth of 100 m, according to the conditions of occurrence, the following are distinguished: perched water, sporadic-distribution waters, Berezina-Dnieper aqueoglacial complex and Buchak aquifer.

The perched water is met by a single well 52 at a depth of 3.9 m (the absolute mark is 144.01 m). The water-bearing soils consist of fine sands. The thickness of the water-bearing soils is 2.4 m. The lower water barrier is the argillaceous deposits of the Dnieper moraine. The perched water (groundwater) is fed by infiltration of atmospheric precipitation and unloaded by water migration into underlying aquifers. The water is non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures.

The sporadic-distribution waters (gIId) are associated with thin layers of sand in the clay moraine deposits of the Dnieper horizon. The thickness of water-saturated interlayers does not exceed 0.1 m. The static levels are recorded at a depth of 6.6–18.5 m (the absolute mark is 120.05-136.15 m). It is recharged by infiltration of atmospheric precipitation and discharged by water migration into underlying horizon. As regards their chemistry, the waters are non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures. They are fresh, the dry residue varies from 312 to 1,024 mg/dm³. The waters are weakly alkaline (the pH value varries from 7.3 to 7.9).

The Berezina-Dnieper aqueoglacial water-bearing complex (f,lgIbr-IId) lies at a depth of 12.4–26.7 m (the absolute mark is 113.50–121.75 м). It is mainly unconfined. Within some sections, it is confined. The pressure head is 0.4-6.6 m. The static (piezometric) levels are set at a depth of 12.4–26.7 m (the absolute mark is 120.05–121.75 m). The aquifer has not been penetrates with individual wells (wells 35, 53) with a depth of 30 m.

The water-bearing soils are represented by silty, fine and middle sands. The thickness of the water-bearing soils varies from 27.4 to 33.2 m. The lower watertight stratum of the complex consists of loamy sands and loams of the Upper-Middle Paleogene, lying at a depth of 44.6–56.4 m (the absolute mark is 91.51-94.18 m). It is recharged by infiltration of atmospheric precipitation and water migration in the places of distribution of the upper levels (perch water and sporadic-distribution waters). The discharge occurs due to water migration into the underlying aquifer and drainage of the Pripyat and Vit Rivers.

As regards their chemistry, the waters are weakly alkaline (pH = 7.1–7.9), fresh (the dry residue is 301–987 mg/dm³), non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures. According to the data of laboratory work, the filtration coefficients of the soils vary from 0.1 to 21.0 m/day and according to the data of the Geological Information System – from 0.19 to 17.24 m/day (the average value is 5.0 m/day), and according to the data of aquifer testing – from 2.65 to 10.2 m/day (the average value is 6.4 m/day).

The Buchak Mid-Paleogene aquifer (P2bc) has been penetrated at a depth of 86.0 to 96.0 m (the absolute mark is 51.3–52.1 m). It is confined. The upper watertight stratum consists of clayey deposits of Upper and Mid-Paleogene (loamy sands and loams). The thickness of the upper watertight stratum is 39.6–42.4 m. The water-bearing soils are presented by fine and middle sands. The penetrated thickness of the water-bearing soils reaches 1.4-12.4 m. There is no information about the site's horizon levels and heads.

At a distance of 3.6 km to the north and north-west of the Site, the piezometric level was recorded at a depth of 12.5 m (the absolute mark is 119.5 m) by exploration well 1977 (Kozeluzhye Village) The well flow rate was 7.2 m^3/h with a decrease in the level by 62.0 m (the specific flow rate was 0.12 m^3/h), the water is fresh with a mineralization of 0.2 g/dm^3.

The filtration coefficients of water-bearing soils according to the data of the Geological Information System vary from 1.65 to 9.42 m/day (the average value is 5.8 m/day). According to the data of hydro-geological investigations, the coefficient of permeability of the horizon varies from 221 to 516 m^2/day. The aquifer is used for water supply of the Khoiniki Town. The operational reserves of the aquifer in categories A+B in 1981 for the Gorodok and Vostochny water intakes were approved at an object to be 25,500 m^3/day [5].

5.3 Subsurface resource (including the geological, hydrogeological, engineering-geological and other conditions)

Area of location of Site 2-1

The general information about the geomorphology, geological structure and hydrogeological conditions of the area is provided based on the data and results of surveys and investigations at Site 2-1 and in the immediate vicinity to it.

Geomorphology

According to the scheme of geomorphological zoning of the territory of Belarus, Site 2-1 is associated with the area of the Vileisk lowland of the West Belarusian subregion of the Central Belarusian Uplands and ridges. The main components of the region's relief are the valley of the Vilia River, flat-undulating Vilia plain and the Svir (in the north-east) and Oshmyany (in the south-west) moraine uplands.

There are no current geological processes in the territory of Site 2-1, which would prohibit or restrict the construction of a radioactive wastes landfill.

Tectonics

Site 2-1 is located in the northern section of the Belarusian crystalline core-area in the area of junction with the Baltic syneclise. In the territory of the Baltic monocline, the outskirts of the Baltic syneclise, the crystalline basement lies here at absolute marks from minus 0.2 to minus 0.45 km. The basement rocks belong to the Belarusian-Baltic granulite complex, which stretches in a north-easterly direction and consists of alternating granulite blocks and blastomylanites.

Within the contour of Site 2-1, the Earth's crust type A is developed that indicates the geotectonic stage and the subsequent evolution of the research area. On the area of Site 2-1, the depth of the crystalline basement rocks is located at a depth of 480-500 m and the distance from deep regional tectonic faults is up to 45-50 km that indicates the geological and tectonic stability. In the course of the research work, the followings were not ascertained at the Site [6]:

- the manifestation of active neotectonic blocks based on other research methods;
- geotectonic faults according to the studies completed in 2024;
- geotectonic factors prohibiting the siting of the radioactive wastes landfill.

Appendix B shows a map of the gravitational field, recalculated to a depth of 500 m. In the south-east, there are increased field values associated with dense intrusive rocks. In addition, the crystalline basement is expected to rise along the Western Ostrovets fault. The central and south-eastern part of the territory under consideration is occupied by an area of a reduced gravitational field. It is associated with the predominance of ancient gneissified granitoids in the crystalline basement. There is a general increase in the field in the north-westerly direction due to underlying factors.

Seismic conditions

The data from instrumental observations were processed with compilation of bulletins based on recorded events at local network seismological observation points located in the area of Site 2-1: 2.1 Boyary, 2.2 Gradovshchizna, 2.3 Vadatishki, 2.4 Selishche, 2.5 Gornaya Kaimina, 2.6 Vorobyi and 2.7 Litvyany.

According to the Map of the General Seismic Zoning of Northern Eurasia GSZ-97-D, the level of the maximum credible earthquake with a recurrence of once every 10,000 years (the average annual risk is 10^{-4}) for the site is 7 points (Figure 5.7).

The maximum estimated intensity from a possible seismic event in the nearest Oshmyany area of a possible earthquake source (M_{max} = 4.5, H = 5 km, Δ = 30 km) is 5 points.

The maximum estimated intensity from a possible seismic event in the Vrancha area (M_{max} = 8.2, H = 80 km, Δ = 885 km) is 5 points.

Among the distant earthquakes during the reporting period, the earthquake, which occurred on the island of Crete, Greece on May 22, 2025 with a magnitude *mb* = 6.5, hypocentre depth of 70 km and epicentral distance to the Site of 2040 km, made the greatest impact on the Site; the estimated impact on the Site 2-1 was 1.2 points.

Among the regional earthquakes during the reporting period, two earthquakes, which occurred in Poland, could have had an impact on the Site: August 8, 2025 with a magnitude *mb* = 4.7, hypocentre depth of 10 km and epicentral distance to the site of 727 km, the estimated impact on the Site was 0 points; October 21, 2025 with a magnitude *mb* = 4.7, hypocentre depth 5 km and epicentral distance to the site of 752 km, the estimated impact on the site was 0 points.

For the nearby Soligorsk earthquakes, the earthquake, which occurred on June 7, 2025 with a magnitude *mb* = 2.4, hypocentre depth of 25 km and epicentral distance to the site of 269 km had the greatest impact on the Site, the estimated impact on the Site was minus 1.9 points.

The strongest historical earthquake closest to the Site occurred in the area of Gudogai village, Ostrovetsky district on December 28, 1908 with a magnitude of 4.0, epicentral distance to the Site of 35 km and predicted intensity of seismic impact on the Site of 3.5 points.

In accordance with the above, there are no prohibiting or limiting factors in terms of seismic conditions for siting the the radioactive wastes landfill [6].

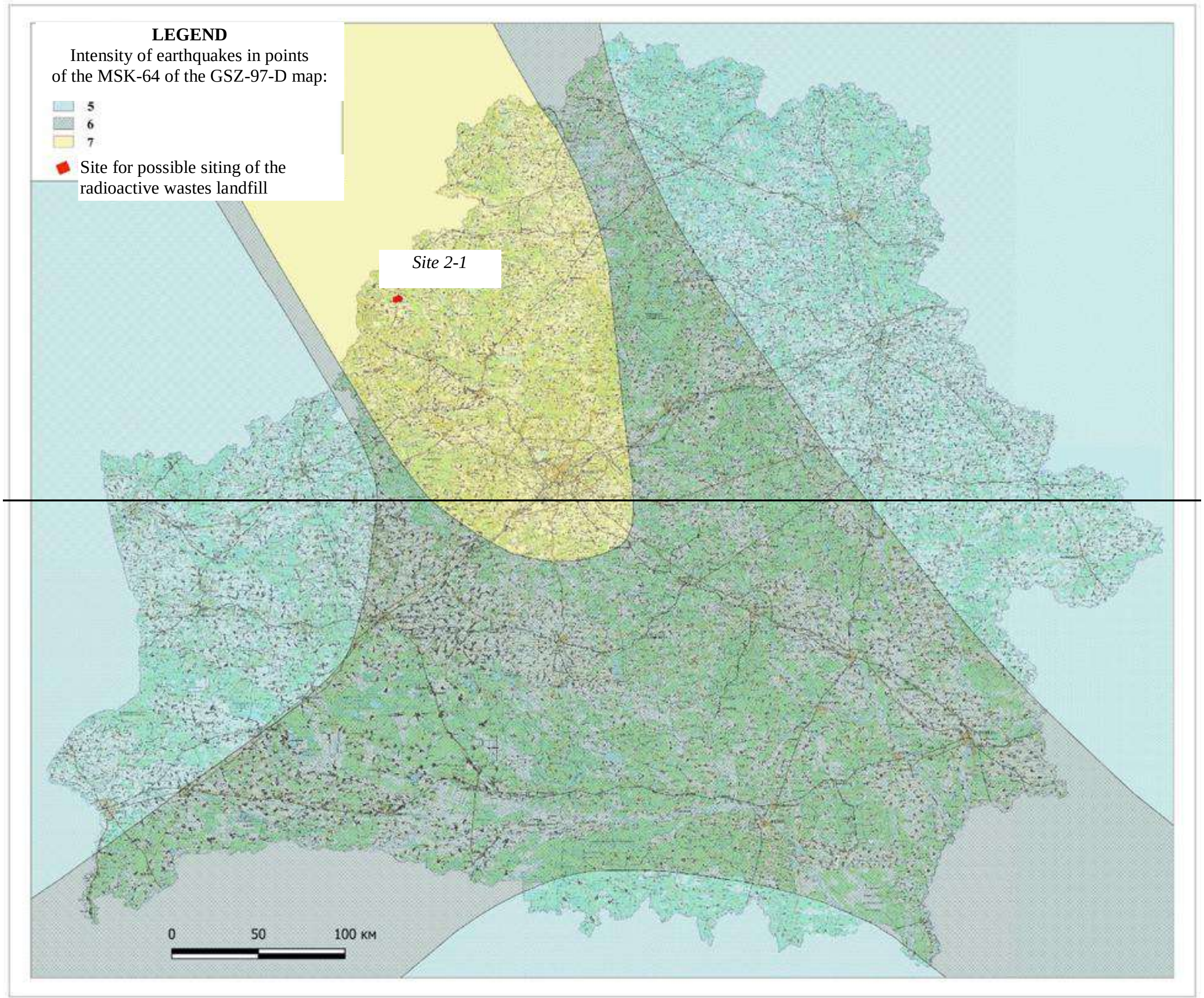


Figure 5.7 – Fragment of the GSZ-97-D map with indicating the position of Site 2-1 for siting the the radioactive wastes landfill

Sedimentary cover structure

The sedimentary cover contains formations of the Upper Proterozoic, Cambrian, Ordovician, Silurian, Neogene and Quaternary systems.

A brief description of the section is given below, taking into account the data in the territory adjacent to Site 2-1, which was studied, among other things, when choosing the site for the Belarusian NPP.

The sedimentary cover contains formations of the Upper Proterozoic, Cambrian, Ordovician, Silurian, Neogene and Quaternary systems.

The crystalline basement (*Archaea - Lower Proterozoic* (AR-PR_1)) is represented by granites, crystalline schists, and gneisses.

A weathering crust is developed on the crystalline basement, overlain by sedimentary rocks of the Upper Proterozoic *(Vendian).* The Vendian sediments include the *Volyn and Valdai series* composed of terrigenous rocks (clays, sandstones, siltstones, gravelites, and conglomerates).

The sediments of the *Volym series* (Vvl) are penetrated at a depth of 337.6-496.6 m. The thickness is 58-82 m.

The sediments of the *Valdai series* (Vvd) are penetrated at a depth of 288-379 m. The thickness is 88-167 m and more.

The sediments of the *Cambrian system* (lower ($Є_1$) and middle divisions ($Є_2$)) lie at a depth of 120.2-281.0 m; the thickness is up to 109 m. The deposits of terrigenous composition consist mainly of siltstones, sandstones and clays.

Within the *Ordovician system,* the sediments of the lower (O_1), middle (O_2) and upper (O_3) divisions lie at a depth of 64.0-209.4 m. The rocks are represented by terrigenous and carbonate formations. The carbonate content increases upward along the section, where limestones, marls and clays predominate.

The *Silurian system* is represented by sediments of the *Llandoverian* (S_1l) and *Wenlockian* (S_1v) divisions. The roof lies at a depth of about 60.0-115.6 m. The thickness is up to 86 m. The sediments are represented by dolomites, marls and clays.

The *Brinev* (N_1br) and *Antopol* (N_1an) *horizons of the Neogene (Miocene)* lie over the Silurian sediments with a significant break.

The *Antopol* (N_1an) *horizon* is represented by loamy sands and loams, clays, loam with plant remains, with lenses of dusty sands. The horizon bottom was penetrated at a depth of 90.7 m; the thickness was 11.5 m.

The *Brinev* (N1br) *horizon* is represented by fine water-saturated sands. The bottom lies at a depth of 98.8-103.4 m, the thickness is 8.1–10.8 m.

In the territory under consideration, the *quaternary sediments* have a thickness from 60.6 to 145.0 m. The minimum thickness values are associated with the lowest marks of the daytime surface, the valley of the Vilia River. The maximum thickness of Quaternary sediments is observed on terminal morainic uplands.

In terms of Quaternary deposits, the horizons are distinguished: Gomel, Brest, Narev, Belovezha, Berezina, Alexandriya, Pripyat (with two subhorizons: Dnieper and Sozh), Muravin, Poozerye and Sudobl (Holocene).

There is no information about the deposits of the *Gomel* and *Narev horizons* of the research area (the deposits have not been penetrated).

The *Brest Horizon* has an island development. It is composed mainly of lacustrine and alluvial deposits: loamy sands, clays and sands. The thickness is about 5-10 m. The sediments do not reach the daylight surface.

The *Belovezha horizon* is composed mainly of lacustrine and alluvial clays, fine loamy sands and sands.. Peat and peaty soils are found in isolated sections. The sediments are developed in confined areas. The thickness is 3-10 m.

The *Berezina horizon* includes morainic, aqueoglacial formations. It is not everywhere developed. The stratum includes bouldery loamy sands or loams coloured grey or brownish with interlayers of sands, loamy sands, and sandy-gravel material. The aqueoglacial deposits of the Berezinsky horizon, represented by sands and loamy sands, range in thickness from several meters to 20 m, rarely more. In a number of areas, these strata converge with similar accumulations of the presumably Narev and Dnieper horizons and form an undifferentiated complex reaching a thickness of 100-120 m.

The *Alexandrian horizon* is composed of rocks of alluvial, lacustrine, and swamp origin: sands, loamy sands, loams, saprocols, marls, and peat. The thickness is 2-25 m.

The *Dnieper subhorizon* of the Pripyat horizon is developed almost everywhere. It is represented by moraine and aqueoglacial accumulations. The dominating thickness is 5–30 m and the maximum one is 43.4 m. It includes the erratic masses of underlying rocks.

The *Sozh subhorizon* is spread as widely as the Dnieper one. The morainic formations are developed within the Oshmyany ridge. The thickness of the moraine composed of red-white coarse loamy sands and loams reaches mainly 10-25 m and somewhere 84.1 m. Aqueoglacial sands and clays in many places underlie and overlap the moraine and have a thickness from several to 20 m with the average value of 7 m.

The structure of the *Muravin horizon* is dominated by alluvial and swamp accumulations. The average thickness is 2–6 m and the maximum one is up to 18–20 m.

Poozerye horizon. The average thickness is 25 m and reaches 60-70 m in erosive depressions. The moraine is represented by red-brown boulder loamy sands, loams and clays (the average thickness is about 20 m). Fluvioglacial sands have a thickness of 10 to 25 m. Lake sands, fine loamy sands, and clays reach a thickness of 10-15 m or more. The Poozerye horizon includes also deposits of the first and second terraces above the flood-plain (from the first to several tens of meters) represented mainly by sands, lake-alluvial formations in ancient lake basins as well as locally developed lacustrine, aeolian, slope and other depositions.

The *Sudoblsky horizon* (Holocene) includes alluvial, lacustrine, swamp, slope, aeolian, and man-made formations. The largest strata of Holocene formations are associated with alluvium in the floodplains of rivers. Modern alluvium is represented by riverine, floodplain, and ancient facies. The thickness of the alluvial accumulations of the Vilia River reaches 15-18 m, in smaller rivers – 5-10 m. Other genetic types of Holocene deposits have a low distribution [7].

The *current state of the geological environment* directly at Site 2-1 is reviewed based on data from engineering and geological surveys and hydrogeological studies on scales of 1:25,000 and 1:10,000.

The Site is a plateau-shaped area of high ground on the watershed of the Vilia River and its tributary, Gozowka River. The surface is gently undulating and slightly rounded. It is characterised by a calm relief with a relative amplitude of heights of less than 3 m. The absolute marks at the mouths of engineering and geological wells are 163.49-177.78 m. The most elevated section (the absolute mark is 177.78 m) is located in the centre of the Site. From the centre of the site, a more significant slope of the surface is observed to the east and north-east, towards the valley of the Vilia River. A less pronounced slope is directed to the south-west, towards the Gozovka River.

The conditions of the surface runoff are satisfactory.

The specified depth of seasonal freezing is:

- 99 cm for loams and clays;
- 120 cm for loamy, fine and silty sands;
- 129 cm for gravelly, coarse and middle sands;
- 146 cm for macrofragmental soils.

Geological structure of the Site

The *pre-quaternary deposits* are characterised above according to the data of the engineering and geological survey of the location of the Nuclear Power Plant and literature data [7].

Quaternary deposits occur on the eroded surface of the Silurian and Neogene. These formations are considered further in the order of their occurrence.

The thickness of the quaternary deposits within the site is 79.2-92.6 m.

In the *Sozh horizon*, the sediments interpreted as terminal morainic and morainic (the main moraine of the Sozh horizon) are distinguished.

The terminal morainic deposits (gtIIsž) in the roof are represented by red-brown and brown loamy sands, rarer loams with up to 30% gravel and pebbles. loamy sands are often sanded, with numerous interlayers and lenses of sand of varying thickness.

They are underlain by sands ranging from dusty to gravelly, greyish-yellow, dark yellow, with lenses and interlayers of loams, clays. The bottom is penetrated at a depth of 10.0-27.4 m. The thickness is 9.8-27.1 m.

In a part of the Site, the terminal morainic deposits down to a depth of 30 m have not been completely penetrated; the maximum penetrated thickness was 29.8 m.

Morainic deposits (gII*sž*). Loamy sands, loams, rarely clays (as a rule, in the roof of sediments) are brown, brownish-brown and grey, with gravel, pebbles and thin (5-10 mm) sandy layers or lenses of sands of various coarseness, often clayey ones. The bottom was penetrated at a depth of 38.8-54.5 m; the thickness was 17.5-38.9 m. In a part of the site, the wells with a depth of 30 m have not been completely penetrated, and the maximum penetrated thickness is 14.8 m.

According to the results of surveys on a scale of 1:10,000, the Sozh moraine is pervasive at Site 2-1 and can be considered as a regional water barrier. As established during the surveys for the selection of the Belarusian NPP site, outside Site 2-1 there are local areas, where this moraine is absent.

Dnieper and Sozh horizons: an undifferentiated complex of glaciofluvial deposits (f,lgII*d-sž*). It is represented by sands ranging from silty to gravelly, rarely by gravelly soil. Interlayers of fragmentary material, interlayers and lenses of moraine-like and silty loamy sands, loams and loamy sands are common in the sands. The bottom is penetrated at a depth of 51.5-74.5 m. The thickness is 1.2-26.3 m.

Dnieper horizon (gII*d*). Moraine loamy sands, loams with gravel and pebbles, “silty” loamy sands, with lenses of silty to coarse sands lie to a depth of 74.4-92.6 m; the thickness is 17.2-36.0 m.

Berezina and Dnieper horizons: glaciofluvial (f,lg,l,aI*br*-II*d*) silty, fine, middle and coarse sands, loamy sands and loams. The bottom is penetrated at a depth of 76.4-86.8 m, the thickness is 2.0–3.7 m.

Berezina horizon (gI*br*). Morainic loamy sands. The bottom lies at a depth of 79.2-90.8 m, the thickness is 2.4–10.8 m.

The thickness of the vegetable ground and topsoil in the wells was 0.1-0.4 m.

Engineering and geological conditions.

Based on the results of engineering and geological surveys to a depth of 40 m, the following engineering and geological elements (EGE) were identified (Table 5.5).

Sozh horizon

Terminal morainic and morainic sands

EGE-1a. Silty moderate-strength, slightly wet sand, $q_c \leq 7$ MPa
EGE-2. Strong silty sand
EGE-3. Fine moderate-strength sand
EGE-3a. Fine moderate-strength sand, $q_c \leq 5$ MPa
EGE-4. Strong fine sand
EGE-6. Medium moderate-strength sand
EGE-7. Strong medium sand
EGE-8. Coarse gravelly moderate-strength sand
EGE-9. Strong coarse gravelly sand

Terminal morainic and morainic loamy sands and loams

EGE-10. Weak loamy sand
EGE-11. Loamy moderate-strength sand
EGE-12. Strong loamy sand
EGE-12a. Strong loamy sand, $q_c \leq 4$ MPa
EGE-13. Very strong loamy sand, $q_c \leq 20$ MPa

EGE-14. Very strong loam, q_c > 20 MPa
EGE-14a. Very strong loamy sand, q_c > 20 MPa, slightly wet *Sr*< 0.8
EGE-15. Very strong silty clay.

Table 5.5 – Specified values of the soil characteristics

EGE, silt	Specific weight γ_n, kN/m³	Specific cohesion c_n, kPa	Internal friction angle φ_n, deg.	Modulus of deformation *E*, MPa
EGE-1a. Silty moderate-strength, slightly wet sand $q_c \leq 7$ MPa	17.2	3.5	29	15
EGE-2. Strong silty sand	$\frac{17.2}{10.0}$	5.0	33	38
EGE-3. Fine moderate-strength sand	16.3	2.0	32	21
EGE-3a. Fine moderate-strength sand, $q_c \leq 5$ MPa	16.3	1.0	30	16
EGE-4. Strong fine sand	$\frac{16.3}{9.6}$	5.0	37	37
EGE-6. Medium moderate-strength sand	$\frac{16.7}{9.8}$	1.0	35	28
EGE-7. Strong medium sand	$\frac{16.7}{9.8}$	2.0	38	40
EGE-8. Coarse gravelly moderate-strength sand	$\frac{17.9}{10.9}$	1	39	30
EGE-9. Strong coarse gravelly sand	$\frac{17.9}{10.9}$	1.5	40	44
EGE-10. Weak loamy sand	21.6	28	26	$\frac{7.5}{0.200\text{-}0.375}$
EGE-11. Loamy moderate-strength sand	22.1	31	31	$\frac{12.5}{0.250\text{-}0.350}$
EGE-12. Strong loamy sand	22.2	39	29	24.5
EGE-12a. Strong loamy sand $q_c \leq 4$ MPa	21.9	34	28	14
EGE-13. Very strong loamy sand $q_c \leq 20$ MPa	22.6	51	31	29.5
EGE-14. Very strong loam q_c > 20 MPa	22.7	57	32	45
EGE-14a. Very strong loamy sand q_c >20 MPa, *Sr*<0.8	$\frac{22.2}{22.9}$	$\frac{57}{35}$	$\frac{35}{32}$	$\frac{36}{30}$
EGE-15. Very strong silty clay	21.4	116	20	37

Remarks

1. Sands of EGE-2, 4-9; loamy sands of EGE-14a: the specific weight value over the horizontal bar corresponds to the natural humidity and that under the horizontal bar – to the full water saturation;

2. EGE-14a: the characteristics c_n, φ_n, and *E* over the horizontal bar corresponds to the natural humidity and that under the horizontal bar – to the full water saturation;

3. EGE-10, 11 under the horizontal bar: limit of proportionality according to the results of the plate-loading test

The terminal morainic deposits (gtII*sž*) to a depth of 4.1-18.4 m are composed of loamy sands and loams, which are weak (EGE-10), medium-strong (EGE-11), strong (EGE-12, 12a) and very strong (EGE-13, 14, 14a).

The thin (0.3-0.5 m, 1.3-3.6 m in individual wells) lenses of silty (EGE-1a, 2), fine (EGE-3, 3a, 4), medium (EGE-6) and gravelly (EGE-8) sands lie on loamy sands and loams. The clayey subsoil thickness is 2.6-17.7 m.

The section below is composed of silty to gravelly, mainly strong (EGE-2, 4, 7, 9) sands, rarer moderate-strength (EGE-6) ones. In the sands, there are single lenses of moderate-strength loamy sands (EGE-11), very strong loamy sands and loams (EGE-13, 14) and clays (EGE-15). The sand layer thickness is 4.3-19.9 m.

Near well 140, the sands wedge out and the terminal morainic loamy sands lie on the loamy sands of the main moraine.

As a rule, the sands (EGE-1a, 3a) and loamy sands (EGE-10, 11, 12a) characterised by a modulus of deformation *E*<20 MPa are allocated in the roof of the terminal morainic deposits. They lie at a depth of up to 2.5-5.0 m, rarer deeper. They form lenses with a thickness of 0.4-3.2 m.

The bottom of deposits is penetrated at a depth of 12.5-27.4 m. The thickness is 12.4-27.1 m. Some wells have not penetrated the deposits, the penetrated thickness is 28.8 m.

The morainic (gII*sž*) loamy sands and loams are very strong (EGE-13, 14), the clays are very strong (EGE-15) with single lenses of strong loamy sands (EGE-12 and EGE-12a).

The loamy sands (EGE-10, 11, 12a) are characterised by the modulus of deformation *E*<20 MPa. They stand out, as a rule, in the roof of clay terminal moraine deposits at a depth of up to 2.5-5.0 m, rarely up to 7.5 m and 10.0 m in the form of lenses, with a thickness from 0.4-1.9 m to 2.4-3.2 m. The EGE-11 lenses are also found in the sands at depths of 17.6 m and 20.5 m. In the main Sozh moraine, these EGE are rare at the Site. The EGE-12a lens with the thickness of 0.7 m is distinguished in well 125 at a depth of 24.8 m.

The EGE-14a reduce their strength and deformation characteristics at full water saturation (*Sr*>0.8) [7].

The examples of geotechnical cross-sections intersecting the Site are presented in Appendices C, D and E.

Hydrogeological conditions

The following water-bearing complexes and aquifers are identified in the research territory.

The aquifer of the Sozh terminal moraine deposits (gtIIsz) is the first one from the surface and has sporadic distribution and confined-unconfined nature. The free and piezometric levels of subsoil waters were recorded at a depth of 0.6-12.6 m (at an absolute mark of 153.63-165.41 m). The head from under low-permeability sediments can be 1.1-11.0 m. The water-bearing materials are represented by sands of different granularity: from dusty to gravelly, with a thickness of 12.5-34.4 m. The unconfined subsoil waters (groundwater) is replenished over the entire area of their distribution by infiltration of atmospheric precipitation, which is the main source of groundwater replenishment. The groundwater is discharged into rivers, brooks and land reclamation canal. In the watershed areas, groundwater is consumed for migration into the underlying aquifers Quaternary and Pre-Quaternary sediments. It is exploited in rural areas by means through wells.

The sporadic-distribution waters in the clayey soils of the Sozh moraine (gIIsz) are associated with the layers (5-10 mm), lenses and interlayers (0.8-9.8 m) of sands of various granulometric composition from silty to gravelly. The waters are confined and unconfined. The waters associated with the large lenses had a head of 1.1-12.4 m. The waters were penetrated by separate wells at a depth of 2.8-16.5 m, during the survey of the year 2024 by wells No. 14, 24 at a depth of 16.7-24.9 m (the absolute mark is 147.76-149.24 m). Well No. 54 (drilled at the site of the BelNPP) was opened at a depth of 50.5-55.8 m. The horizon is replenished by the water migration from the overlying horizons or infiltration of atmospheric precipitation.

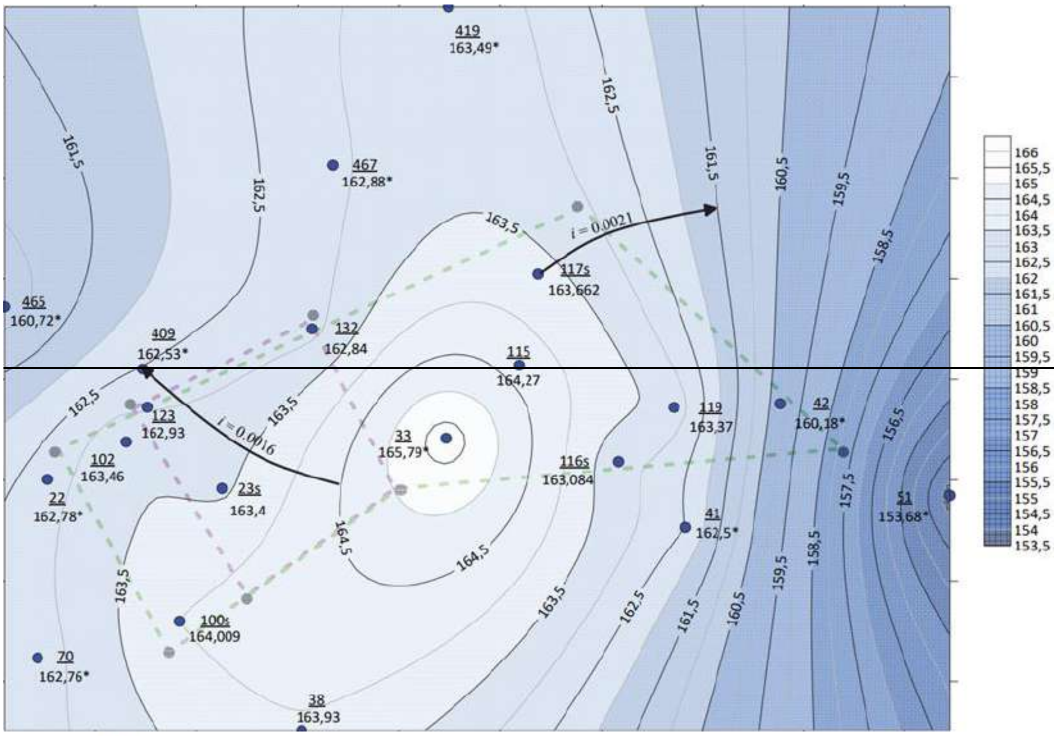
The Dnieper-Sozh aqueoglacial water-bearing complex (f,lgIId-sz) is widely developed in the research territory. The depth of the horizon is 41.3-73.2 m. The water-bearing sediments are mainly represented by medium, fine and silty sands. The thickness of the water-bearing materials reaches 30.6 m. The water-bearing complex is confined. The upper watertight stratum consists of loamy sands and loams of the Sozh moraine, and the lower one – of those of the Dnieper moraine. In the areas, where the Dnieper moraine is eroded, there are deposits of the Berezinskaya moraine and Neogene deposits. Within the boundaries of the study performed in 2024, piezometric levels were recorded at a depth of 10.50-33.54 m (at the absolute mark of 133.89-157.72 m), the head was 10.0-37.9 m. According to pumping test performed as a part of previous studies, the hydrogeological parameters of the complex were as follows: the coefficient of permeability was 11-179 m^2/day, the filtration coefficient was 2.7-17.2 m/day and the piezoconductivity coefficient was 1.4·103-6.2·105 m^2/day. The Dnieper-Sozh water-bearing complex is replenished mainly outside the territory under study on the Oshmyany ridge as well as by migration from the groundwater horizon in the watershed areas, and in the valleys of the Vilia and Gozovka Rivers – by the influx of Quaternary and Pre-Quaternary Sediments from the underlying pressure aquifers. The direct role of precipitation in the replenishment of the complex is not so significant, since it is almost everywhere overlain by relatively water-resistant morainic sediments. The discharge occurs in the valleys of the largest rivers such as Vilia and Oshmyanka as well as lake basins. The complex is discharged by water migration into the overlying groundwater horizon in areas, which are adjoined to the river valleys and other large relief depressions (swamps, lake basins), within which the piezometric surface of the subsoil waters of this horizon is higher than the surface of the groundwater. In watershed areas, a part of the subsoil water reserves of the horizon is consumed for migration into the underlying horizons of Quaternary and Pre-Quaternary sediments. The water-bearing complex is widely exploited through wells due to its ubiquitousness, with a relatively shallow occurrence and sufficient abundance of water in the rocks.

The *Berezina-Dnieper aqueoglacial water-bearing complex (flglbr-IId)* has a local distribution and penetrated by well No. 54 within the depth range from 88.9 to 92.0 m and well No. 162 (drilled west of the site, where the Belarusian Nuclear Power Plant is currently located) within the depth range from 83.7 to 85.0 m. The water-bearing materials are represented by sands of various granularity interspersing with layers of loamy sand and loam. The thickness of the water-bearing materials is 1.3-3.1 m. The deposits of the Berezina-Dnieper complex are overlain by a Dnieper-age moraine, the lithological composition of which is very heterogeneous: from coarse loamy sands and loams, less often clays to multi-grained powdery sands with the inclusion of fragmentary material. The filtration coefficients of water-saturated sands depend on their granulometric composition and vary from fractions to 27 m/day with the average values of 10-12 m/day. During the experimental work, the well flow rates were 0.1-13.8 l/s at recessions of 1-13 m. The prevailing values of specific flow rates are 0.5-5.5 litres/s.

The prevailing values of the coefficient of permeability is 100-200 m^2/day. The water-bearing complex is confined; the pressure value on the watersheds can reach 70-100 m with decrease to 20-30 m in the valleys. When penetrating the horizon, the subsoil water levels are set at depths from +1 m (self-discharge) to 28.0 m.

The *Brinev terrigenous aquifer (N_1br)* is spread sufficiently widely and penetrated at a depth of 51.6-106.0 m. The water-bearing sediments are represented by fine and medium sands. The thickness of the water-bearing materials reaches 15.8 m. The aquifer waters are confined. The lower watertight stratum consists of deposits of the Narov clastic-carbonate complex. The upper watertight stratum consists of loams of the Antopol horizon of the Lower Neogene or of deposits of the Berezina and Dnieper moraines. It is penetrated within the depth range of 92.6-103.4 m; the water-bearing material consists of fine sands. The upper watertight stratum consists of sediments of the Dnieper moraine. Piezometric water levels were recorded at depths of 26.39 m (absolute mark 150.25 m), 29.98 m (absolute mark 150.39 m) and 30.79 m (absolute mark 149.61 m). The head value is 67.2-71.5 m. According to the data of the previously performed cluster pumping test, the hydrogeological parameters of the horizon were as follows: the coefficient of permeability is 77 m^2/day, the filtration coefficient is 6.1 m/day and the piezoconductivity coefficient is 1.1 x 10^5 m^2/day.

The *Narov clastic-carbonate complex (D2nr)* is penetrated at depths of 56-143 m with immersion in a north-easterly direction, the penetrated thickness reaches 45 m [5]. East of Site 2-1, these deposits were penetrated at a depth of 103-107 m, but they were not fully penetrated [3]. The Devonian deposits are overlain by the deposits of the Lower Neogene of the Brinevsky (N_1br) and Antopolsky (N_1an) horizons. The water-saturated sediments are represented by permeable fractured marl, dolomitised limestone and sandstone. In the watershed area (within the BelNPP site), the level of subsoil waters is at a depth of 27 m. The horizon is confined. The head values under the roof of the horizon range from 62.2 m to 90.64 m. The piezometric levels are set at marks from 149.64 m in the watershed areas to 127.16-134.87 m in the valley of the Vilia River. In the watershed area (within the BelNPP site), the depth of the level of subsoil waters was 27.28 m, and in the valley of the Vilia River it was set at 1.6 m to 2.45 m above the ground and 6.97-16.6 m above the water's edge in the Vilia River. The abundance of water in the rocks varies depending on fracturing. The specific flow rates of wells vary from 0.03-1.67 l/s to 8.3 l/s, the filtration coefficient varies from 0.3 m/day to 6.9 m/day. The coefficient of permeability does not exceed 80 m^2/day. The water-bearing complex is replenished within today's watersheds due to the water migration from the overlying Quaternary horizons. In the direction of the Vilia River valley, the piezometric levels of subsoil waters of this complex decrease to a depth of 127.16-134.87 m, which indicates that the subsoil waters of the complex is partially discharged in the river valley. The water-bearing complex is operated by single water intakes (Figure 5.8) [8].

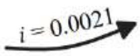


- hydrogeological well: well number (top), absolute mark of the static (piezometric) level (bottom), m;


- hydroisohypse, its absolute mark, m


- Survey site boundaries (survey scale 1:25,000)

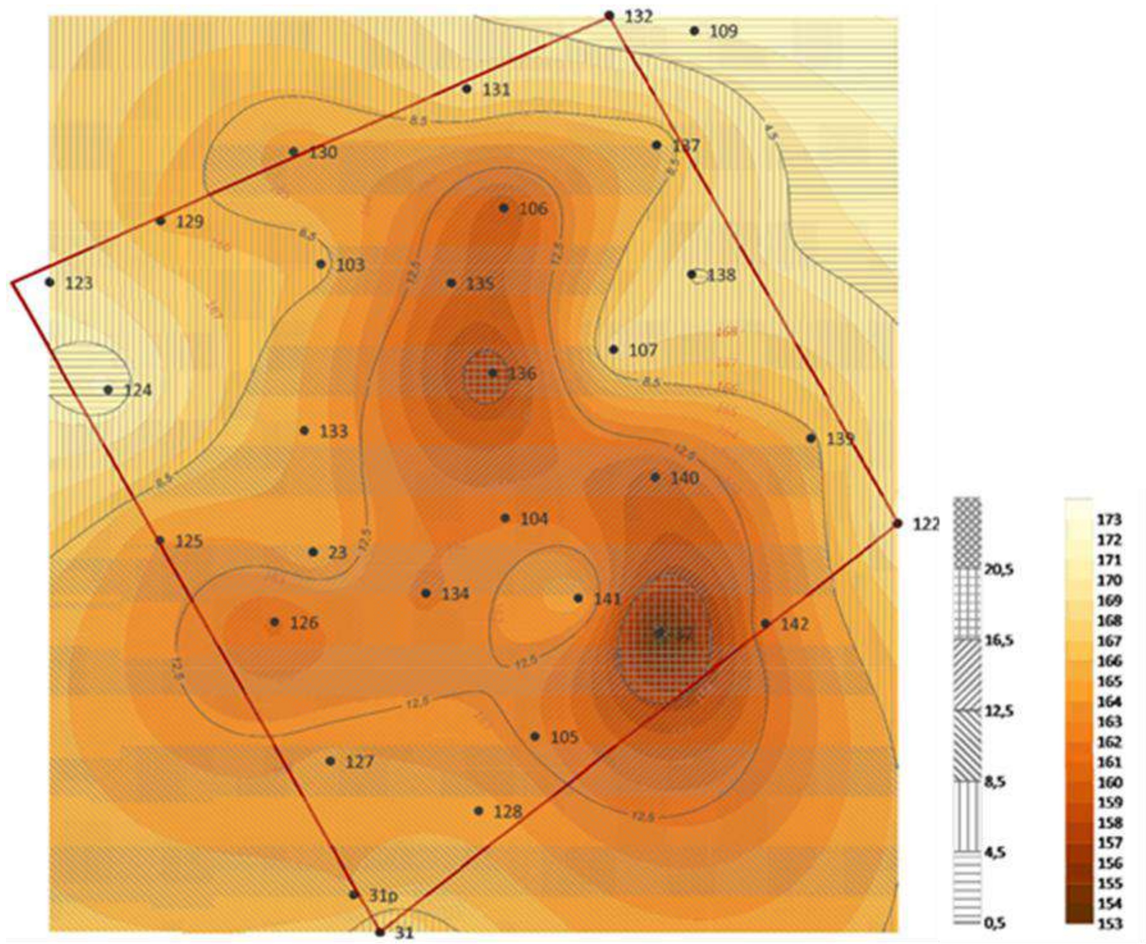

- Survey site boundaries (survey scale 1:10,000)



- Direction of the flow of groundwater and its slope

Figure 5.8 – **Schematic map of the hydroisohypses of groundwater**

Aeration zones. The aeration zone is represented by clayey (loamy sands, morainic loams) and sandy soils with various granulometric compositions. The argillaceous deposits of the aeration zone are deposited from the surface under a soil-vegetation layer or under sandy soils at a depth of up to 2.3 m. The thickness of the clay layer is 2.6-17.7 m. The natural protection of groundwater is highest in the central part of the Site (Figure 5.9).



Thickness and absolute marks of the roof, m

● 31 Research point, its number

163 Isoline

Contours of Site 2-1

Figure 5.9 – **Map of the thickness of the clayey layer of the aeration zone**

Hydrogeochemical composition of the groundwater

In the research area, the main aquifers containing fresh subsoil water and exploited actively for water supply are:

- aquifer of the marginal facies of the Sozh glaciation (*gtIIsz*) (ground);
- aquifer of aqueoglacial, alluvial, and lacustrine-alluvial deposits between the Dnieper and Sozh moraines (*f,lgIId-sz*);
- aquifer of Narov Mid-Devonian depositions (D_2nr).

The *aquifer of the Sozh terminal moraine deposits (gtIIsz)* lies next to the surface and contains mainly unconfined subsoil water (groundwater). The aquifer is exploited actively through excavated well in all settlements.

As regards their chemistry, the aquifer's waters are characterised by a very wide variety – from magnesium-calcium bicarbonate to nitrate-sodium-calcium bicarbonate ones with a total mineralization from 0.23 g/dm^3 to 1.04 g/dm^3.

The results of chemico-analytical investigation of the quality of waters the aquifer of the Sozh terminal morainic deposits, conducted in 2025, are shown in Tables 5.6, 5.7.

Table 5.6 – Hydrogeochemical characteristics of waters of the soil horizon according to the data of the investigations performed in 2025

List of wells	Bobrovniki Village	Former farmstead in the south-each of the Goza Village	Goza Village	Matskely Village	Mislyany Village	Katenovichi Village
Description of the index	**Actual value, mg/dm^3**					
Ammonium ion	<0.5	0.5	<0.5	<0.5	<0.5	<0.5
Total iron	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Iron II	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Iron III	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Chloride ion	7.0	23.0	46.1	11.2	5.3	8.7
Sulphate ion	13.1	6.5	62.5	10.0	9.1	8.0
Nitrate ion	127.0	12.10	15.70	20.30	19.00	25.00
Nitrite ion	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
pH (at 20°C)	7.5	7.6	7.4	7.3	7.8	7.1
Mineralisation (according to dry residue at 110°C)	581	388	634	286	538	341
Manganese	<0.001	0.003	0.009	<0.001	0.002	0.012
Copper	0.004	0.029	0.004	<0.001	0.001	0.001
Strontium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Zinc	0.015	0.241	0.047	0.031	0.113	0.020
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total phosphor	0.029	0.320	0.191	0.158	0.137	0.261
Hydrocarbonates	427.0	378.2	488.0	244.0	494.1	323.3
Carbonates	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Sodium	5.5	10.5	49.7	1 1.0	14.9	12.6
Potassium	<0.5	28.0	48.0	1 1.0	92.5	13.7
Calcium	110.8	83.6	97.6	65.4	77.1	81.4
Magnesium	40.5	20.0	26.1	8.4	18.0	12.2
Permanganate oxidizability	2.16	3.04	5.28	4.96	2.72	4.96
Silicon	4.58	3.9	5.30	3.94	3.60	5.4
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoride	0.14	0.13	0.17	<0.1	0.11	<0.1
Volumetric activity ^{137}Cs	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l
Specific total α-radioactivity	0.0±0.0202 Bq/l	0.0±0.0336 Bq/l	0.0±0.0560 Bq/l	0.0±0.0220 Bq/l	0.0±0.0458 Bq/l	0.0±0.0215 Bq/l
Specific total β-radioactivity	0.0± 0.0455 Bq /l	0.696± 0.181 Bq/l	1.3798± 0.3541 Bq/l	0.3686± 0.1165 Bq /l	2.2810± 0.5306 Bq /l	0.3612± 0.1094 Bq/l

List of wells	Bobrovniki Village	Former farmstead in the south-each of the Goza Village	Goza Village	Matskely Village	Mislyany Village	Katenovichi Village
Description of the index	**Actual value, mg/dm^3**					
Ammonium ion	<0.5	<0.5	<0.5	<0.5	<0.5	
Total iron	<0.100	<0.100	<0.100	<0.100	<0.100	
Iron II	<0.100	<0.100	<0.100	<0.100	<0.100	
Iron III	<0.100	<0.100	<0.100	<0.100	<0.100	
Chloride ion	3.1	3.6	5.5	15.2	61.1	
Sulphate ion	4.0	14.1	13.2	20.3	23.2	
Nitrate ion	10.60	10.60	35.40	9.70	130.0*	
Nitrite ion	<0.2	<0.2	<0.2	<0.2	<0.2	
pH (at 20°C)	7.6	7.6	7.8	8.0	7.4	
Dry residue (mineralisation), 110°C	232	493	329	324	664	
Manganese	0.002	0.004	<0.001	0.030	0.012	
Copper	0.003	0.002	<0.001	<0.001	<0.001	
Strontium	<0.5	<0.5	<0.5	<0.5	<0.5	
Chromium	<0.025	<0.025	<0.025	<0.025	<0.025	
Zinc	0.021	0.038	0.025	0.054	0.061	
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	
Total phosphor	0.43	0.123	0.033	0.044	0.036	
Hydrocarbonates	225.7	488.0	268.4	298.9	311.1	
Carbonates	Not detected	Not detected	Not detected	Not detected	Not detected	
Sodium	22.0	22.9	9.9	21.4	29.8	
Potassium	2.7	52.8	2.3	10.3	22.0	
Calcium	49.3	85.7	66.4	76.1	118.0	
Magnesium	5.3	19.8	15.8	8.6	17.6	
Permanganate oxidizability	6.40	1.92	4.56	3.04	2.08	
Silicon	3.21	3.77	4.48	3.6	4.07	
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	
Fluoride	<0.1	0.12	0.16	<0.1	<0.1	
Volumetric activity ^{137}Cs	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	
Specific total α-radioactivity	0.0±0.0229 Bq/l	0.0±0.0348 Bq/l	0.0±0.0255 Bq/l	0.0±0.0277 Bq/l	0.0±0.0517 Bq/l	
Specific total β-radioactivity	0.7507± 0.1890 Bq /l	0.2205± 0.1068 Bq/l	0.0975± 0.0458 Bq/l	0.0299± 0.0143 Bq /l	0.5441± 0.1392 Bq /l	

Hydrogeochemical composition of subsoil waters of confined aquifers

The *Dnieper-Sozh aqueoglacial water-bearing complex (f,lgIId-sz)* is the first confined aquifer from the surface in the research territory. It is pervasive and actively exploited through numerous water intake wells, providing the water supply to settlements and livestock farms (Goza, Shulniki, Aveni, Bobrovniki, Czechs and other villages). As regards its chemistry, the subsoil waters of the horizon is predominantly bicarbonate magnesium-calcium one. Its mineralisation varies from 0.20 g/dm³ to 0.71 g/gm³ and its average value is 0.3-0.4 g/dm³. The pH varies from 7.88 to 8.25, e.g. waters are weakly alkaline.

The results of chemico-analytical investigation of the quality of waters of the Dnieper-Sozh water-bearing complex for the year 2025 are shown in Tables 5.7, 5.8.

Table 5.7 – Hydrogeochemical characteristics of waters of the Dnieper-Sozh complex according to the data of the testing performed in 2025

List of wells	Bobrovniki Village (well No.43641/88)	Goza Village, Dairy Complex (well No.29218/76)	Mikhalishki Agro-Town, Farm Shop (well No.45233/90)	Markuny Village, Diary Farm (well No.36903/83)	Chekhi Village, Diary Farm (well No.29397/77)	Shulniki Village (well No.31871/78)
Description of the index	**Actual value, mg/dm³**					
Ammonium ion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total iron	0.826	0.842	<0.100	1.28	<0.100	0.672
Iron II	<0.100	0.549	<0.100	0.705	<0.100	<0.100
Iron III	0.825	0.293	<0.100	0.575	<0.100	0.672
Chloride ion	5.0	2.6	23.0	4.0	5.8	5.7
Sulphate ion	10.0	5.8	14.0	8.2	9.3	10.5
Nitrate ion	0.23	1.30	45.30	<0.2	<0.2	0.32
Nitrite ion	<0.2	1.40	<0.2	<0.2	<0.2	<0.2
pH (at 20°C)	7.1	7.6	7.6	7.6	7.5	7.8
Dry residue (mineralisation), 110°C	348	250	283	301	303	255
Manganese	0.005	0.093	0.002	0.052	0.079	0.001
Copper	0.003	0.002	0.002	0.011	<0.001	<0.001
Strontium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Zinc	0.003	0.004	0.005	0.008	0.007	0.006
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Total phosphor	<0.025	<0.025	0.033	0.036	<0.025	<0.025
Hydrocarbonates	372.1	274.5	176.9	317.2	317.2	274.5
Carbonates	Not detected	Not detected	Not detected	Not detected	Not detected	Not detected
Sodium	4.8	4.1	3.2	3.9	4.2	4.9
Potassium	1.2	1.0	0.8	1.0	1.2	1.1
Calcium	85.7	61.7	61.1	79.3	75.0	68.6
Magnesium	21.7	15.7	14.2	15.7	16.8	14.8
Permanganate oxidizability	1.12	1.76	0.96	1.92	1.28	1.28
Silicon	7.50	7.6	3.86	8.52	7.13	4.94
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Fluoride	0.18	0.18	<0.1	0.15	0.15	0.15
Volumetric activity ^{137}Cs	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l	<3.7 Bq/l

List of wells	Bobrovniki Village (well No.43641/88)	Goza Village, Dairy Complex (well No.29218/76)	Mikhalishki Agro-Town, Farm Shop (well No.45233/90)	Markuny Village, Diary Farm (well No.36903/83)	Chekhi Village, Diary Farm (well No.29397/77)	Shulniki Village (well No.31871/78)
Description of the index	**Actual value, mg/dm^3**					
Specific total α-radioactivity	0.0±0.0258 Bq/l	0.0±0.0569 Bq/l	0.0±0.0248 Bq/l	0.0±0.0230 Bq/l	0.0±0.0298 Bq/l	0.0±0.0270 Bq/l
Specific total β-radioactivity	0.0±0.0346 Bq/l	0.0850± 0.0366 Bq/l	0.0369± 0.0179 Bq/l	0.0553± 0.0240 Bq/l	0.0602 ± 0.0240 Bq/l	0.2851 ± 0.0867 Bq/l

Table 5.8 – Hydrogeochemical characteristics of waters of well No.23d on Site 2-1 according to the data of the testing performed in 2025

Wells	No.23d Sampling date: June 19, 2025	No.23d Sampling date: September 9, 2025	Allowable concentration*, mg/dm^3	Physiological usefulness norm***, mg/dm^3
Description of the index	**Actual value, mg/dm^3**			
Turbidity	–	1.80	1.5	–
Total hardness (hardness degree)	–	4.41	7.0	1.5-7.0
Ammonium ion	<0.5	–	1.5	–
Total iron	0.476	0.774	0.3	–
Iron II	0.476	–	not rated	–
Iron III	<0.100	–		–
Chloride ion	1.2	6.2	350	–
Sulphate ion	3.4	7.0	500	–
Nitrate ion	<0.2	1.25	45	–
Nitrite ion	<0.2	<0.2	3.0	–
pH (at 20°C)	7.6	7.5	6-9	–
Dry residue (mineralisation), 110°C	249	266	1000	100.0-1000.0
Total petroleum products	–	0.014	0.1	–
Manganese	–	0.234	0.1	–
Copper	–	<0.001	1.0	–
Strontium	–	<0.5	7.0	–
Chromium (III)	–	<0.025	0.5	–
Chromium (VI)	–	<0.025	0.05	–
Zinc	–	0.530	5.0	–
Lead	<0.005	<0.001	0.01	–
Selenium	–	<0.0001	0.01	–
Phosphate ion	–	0.27		–
Sodium	5.2	8.4	200.0	–
Hydrocarbonates	292.8	280.6	not rated	30.0-400.0
Carbonates	Not detected	–		–
Potassium	1.0	1.4		2.0-20.0

Wells	No.23d Sampling date: June 19, 2025	No.23d Sampling date: September 9, 2025	Allowable concentration*, mg/dm^3	Physiological usefulness norm***, mg/dm^3
Description of the index	Actual value, mg/dm^3			

The *aquifer of the Narov Mid-Devonian deposits of the (D_2nr)* in the research area is pervasive and has relatively large depths of occurrence (up to 80-110 m) and sufficiently high protection from surface contamination. Currently, it is exploited in the research area by only a few wells in the Mikhalishki Agro-Town and Goza Village.

The chemical composition of the aquifer waters is complex and variable. Their mineralisation varies from 0.53 g/dm^3 to 0.73 g/dm^3. At a mineralisation of 0.53 g/dm^3, the composition comprises sodium-magnesium-calcium bicarbonates and at a higher mineralisation (0.65-0.73 g/dm^3) – magnesium-sodium-calcium and magnesium-calcium-sodium bicarbonates and bicarbonates-sulphates. The increase in mineralisation and the change in the chemical composition of the subsoil waters in the horizon are caused by the accumulation of Cl^-, SO_4^{2-} and Na^+ ions. The increase in the content of these components is associated with the proximity of the zone of mineralised sulphate-chloride sodium waters, the roof of which lies here at a depth of about 150 m. There are no traces of anthropogenic pollution in the aquifer waters.

Area of location of Site 3-3

Geological conditions

The general information about the geomorphology, geological structure and hydrogeological conditions of the area is provided based on the data and results of surveys and investigations at Site 3-3 and in the immediate vicinity to it.

Geomorphology

As regards its geomorphology, Site 3-3 is associated with the Gorky Plain. The most part of the territory lies at altitudes of 190-200 m. The surface of the plain is flat and undulating with relative elevations of 3-5 m.

The relief is everywhere slightly technogeneousally transformed as a result of the ploughing of agricultural land.

In the territory of site 3-3, the manifestation of the suffusion process was recorded at four local sites in its southern and south-eastern parts. Currently, there are no other geological processes in the territory of Site 3-3, which would prohibit or restrict the construction of a radioactive wastes landfill.

Tectonics

Site 3-3 in the Mstislavsl District is located in the south-eastern part of the Orsha Depression on the border with the Voronezh Anteclise (Table 5.9).

Table 5.9 – **Geological and tectonic characteristics of Site 3-3 in the Mstislavsl District**

Item No.	Geological and tectonic characteristics	Site
		3-3
1	Earth crust type	AB
2	Depth of occurrence of the basement rocks, m	1400

Item No.	Geological and tectonic characteristics	Site
		3-3
3	Distance to the nearest deep-laid regional tectonic fault, km	85
4	Manifestation of active neotectonic blocks based on other research methods;	not established
5	Establishment of geotectonic faults from the research performed	not established
6	Establishment of geotectonic factors prohibiting the siting of the radioactive wastes landfill.	not established

According to the complex of performed geological and geophysical studies taking into account the geological and tectonic characteristics of the Mstislavl District area by the type of the earth's crust, the depth of occurrence of the crystalline basement, and the distance to deep regional and zonal tectonic faults in the area of Site 3-3 studied at the stage of detailed studies, no geotectonic factors have been established, which would prohibit the siting of a radioactive wastes landfill.

Appendix F contains a map of the gravitational field, recalculated to a depth of 500 m. According to the data of the gravity survey on a scale of 1:200,000 area and magnetic survey on a scale of 1:25,000, the inactive Volovniki latitudinal fault passes beyond the northern edge of the Site without extending into the upper parts of the section.

Seismic conditions

The data from instrumental observations were processed with compilation of bulletins based on recorded events at local network seismological observation points: 3-3.1 Mushino, 3-3.2 Sinezh, 3-3.3 Uspolye, 3-3.4 Pavlovichi, 3-3.5 Perevalochnaya.

According to the Map of the General Seismic Zoning of Northern Eurasia GSZ-97-D, the level of the maximum credible earthquake with a recurrence of once every 10,000 years (the average annual risk is 10^{-4}) for the site is 5 points.

The maximum estimated intensity from a possible seismic event in the nearest Mogilev area of a possible earthquake source (M_{max} = 4.5, H = 10 km, Δ = 33 km) is 4 points.

The maximum estimated intensity from a possible seismic event in the Vrancha area (M_{max} = 8.2, H = 80 km, Δ = 850 km) is 5 points.

Among the distant earthquakes during the reporting period, the earthquake, which occurred in the Hindu Kush region, Afghanistan on February 11, 2025 with a magnitude *mb*=6.5, hypocentre depth of 10 km and epicentral distance to the Site of 3,360 km, made the greatest impact on the Site; the estimated impact on the Site 3-3 was 0.4 points.

Among the distant earthquakes during the reporting period, the earthquake, which occurred in Romania on December 1, 2025 with a magnitude *mb*=3.8, hypocentre depth of 140 km and epicentral distance to the Site of 985 km, could make the highest impact on the site; the estimated impact on the Site 3-3 was below 0 points.

For the nearby Soligorsk earthquakes, the earthquake, which occurred on December 7, 2025 with a magnitude *mb* = 2.0, hypocentre depth of 33 km and epicentral distance to the site of 282 km had the greatest impact on the Site, the estimated impact on Site 3-3 was below 0 points.

The strongest historical earthquake closest to the Site occurred in the area of Mogilev City on November 12, 1896 with a magnitude of 4.0, epicentral distance to the

Site of 84 km and predicted intensity of seismic impact on the Site of 2.3 points (Figure 5.10) [7].

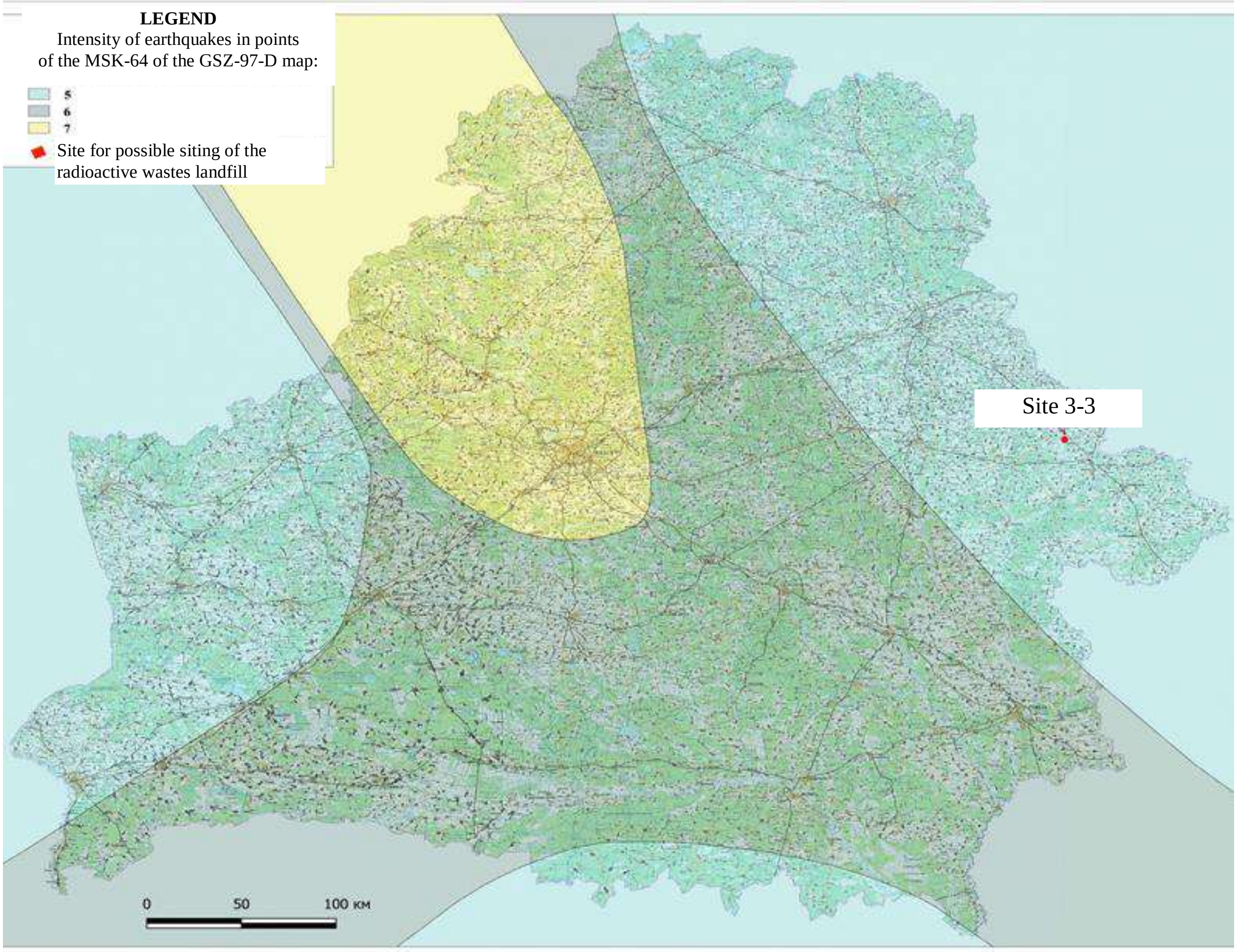


Figure 5.10 – Fragment of the GSZ-97-D map with indicating the position of Alternative Site 3-3 for siting the the radioactive wastes landfill

Engineering and geological conditions

Sedimentary cover structure

The area of the proposed location of the object is associated with the Mogilev Mould within the Orsha Depression. The depth of occurrence of the crystalline basement and thickness of the sedimentary apron is 1.0-1.3 km. The crystalline basement of igneous and metamorphic rocks of the Archaean-Lower Proterozoic (AR-PR_1). The sedimentary cover contains formations of the Riphean, Vendian, Devonian, Jurassic, Cretaceous, and Quaternary systems.

A weathering crust with a thickness of about 1 m is developed on the crystalline basement, overlain by sandstones, siltstones, mudstones, gravellites, conglomerates of the *Sherovichi and Belarussian series of the middle and Upper Riphean.* The roof lies at a depth of about 639 m.

The *Vendian* sediments include deposits of the *Vilcha and Volyn series*, composed of terrigenous rocks (clays, sandstones, siltstones, gravelites, conglomerates), and tuff and tuffite interlayers in the upper part of the Volyn series section. The roof lies at a depth of about 498 m.

The deposits of the *Devonian system* belong to the Emian, Eiffel, Givet, and Frasnian tiers. They are composed of alternating terrigenous (clays, siltstones and sandstones, with layers and nests of gypsum and anhydrite) and carbonate (mainly dolomites) strata. The roof occurrence depth is about 156 m.

The Devonian deposits are overlain by formations of the Callovian stage of the middle section of the Jurassic system: sands, weakly cemented sandstones, siltstones and clays. Jurassic deposits are found almost everywhere within the district. The roof is penetrated by the Klimovichskaya 4P parametric well at a depth of 96 m, at Site 3-3 – at a depth of 64.4-68.4 m.

The Jurassic sediments are overlain by the sediments of the *Cretaceous system.* The lower section and lower part of the upper section (the Gotterivian and Albian tiers, and the lower part of the Cenomanian tier) are composed mainly of sands. The most part of the upper section of the Cretaceous system is composed of carbonate rocks: chalk and marl. In the area of the Site, the roof of the Cretaceous system lies at various depths: it protrudes to the surface in some places of the valley of the Sozh River and submerges by several tens of meters in the most part of the area. The areal extension of the Cretaceous deposits of the region is complex: in some areas they are destroyed and the Jurassic formations are directly overlain by Quaternary ones. In some places, the carbonate (fine-marl) formations have been eroded in the section of the Cretaceous system in the presence of terrigenous ones. Island areas of Cretaceous deposits have been identified directly at the Site.

Thus, the Pre-Quaternary surface of the area is mainly represented by deposits of the Jurassic and Cretaceous systems.

The *Quaternary sediments* in the area under consideration have a thickness of 40.0-100.0 m, in some areas – up to the first meters (valley of the Vikhra River, Mstislavl town). In the valley of the Sozh River in the Krichev town area, the Quaternary sediments are completely wedged out, with the exposure of Cretaceous rocks.

In terms of Quaternary deposits, the horizons are distinguished: Gomel, Brest, Narev, Belovezha, Berezina, Alexandriya, Pripyat (with two subhorizons: Dnieper and Sozh), Muravin, Poozerye and Sudobl.

The deposits of the Gomel-Berezina as well as the Alexandrian and Muravin horizons of the Pleistocene have a local development. They are composed mainly of loamy sands, clays, sands, peat and peaty soils.

The poorly defined aqueoglacial deposits of the Berezina-Pripyat (Berezina-Dnieper) horizons are more consistent in their strike. The stratum includes sands with nests and interlayers of loamy sands, loams and clays. As a rule, the stratum thickness in this region does not exceed 8 m.

The *Dnieper subhorizon* of the Pripyat horizon is developed almost everywhere. It is represented by morainic (loamy sands and loams, lenses and sand interlayers) and aqueoglacial deposits. The latter ones form a poorly defined Dnieper-Sozh aqueoglacial stratum with a thickness of 5-17 m. The greatest thickness of the Dnieper morainic formations exceeds 20 m.

The morainic formations of the *Sozh subhorizon* are also distributed almost throughout the entire territory of the region, including the site. They are composed of loamy sands and loams with boulders and pebbles, with an average thickness of about 3-15 m.

The *Poozerye horizon* includes loess-like formations, represented mainly by loess-like loamy sands and loams, which occur almost everywhere. Their thickness in the area of the Sire reaches about 10 m.

The Sudobl horizon (Holocene) includes mainly alluvial (river and ravine alluvium), swamp, slope, and man-made formations. The river alluvium is represented by riverine and floodplain facies with a thickness of up to 15 m in the lower reaches of the Chernaya Natopa River. Immediately to the south of the site, in the valley of the Chernaya Natopa River, there are swamp formations that were previously exploited by peat mining. Formations of other genesis are local.

The current state of the geological environment within Site 3-3 is reviewed based on the data of engineering and geological surveys.

The terrain of the site is flat and weakly hilly. The slopes are medium-level and gently sloping, 1-3°. The general slope of the surface is directed to the south and south-west: absolute elevations decrease towards the valley of the Chernaya Natopa River from 197 to 177 m.

In the southern part of the Site, the upper reaches of the outflow dish directed towards the Chernaya Natopa River are located. The sides of the dish are flat, grass-covered and having no traces of water erosion. The dish is swamped in places in the depressions. Taking into account the dish mouth (south-west of the site), the local elevation difference is about 33 m.

Until recently, the territory was arable land, with areas of small separated deciduous forest stands confined mainly to the upper reaches of the dish. By October 2025, the woody and shrubby vegetation on the site was removed during land reclamation. A part of the dish on the southern border of the Site was deepened, with a closed excavation (trench) about 1.5 m deep, filled with excavated soil. The bottom and sides of the trench are composed of clayey soils; precipitation and melt-water may accumulate in it. At the time of observations in October 2025, the trench was not flooded. In some areas of the rest of the dish, flooding and the appearance of flarks are possible after snow melt and fallout of precipitation.

The specified depth of seasonal soil freezing under the surface exposed to snow is:

- 109 cm for loams and clays;
- 132 cm for loamy, fine and silty sands;
- 129 cm for gravelly, coarse and middle sands;
- 161 cm for macrofragmental soils.

Geological structure of the Site

The Quaternary system (Q) is represented by the following sediments, in the order of their occurrence from top to bottom.

Vegetable ground and topsoil. The thickness is 0.2-0.5 m.

Industrial deposits. They are composed mainly of bulk soils formed during the construction of earth roads and during land reclamation. They are distributed locally.

Poozerye horizon. Deposits of problematic distribution (prIII*pz*) are loams and loess-like loamy sands with layers of slightly wet and wet sand. They occur from the surface and under the Vegetable ground and topsoil to a depth of 0.7-5.1 m. The thickness is 0.4-4.8 m.

Sozh horizon. Morainic deposits (gII*sž*). Red-brown and dark brown loamy sands and loams with gravel and pebbles up to 10-15%, with intermediate layers of up to 20 cm and lenses of up to 3.4 m of silty to gravelly slightly wet, wet and water-saturated sands. Single lenses of silty loamy sands are found. They occur under the loess-like deposits at a depth of 0.7-5.1 m, sometimes from the surface. The bottom is penetrated at a depth of 6.0-22.1 m, the thickness is 3.7–17.7 m.

Dnieper and Sozh horizons. The aqueoglacial intermorainic deposits (f, lgII*d-sž*) consist of silty to coarse, somewhere clayey sands with interlayers and lenses of loams and loamy sands. Loams and loamy sands lie irregularly in depth and plan and form interlayers and lenses with a thickness of 0.5-10.2 m (found in the middle and lower parts of the section at a depth of 13.9-27.9 m). The deposits lie under the Sozh moraine. The bottom of deposits is penetrated at a depth of 17.2-38.9 m. The thickness is 7.4-21.2 m. Some wells have not penetrated completely, the penetrated thickness is 7.9-23.6 m.

Dnieper horizon. The morainic deposits (gII*d*) consist of loams, loamy sands, often sandy clay loams; they contain gravel and pebbles up to 10-15% and intermediate layers (10-20 cm) of water-saturated sands. The deposits are coloured from dark brown to grey-green. The bottom is penetrated at a depth of 35.2-50.8 m, the thickness is 6.3-21.3 m. Some wells have not penetrated the deposits completely, the penetrated thickness is 1.7-13.5 m. The Dnieper moraine is pervasive at the Site and forms the second regional water barrier, which is more stable than the Sozh moraine.

Berezina-Dnieper horizon. The aqueoglacial lacustrine intermorainic deposits (f,lgI*br-d*) consist of fine to coarse water-saturated sands, somewhere with interlayers and lenses (up to 1.6 m) of loams and loamy sands. They contain inclusions of organic matters somewhere at a depth of 40.2-52.6 m. The deposits are penetrated under loamy sands of the Dnieper horizon. The bottom lies at a depth of 37.6-56.0 m, the thickness is 1.6–13.2 m.

The total thickness of quaternary deposits at the Site is up to 56.0 m.

The *Pre-Quaternary deposits* from Proterozoic to Jurassic inclusive as well as the rocks of the *crystalline basement* roof are described above.

The roof of the deposits of the upper section of the *Cretaceous system* was penetrated beneath the Quaternary formations at a depth of 37.6-56.0 m.

Sediments of the *Cenomanian stage* (K_2s) of the upper Cretaceous system are represented by fine and medium glauconite water-saturated sands (they lie in the roof of sediments at a depth of 37.6-49.4 m in a layer of 3.2-8.8 m, not everywhere) as well as carbonate rocks: chalk, clay chalk, marl and calcareous clay. The carbonate deposits lie at a depth of 39.6-53.0 m, the thickness is 3.2-10.4 m. The sites have the largest thickness in the centre and in the south-east of the Site. The content of $CaCO_3$ varies from 7.1 to 99.5%. They are missing in the south-west, north-west, and north of the site.

The poorly defined sediments of the *Albian-Cenomanian stages* ($K_{1+2}al+s$) of the lower and upper sections of the Cretaceous system are represented by fine and medium, clayey and water-saturated sands. They occur throughout the Site. The roof is penetrated at a depth of 50.0-56.6 m, the bottom – at a depth of 64.4-68.4 m. The thickness is 12.4-13.6 m.

The sediments of the *Callovian stage* (J_2k) of the Jurassic system are represented by a sophisticated complex of clays, loams, powdery sands and siltstones. The argillaceous deposits predominate. Silty-sandy and silty rocks occur in them in the form of lenses and interlayers. The argillaceous deposits are characterised by carbonation and the presence of organic matter. The roof of the deposits lies at a depth of 64.4-68.4 m. Drilling to a depth of 100 m has not penetrated the deposits at full thickness and the penetrated thickness is up to 35.6 m.

Engineering and geological conditions

The following EGEs are distinguished at the Site (Table 5.10).

Quaternary system. Loess-like deposits

EGE-1a. Weak loamy sand
EGE-1. Moderate-strength loam
EGE-2. Strong loam
Morainic deposits of the Sozh horizon
EGE-3. Weak loamy sand
EGE-4a. Silty loamy moderate-strength sand
EGE-4. Loamy moderate-strength sand
EGE-5. Strong loamy sand (q_c≤3.8 MPa, *Pd*≤4.0 MPa)
EGE-6. Strong loamy sand (*qc*>3.8 MPa, *Pd*>4.0 MPa)
EGE-7. Very strong loamy sand (q_c≤15.0 MPa)
EGE-8. Very strong loamy sand (q_c>15.0 MPa)
EGE-9. Strong silty sand
EGE-10. Strong fine sand
EGE-11. Medium moderate-strength sand
EGE-12. Strong medium sand
EGE-13. Strong coarse gravelly sand
Aqueoglacial intermorainic deposits of the Drieper and Sozh horizons
EGE-15. Strong silty sand
EGE-16a. Fine moderate-strength sand
EGE-16. Strong fine sand
EGE-17. Medium moderate-strength sand
EGE-18. Strong medium sand
EGE-19. Coarse moderate-strength sand
EGE-20. Strong coarse sand
EGE-21. Strong loam (q_c≤3.8 MPa, *Pd*≤4.0 MPa)
EGE-22. Strong loam (q_c>3.8 MPa, *Pd*>4.0 MPa)
EGE-23. Very strong loamy sand
Morainic deposits of the Dnieper horizon
EGE-24. Moderate-strength loam
EGE-25. Strong loam (q_c≤3.8 MPa, *Pd*≤4.0 MPa)
EGE-26. Strong loam (q_c>3.8 MPa, *Pd*>4.0 MPa)
EGE-27. Very strong loam
Morainic deposits of the Dnieper horizon
EGE-28. Semi-hard loam
Aqueoglacial intermorainic deposits of the Berezina and Drieper horizons
EGE-29. Fine sand
EGE-30. Medium sand
EGE-31. Coarse sand
EGE-31a. Loam with inclusion of organic matter
Quaternary system. Cenomanian stage (K_2s)
EGE-32. Marl
EGE-33. Chalk
EGE-34a. Fine sand
EGE-34. Medium sand
Albian and Cenomanian Stages (K_{1+2} al+s)
EGE-35. Fine sand
EGE-36. Medium sand
Jurassic system. Callovian stage (J_2k)
EGE-37. Loam
EGE-38. Clay with inclusion of organic matter

EGE-39. Peaty loam and clay
EGE-40. Silty sand

Table 5.10 – **Estimated values of the soil characteristics**

EGE, soil	**Specific weight** γ_n**, kN/m**^{3}	**Specific cohesion** c_n**, kPa**	**Internal friction angle** φ_n**, deg.**	**Modulus of deformation** E**, MPa**
EGE-1a. Weak loamy sand	20.3	31	24	4.4
EGE-1. Moderate-strength loam	19.8	38	24	11.1
EGE-2. Strong loam	18.8	36	25	15
EGE-3. Weak loamy sand	21.5	17	27	4.9
EGE-4a. Silty loamy moderate-strength sand	20.2	29	25	11
EGE-4. Loamy moderate-strength sand	21.5	27	28	9.7
EGE-5. Strong loamy sand (q_c≤3.8 MPa, *Pd*≤4.0 MPa)	22.0	32	27	18.7
EGE-6. Strong loamy sand (q_c>3.8 MPa, *Pd*>4.0 MPa)	22.0	32	31	24.3
EGE-7. Very strong loamy sand (q_c>15.0 MPa)	22.4	40	30	31
EGE-8. Very strong loamy sand (q_c>15.0 MPa)	22.2	40	30	41
EGE-9. Strong silty sand	$\frac{18.2}{10.6}$	5	33	$\frac{30}{25}$
EGE-10. Strong fine sand	$\frac{18.2}{11.5}$	3	35	38
EGE-11. Medium moderate-strength sand	$\frac{18.5}{11.1}$	1	36	33
EGE-12. Strong medium sand	$\frac{18.5}{11.1}$	2	38	49
EGE-13. Strong coarse gravelly sand	$\frac{19.3}{11.3}$	1	41	49
EGE-15. Strong silty sand	$\frac{-}{10.7}$	6	34	35
EGE-16a. Fine moderate-strength sand	$\frac{-}{10.7}$	2	32	22
EGE-16. Strong fine sand	$\frac{18.3}{10.7}$	4	36	40
EGE-17. Medium moderate-strength sand	$\frac{18.2}{10.3}$	1	36	21
EGE-18. Strong medium sand	$\frac{18.5}{10.9}$	2	38	44
EGE-19. Coarse moderate-strength sand	$\frac{19.2}{9.8}$	1	39	21
EGE-20. Strong coarse sand	$\frac{-}{11.0}$	1	41	42
EGE-21. Strong loam (q_c≤3.8 MPa, *Pd*≤4.0 MPa)	21.2	24	26	18
EGE-22. Strong loam (q_c>3.8 MPa, *Pd*>4.0 MPa)	21.9	34	25	24

EGE, soil	**Specific weight** γ_n**, kN/m³**	**Specific cohesion** c_n**, kPa**	**Internal friction angle** φ_n**, deg.**	**Modulus of deformation** *E***, MPa**
EGE-23. Very strong loamy sand	21.3	34	26	28
EGE-24. Moderate-strength loam	21.8	27	27	11.5
EGE-25. Strong loam (q_c≤3.8 MPa, *Pd*≤4.0 MPa)	22.2	31	26	15.9
EGE-26. Strong loam (q_c>3.8 MPa, *Pd*>4.0 MPa)	22.0	36	26	25
EGE-27. Very strong loam	22.2	41	25	40
EGE-28. Semi-hard loam	22.2	34	23	33
EGE-29. Fine sand	10.4	3	34	25
EGE-30. Medium sand	10.6	2	38	35
EGE-31. Coarse sand	10.0	–	38	30
EGE-31a. Loam with inclusion of organic matter	20.5	64	25	14
EGE-32. Marl	18.8	91	12	25
EGE-33. Chalk	18.9	33	28	25
EGE-34a. Fine sand	10.9	5	37	35
EGE-34. Medium sand	9.7	2	37	30
EGE-35. Fine sand	9.2	3	34	25
EGE-36. Medium sand	10.0	1	35	25
EGE-37. Loam	20.4	37	21	20
EGE-38. Clay with inclusion of organic matter	20.1	89	11	14
EGE-39. Peaty loam and clay	18.0	60	17	7.5
EGE-40. Silty sand	10.0	4	30	25

Notes:

1. The specific weight of sands above the horizontal bar corresponds to slightly wet and wet sands and that under the horizontal bar – to water-saturated ones taking into account the buoyant force of water;
2. The E value of silty sand of EGE-9 above the horizontal bar corresponds to slightly wet sands and that under the horizontal bar – to water-saturated ones.

The loess-like loamy sands, loams of EGE-1a, 1, 2 cover the underlying sediments everywhere, with the exception of local areas. Non-subsiding ones heaving when being frozen can exhibit thixotropic properties and reduce strength and deformation characteristics under dynamic influence. The modulus of deformation is less than 20 MPa.

The *morainic deposits of the Sozh horizon* consist of loamy sands and loams from weak to very strong (EGE–3-8), with single lenses of silty loamy moderate-strength sand (IGE-4a). They contain the interlayers and lenses of sands being preferably strong (EGE-9, 10, 12, 13) and rarer –moderately strong EGE-11.

The soils of EGE-3, 4, 4a5 characterised by a modulus of deformation *E* <20 MPa are distinguished everywhere, with the exception of the north-eastern part of the site. They occur in the form of lenses and interlayers at depths from 2.5 to 20.9 m.

The aqueoglacial intermorainic deposits of the Dnieper and Sozh horizon consist of moderate-strength (EGE-16a, 17, 19) and strong (EGE-15, 16, 18, 20) sands. They are characterised by a modulus of deformation E>20 MPa. In the sands, the lenses of strong loams (EGE-21, 22) and very strong loamy sands (EGE-23) are distinguished. The strong loam (EGE-21) (E<20 MPa) is found locally in the southern part of the Site.

The morainic deposits of the Dnieper horizon consist of moderate-strength (EGE-24) and strong (EGE-25) (E<20 MPa) loams are found locally and developed to the depth of 34.3 m.

The examples of geotechnical cross-sections intersecting the Site are presented in Appendices G, H and I [5].

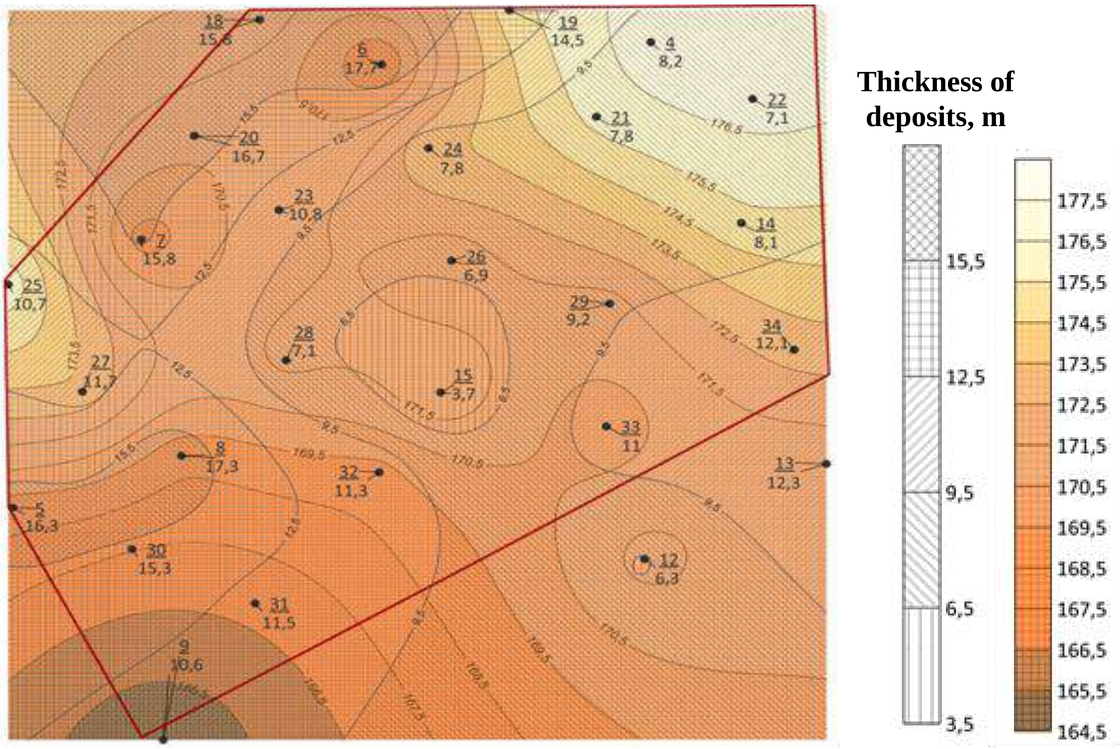
Hydrogeological conditions

Aeration zones.

The aeration zone is dominated by water-resistant clayey soils, including loess-like and morainic loams and loamy sands. To a lesser extent, sandy soils are developed in the aeration zone, with a predominance of fine sands, less often of a different grain composition.

The thickness map of the morainic layer of the Sozh horizon, which is composed predominantly of clayey soils and determines the protection of subsoil waters from surface contamination, is shown in Figure 5.11. The best natural protection of subsoil waters is provided in the north-west, west and south-west of the site, while in the central part and south-east of the site (the hollow area) the protection is minimal.

Taking into account the higher sorption properties of clayey soils compared to sandy soils, the predominance of clayey soils in the aeration zone is a favourable factor.



Legend:

31
11,5
- **Number of the research point (above the horizontal bar), thickness of the deposits, m (under the horizontal bar)**

170,5
- **Isohypse of the bottom of the deposits, its absolute mark, m**

12,5
- **Isoline of the thickness of the deposits, m**

- **Site contour**

Figure 5.11 – Map of the thickness of morainic soils of the Sozh horizon

Aquifers and water-bearing complexes. In accordance with the geological structure and lithological features of the water-bearing soils, aquifers of Quaternary and Pre-Quaternary deposits are distinguished up to a depth of 100 m.

The perched water is penetrated with well No.10 at a depth of 3.3 m (the absolute mark is 168.07 m) in medium sands deposited on the roof of the Sozh moraine. The thickness of the water-bearing soils is 2.2 m.

During the wettest periods of the year, the appearance of a perched waters is also possible in other areas in the sandy deposits of the roof of the Sozh moraine.

The *sporadic-distribution waters* are associated with thin layers and lenses of silty, fine, medium and gravelly sands in the argillaceous deposits of the Sozh horizon. The waters have a confined and unconfined nature. The static (piezometric) levels are set at a depth of 3.4-14.2 m, at absolute elevations of 167.97-176.26 m. The head reaches 4.1 m. They are distributed locally. The thickness of the water-bearing soils is up to 4.1 m.

According to the laboratory measurements, the sand filtration coefficients vary between 0.09-14.0 m/day, and, according to geophysical research, they are 2.4-5.9 m/day.

The waters are formed due to infiltration of atmospheric precipitation. The discharge occurs due to water migration or infiltration into the underlying horizons. The water temperature is about 8°C. As regards their chemistry, the waters have mainly bicarbonate magnesium-calcium composition, they are fresh with a dry residue of 183.0-579.0 mg/dm^3, pH 7.3-8.0 (slightly alkaline), from mild to moderately harsh.

They are non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures.

Dnieper and Sozh aqueoglacial water-bearing complex (f,lgIId-sz). It is pervasive and has confined and unconfined nature, it is unconfined in wells No.21, 22, 25, 27; 2A, 4, 14. The piezometric (static) levels are set at a depth of 3.2-15.6 m (the absolute mark is 167.39-176.91 m).

The depth of the roof of the horizon on the Site varies from 5.9 to 22.1 m. The pressure head is 7.7 m.

The water-bearing soils of the complex are sands ranging from silty to coarse, often clayey, mostly fine and medium ones. In a number of wells, there are layers of silty loams and loamy sands in the sands.

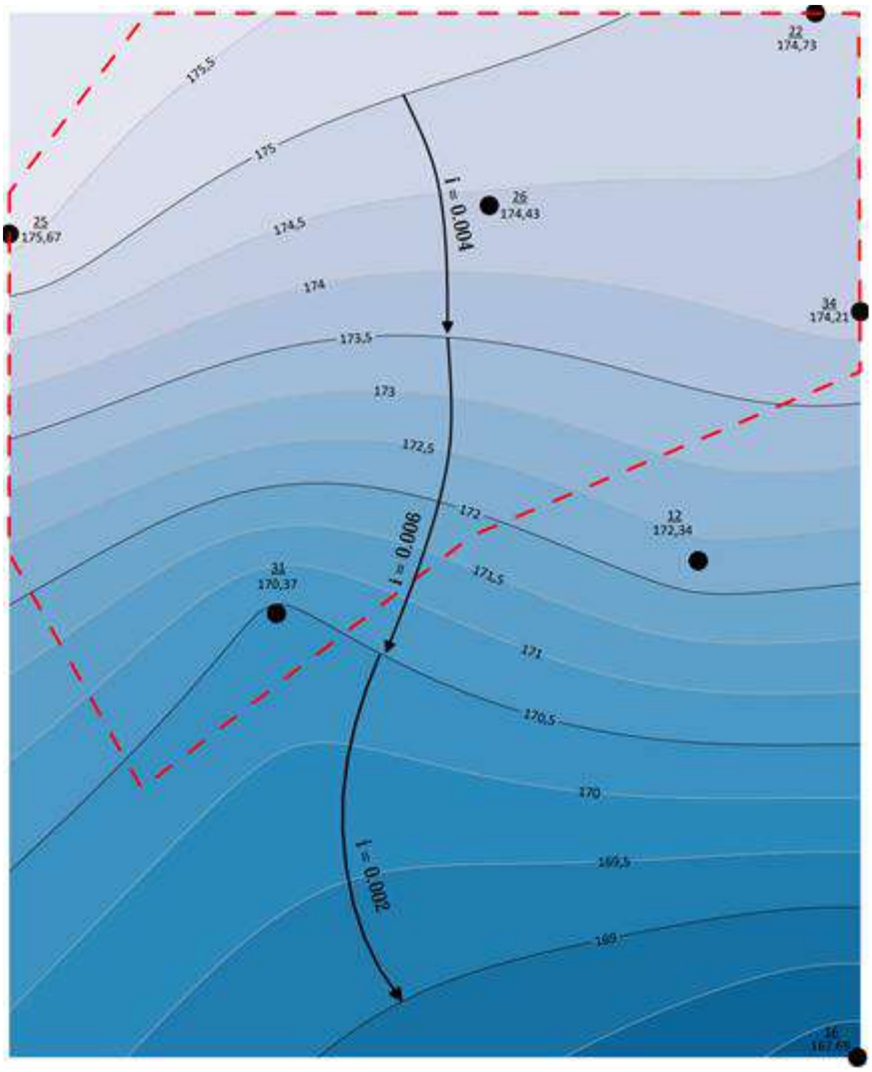
According to the laboratory definitions, the sand filtration coefficients are 0.05-2.00 m/day, according to the geophysical research, they are 0.1-12.1 m/day. The complex is characterised by the anisotropy of filtration properties in the vertical and horizontal directions.

According to the data of the cluster pumping test on adjacent territories (Kamenka quarry), the filtration coefficients of fine and silty sands are 0.1-7.9 m/day (the average value is 5 m/day) and that of medium sands is 21.3 m/day. The complex thickness is 7.4-23.6 m.

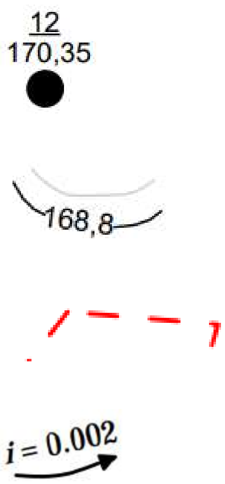
According to the laboratory measurements, the filtration coefficients of loamy sands and loams protecting the aquifer from pollution are 0.0002-0.0032 m/day with an average value of 0.0016; according to the geophysical research data, the weighted average filtration coefficients of the upper watertight stratum, taking into account the sand layers, are 0.149-0.395 m/day. Filtration properties are characterised by anisotropy. The horizon is recharged by infiltration of atmospheric precipitation and due to overflow of water from the overlying horizons (perched water and sporadic-distribution waters) and lateral inflow; it is discharged due to water migration into the underlying horizon and lateral flow.

The water flow direction is south, towards the Chernaya Natopa River. The slope is 0.002-0.006. The top watertight stratum consists of loamy sands and loams of the Sozh moraine.

The predicted level is assumed to be 1 m higher than that recorded during the survey (Figure 5.12).



Legend:



- well number (top), absolute mark of the static level (bottom), m;

- hydroisopiestic line, its absolute mark, m;

- site boundary;

- direction and slope of the subsoil water flow.

Figure 5.12 – Map of hydroisopiestic lines of the Dnieper-Sozh water-bearing complex

Berezina-Dnieper aqueoglacial water-bearing complex (*f,lgIbr-IId)*. It lies at a depth of 35.2-50.8 m and has a confined nature. The piezometric levels were set at a depth of 13.7-19.5 m, the absolute mark is 157.67-160.64 m.

It has not been penetrated with well No.19, in which the Dnieper moraine lies on terrigenous Upper Cretaceous deposits.

The water-bearing soils consist of fine, medium and coarse sands, often clayey, with layers and lenses of silty loams. According to the geophysical research data, the sand filtration coefficients are 0.3-36.2 m/day.

The top watertight stratum is the Dnieper horizon moraine. The complex thickness is 1.6-13.2 m.

The *Upper Cretaceous Cenomanian carbonate-terrigenous complex* (K_{2s}) is exposed by wells No.19, 22, 26, 27, 30, 32, 33, 34; 7, 16 at a depth of 37.6-53.0 m. The water-bearing soils are marl and chalk. In wells No. 30, 32 and 33 of the upper part of the complex, terrigenous deposits are distinguished: fine and medium sands with a thickness of 3.2-8.8 m. The thickness of the complex is 3.2-12.8 m and that of carbonate deposits is 3.2-10.6 m.

There is no information about the level mode on the Site.

According to the data of cluster pumping test from the aquifer in the adjacent territory (Kamenka quarry), the water-bearing soils (chalk) are characterised by a filtration coefficient of 1.31-2.46 m/day. At the same time, the pressure gradient in the upper part of the complex (the change in absolute mark from piezometric levels in depth) is 0.138 and 0.05 in the rest.

The Lower Cretaceous terrigenous water-bearing complex (K_{1-2}) is penetrated at a depth of 49.4-56.6 m. The water-bearing soils consist of medium and fine glauconite-quartz, sometimes clayey sands with interlayers of silt loamy sands. The thickness of the water-bearing soils is 1.4-12.4 m. There is no information about the site's horizon levels. The sand filtration coefficients according to geophysical research data are 0.6-21.4 m/day.

The Jurassic terrigenous water-bearing complex (J_{2k}) is penetrated at a depth of 64.4-68.4 m. The water-bearing soils consist of interlayers of silty sands in loamy sands and loams with a thickness of 3.2-4.8 m.

There is no information about the horizon levels. According to the geophysical research data, the sand filtration coefficients are 0.14-2.50 m/day.

The Site is located in the recharge zone of subsoil waters with a noted downward movement of subsoil waters – migration from the upper levels to the underlying ones. The absolute marks of water levels in the upper levels are always higher than in the underlying ones.

Hydrogeochemical composition of waters of the phreatic aquifer exploited through excavated wells

According to the data of the Mstislavl Regional Centre for Hygiene and Epidemiology Health Care Institution, water in excavated wells is characterised by the following concentrations of components such as nitrates, chlorides, and sulphates:

– the content of nitrates ranges from 0.2 mg/dm^3 to 35.2 mg/dm^3 and that in the wells of the Dobroye and Rakitenka Villages is below the detection limit;

– the content of chlorides ranges from 14 mg/dm^3 to 41.6 mg/dm^3;

– the content of sulphates ranges from 8.0 mg/dm^3 to 38.7 mg/dm^3.

The concentrations of these substances do not exceed the safety indices of non-centralised drinking water supply systems established by the legislation.

The results of chemical and analytical studies of the water quality of excavated wells based on the results of the survey performed in December 2025 are shown in Table 5.11.

Table 5.11 – Hydrogeochemical characteristics of the waters used for the water supply through the excavated wells

List of wells	**Khodosy Agro-Town**	**Belynets Village**	**Volovniki Village**	**Novoye Selo Village**	**Lopatino Villlage**	**Dobroye Village**	**MAC, mg/dm³**
Description of the index	**Actual value, mg/dm³**						
Ammonium ion	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.5
Total iron	<0.10	<0.10	0.13	<0.10	<0.10	0.14	0.3
Chloride ion	6.8	32.8	13.0	100.2	11.3	22.6	350
Sulphate ion	55.1	28.4	23.0	53.5	20.2	32.1	500
Nitrate ion	27.7	8.3	26.3	**151.4**	**47.6**	20.6	45
Nitrite ion	0.015	0.064	0.004	<0.003	0.008	0.007	not observed**
pH (at 20°C)	7.5	7.5	7.5	7.6	7.4	8.1	6-9
Mineralisation (according to dry residue at 110°C)	564	510	434	750	538	350	1,500
Manganese	<0.002	<0.002	0.003	0.003	0.002	<0.002	0.1
Copper	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	1.0
Strontium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	7.0
Total chromium	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.05***
Zinc	0.026	0.032	0.032	0.015	0.016	0.028	5.0
Lead	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.01
Total phosphor	<0.025	<0.025	0.15	<0.025	0.13	0.50	
Hydrocarbonates	521.6	491.1	396.5	384.3	509.4	244.0	not observed
Carbonates	0	0	0	0	0	0	not observed
Sodium	35.0	5.4	13.1	77.3	20.1	19.3	not observed
Potassium	0.8	1.6	20.4	0.6	1.2	50.4	not observed
Calcium	117.6	128.3	96.2	112.2	126.1	62.0	not observed
Magnesium	35.7	36.3	22.7	46.0	32.4	5.2	not observed
Permanganate oxidizability	1.68	0.72	1.28	1.52	0.80	3.52	5.0
Silicon	4.90	5.55	5.87	5.92	4.25	5.95	not obser

List of wells	Khodosy Agro-Town	Belynets Village	Volovniki Village	Novoye Selo Village	Lopatino Villlage	Dobroye Village	MAC, mg/dm^3
Description of the index	Actual value, mg/dm^3						
							ved
Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	not observed
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01
Fluoride	0.30	0.25	0.22	0.22	0.26	0.27	1.5
Specific total α-radioactivity	0.0 ± 0.0238 Bq/l	0.0 ± 0.0403 Bq/l	0.0 ± 0.0424 Bq/l	0.0 ± 0.0517 Bq/l	0.0 ± 0.0543 Bq/l	0.0 ± 0.0356 Bq/l	0.5 Bq/l
Specific total β-radioactivity	0.0 ± 0.0552 Bq/l	0.0 ± 0.0517 Bq/l	0.5046 ± 0.1429 Bq/l	0.0799 ± 0.0352 Bq/l	0.0 ± 0.0565 Bq/l	1.2431 ± 0.3027 Bq/l	1 Bq/l

As regards their chemistry, the aquifer waters are preferably magnesium-calcium hydrocarbonate ones with a total mineralisation from 350 mg/dm^3 to 750 mg/dm^3.

The analysis of the results obtained and data from the Mstislavsky District Center for Hygiene and Epidemiology Healthcare Institution make it possible to note that in addition to nitrates, an increased content of which was detected in two wells of the Novoye Selo and Lopatino Villages, the content of other regulated components of the chemical composition of groundwater did not exceed the safety indices established by the legislation for non-centralised drinking water supply systems.

In addition to the high content of nitrates, the water sampled from the well in D.New Village contained a high level of sulphates, chlorides, sodium and, accordingly, general mineralisation. The increase in the content of these components in the water indicates the sources of agricultural or municipal pollution. In the areas containing sources of agricultural and municipal pollution, the chemical composition of the waters being nearest to the surface can change significantly, which is manifested in an increase of the content of primarily NO_3^-, Cl^-, SO_4^{2-}, Na^+ and K^+ ions.

The total α-radioactivity of the groundwater is at the level of 0.0 Bq/l. The total β-radioactivity varies from 0.0 to 0.5046 Bq/l, except for one water sample, where the value of 1.2431 Bq/l is recorded (Dobroye Village). A preliminary assessment of the permissibility of using drinking water for drinking purposes may be made by the total volumetric α- and β-activity, which should not exceed 0.5 and 1 Bq/l, respectively (paragraph 46 of the hygienic standard “Criteria for assessing radiation exposure”, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 829 dated November 29, 2022).

The redox conditions of subsoil waters are given according to the literature data; no measurements were carried out at Site 3-3. The redox potential (Eh, mV) of subsoil waters in Belarus is characterised by the following indices:

– for groundwater of lowland and transitional swamps (hIV): Eh from +200 mV to +300 mV;

– for groundwater of upland swamps (hIV): Eh from +280 mV to +450 mV;

– for groundwater of alluvial deposits (aIV, aIII) swamped deposits: Eh from +120 mV to +280 mV; on upland areas Eh from +270 mV to +420 mV.

There are no swamps or swamped lands at Site 3-3, which makes it possible to estimate the value of the redox potential of groundwater in the thickness of the terminal morainic deposits in this area in the range from +270 mV to +420 mV.

The alkalinity can be estimated on basis of the results of hydrochemical research performed in 2025. On the basis of the data obtained in groundwater and sporadic-distribution waters, the values of bicarbonate alkalinity vary in the range of 2.80-5.8 mmol/dm^3.

The soil horizon waters are fresh and, therefore, the density of these waters is close to 1.0 g/l at a temperature of 20-25°C.

Groundwater within Site 3-3 has an extremely low dissolving capacity relative to the covering and water-bearing deposits as they are represented primarily by silicate (quartz sands and, more rarely, feldspar-quartz) and aluminosilicate (clay minerals of loamy sands and loams) rocks.

Colloidal impurities in the groundwater of the Site 3-3 are practically absent. In some areas of Belarus, natural colloidal impurities are associated with the presence of elevated (exceeding the degree of solubility) content of silicic acid. The degree of solubility is about 27 mg/dm^3 (in the form of H_4SiO_4) and their observed concentrations in the groundwater of lowland swamps in the Belorussian Polesye zone reached in some cases 50-70 mg/dm^3. In the groundwater at Site 3-3, the content of silicic acid (in the form of H_4SiO_4) varies from 4.25 to 5.95 mg/dm^3, which does not exceed the degree of solubility of silicic acid and, accordingly, it is in the form of a true solution instead of colloid one.

At Site 3-3, the gas composition was characterised according to data from previous studies. The nitrogen gas composition is absolutely predominant in fresh subsoil waters in Belarus. In general, the nitrogen content in fresh subsoil waters is in equilibrium with its content in the atmosphere and amounts to 20.0-25.0 mg/dm^3. Carbon dioxide is also present in significant quantities (10-50 mg/dm^3), the groundwater contains also oxygen. Its content varies greatly depending on the depth of the groundwater. Its maximum concentrations are observed in the near-surface zone: up to 6-8 mg/dm^3; at depths above 20 m the oxygen content, as a rule, does not exceed 1-2 mg/dm^3.

According to the research results, the sporadic-distribution waters the aquifer of the Sozh morainic horizon and the groundwater of the aquifer of the Dneprovsky-Sozh aqueoglacial complex are non-aggressive to concrete and reinforced concrete structures and moderately aggressive to metal structures.

Hydrogeochemical composition of subsoil water of confined aquifers used for the water supply

Frasnian clastic-carbonate water-bearing complex (D_3f)

This water-bearing complex is widely used for water supply. The water sample was taken from the well in the Uspolye Village. The results of the chemico-analytical works are presented in Table 5.13.

According to the well data sheet (No. 5075/6976) at the moment of drilling (1960), the aquifer water was characterised by the following indices: permanganate oxidizability: 4.6 mgO_2/dm^3; content of sulphate ion: not detected, chloride ion: 3.9 mg/dm^3, total iron: 0.5 mg/dm^3; pH: weakly alkaline; total hardness: 20,7°, dry residue: 380 mg/dm^3.

In comparison with the water quality at the time of drilling, there was an increase in mineralisation, while there was no increase in the content of chloride ion and sulphate ion. The permanganate oxidizability value decreased, which reflects the total content of organic and readily oxidizable inorganic substances in water.

Upper Jurassic clastic-carbonate water-bearing complex (J_3)

This water-bearing complex is also widely used for water supply. The water sample was taken from the well in the Molyatichi Agro-Town at the diary farm.

According to the data sheet of the well located in the Zabolotye Village, which exploits the water of the complex at the moment of drilling (1967), the water was characterised by the following indices: permanganate oxidizability: 4.64 mgO_2/dm^3; alkalinity: 6.6 mg-eq/dm^3; content of sulphate ion: not detected, chloride ion: 1.96 mg/dm^3, total iron: 0.6 mg/dm^3; pH: 7.95; total hardness: 5.94 mg/eq, calcium: 85.05 mg/dm^3, magnesium: 16.5 mg/dm^3, dry residue: 340.6 mg/dm^3.

Comparing these indices with the current water quality of the Upper Jurassic clastic-carbonate complex, it can be noted that there have been no significant changes: the total iron concentrations exceed also the acceptable norms, the content of calcium and magnesium is within the limits of the standards of physiological usefulness for drinking water. The water mineralisation has increased insignificantly. The permanganate oxidizability has improved, which shows a decrease in organic and readily oxidizable inorganic substances.

Sargaya and Semiluki clastic-carbonate water-bearing horizon (complex) (D_3sr+sm).

The horizon is exploited through the well at the Diary Farm of the Zabolotye-Agrostandard OJSC, in the Khodosy Agro-Town is equipped. The results of the chemico-analytical studies of the water quality performed in 2025 are presented in Table 5.12

Table 5.12 – Hydrogeochemical characteristics of waters of the aquifers exploited through wells in the reaearch area

List of wells	Khodosy Agro-Town	Uspolye Village	Sychovka Village	Molyatichi Agro-Town	MAC*, mg/dm^3
Description of the index	**Actual value, mg/dm^3**				
Ammonium ion	<0.1	<0.1	<0.1	<0.1	1.5
Total iron	1.53	0.59	<0.10	0.24	0.3
Chloride ion	1.7	1.7	13.6	1.1	350
Sulphate ion	<2.0	<2.0	23.0	<2.0	500
Nitrate ion	2.2	2.2	19.6	<0.1	45
Nitrite ion	<0.003	<0.003	<0.003	0.005	3.0
pH (at 20°C)	7.3	7.2	7.6	7.2	6-9
Dry residue (mineralisation), 110°C	364	426	336	429	1000
Manganese	0.063	<0.002	0.003	0.006	0.1
Copper	<0.001	<0.001	<0.001	<0.001	1.0
Strontium	<0.5	<0.5	<0.5	<0.5	7.0
Chromium	<0.025	<0.025	<0.025	<0.025	0.05
Zinc	0.017	0.009	0.009	0.087	5.0
Lead	<0.005	<0.005	<0.005	<0.005	0.01
Total phosphor	0.046	0.37	<0.025	<0.025	
Hydrocarbonates	424.0	515.4	317.2	524.6	not observed (30.0-400.0)

List of wells	Khodosy Agro-Town	Uspolye Village	Sychovka Village	Molyatichi Agro-Town	MAC*, mg/dm^3
Description of the index	**Actual value, mg/dm^3**				
Carbonates	not detected	not detected	not detected	not detected	not observed (-)
Sodium	4.6	6.5	6.3	7.0	200.0
Potassium	1.4	2.8	0.9	4.6	not observed (2.0-20.0)
Calcium	96.2	122.9	81.2	125.1	not observed (25.0-130.0)
Magnesium	24.0	24.6	24.6	24.0	not observed (5.0-65.0)
Permanganate oxidizability	4.32	1.28	0.72	1.52	5.0
Silicon	6.54	6.35	3.32	4.43	10.0
Molybdenum	<0.001	<0.001	<0.001	<0.001	0.07
Arsenic	<0.001	<0.001	<0.001	<0.001	0.01
Fluoride	0.30	0.25	0.32	0.19	1.5
Specific total α-radioactivity	0.1155 ± 0.0543 Bq/l	0.1778 ± 0.0888 Bq/l	0.0 ± 0.0519 Bq/l	0.0 ± 0.0696 Bq/l	0.5 Bq/l
Specific total β-radioactivity	0.0 ± 0.0443 Bq/l	0.1365 ±0.0680 Bq/l	0.0 ± 0.0462 Bq/l	1.1768 ± 0.0692 Bq/l	1 Bq/l

The quality of the confined subsoil waters of the exploited aquifers and complexes correspond to the safety indices of centralised drinking water supply systems established by the legislation.

The increased content of total iron is a characteristic feature of the fresh subsoil waters of Belarus.

The α-radioactivity of the aquifer waters is within the range 0.0519–0.1778 Bq/l. The β-radioactivity of the subsoil waters varies within the range 0.0–0.0680 Bq/l, the value of 1.1768 Bq/l exceeding the allowable norm (1 Bq/l) is recorded in water of the well in the Molyatichi Agro-Town. A preliminary assessment of the permissibility of using drinking water for drinking purposes may be made by the total volumetric α- and β-activity, which should not exceed 0.5 and 1 Bq/l, respectively (paragraph 46 of the hygienic standard “Criteria for assessing radiation exposure”, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 37 dated January 25, 2021).

The redox conditions of subsoil waters are given according to the literature data; no measurements were carried out at Site 3-3. The redox potential (Eh, mV) of subsoil waters in Belarus is characterised by the following indices:

– Eh from +200 mV to +300 mV for confined waters in the stratum of Quaternary deposits (*f,lgIId-sz, flglbr-IId*) at depths of 25–50 m;

– Eh from +80 mV to +250 mV for confined waters in the stratum of Pre-Quaternary deposits (N, P, K, D) at depths of 50–115 m .

The alkalinity can be estimated on basis of the results of hydrochemical research performed in 2025. On the basis of the data obtained in the confined waters, the values of total alkalinity vary in the range of 5.2-8.6 $mmol/dm^3$.

The waters at the researched depth at Site 3-3 are fresh and, therefore, the density of these waters is close to 1.0 g/l at a temperature of 20-25°C.

Natural colloidal impurities are associated with the presence of elevated (exceeding the degree of solubility) silicic acid contents. The degree of solubility is about 27 mg/dm^3 (in the form of H_4SiO_4). In the subsoil waters of aquifers and complexes, its content vary from 3.32–6.54 mg/dm^3, which does not exceed the degree of solubility of silicic acid, respectively, it is also in the form of a true solution instead of colloid one.

The gas composition was characterised according to data from previous studies. The nitrogen gas composition is absolutely predominant in fresh subsoil waters in Belarus. In general, the nitrogen content in fresh subsoil waters is in equilibrium with its content in the atmosphere and amounts to 20.0-25.0 mg/dm^3. Carbon dioxide is also present in significant concentrations (10–50 mg/dm^3). Both deep–lying waters and groundwater contain also oxygen, but its content is extremely low ranging from “undetected” to 0.5-1.0 mg/dm^3.

Area of location of Site 1-5

The general information about the geomorphology, geological structure and hydrogeological conditions of the area is provided based on the data and results of surveys and investigations at Site 1-5 and in the immediate vicinity to it.

Geomorphology

According to the scheme of geomorphological zoning of the territory of Belarus, Site 1-5 in the Khoiniki District is associated with the geomorphological district of the Khoiniki Lowland of the Polesye Lowland region. The main part of the Site's territory is occupied by a gently undulating morainic plain characterised by a calm, sometimes slightly undulating or low-hilly relief formed by the Pripyat (Dnieper) glacier cover. In the extreme north-west, east and south of the territory of the site under consideration, there are areas of gently undulating aqueoglacial plain of Pripyat (Dnieper) age. The present earth surface is formed by terminal morainic and aqueoglacial formations of the Pripyat (Dnieper) age. The absolute elevation of the earth surface ranges from 138-150 m; the surface is slightly inclined from south to north. The relief is mostly natural occupied somewhere by forest clearings, forest roads, clearings and fire protection strips, the relief is slightly technogeneousally transformed.

In the territory of Site 1-5 in the Khoiniki District, no manifestations of modern geological processes have been recorded – karst, suffusion, planar erosion, ravine erosion, gravitational processes, which are unfavourable geodynamic factors for siting the radioactive wastes landfill. This is due to the peculiarities of the structure and composition of the covering deposits, altitude position, presence of vegetation and weak degree of technogeneous transformation of the site area. This allows for the conclusion that, in terms of geological and geomorphological features, the territory of Site 1-5 in the Khoiniki District meets the requirements of the technological regulations, which regulates the process of selecting a site for the radioactive wastes landfill.

Tectonics

Geologically, the Khoiniki district is located in the south-eastern part of the Pripyat Trough on the border with the Bragin-Loev saddle (Table 5.13).

Site 1-5 is located in the crest block of the Yelsk-Narovlya tectonic stage of the southern part of the Pripyat trough (see Figure 5.13). From the north, the Site is located in close proximity to the Buinovichi-Narovlya fault (Figure 5.13) with a stretching amplitude of up to 100 m and a limiting step on the south side of the Velikopolye-Strelichi local fault (Figure 5.14). The surface of the deposits of the Frasnian stage in the contour of the Yelsk-Narovlya stage (sign IX) rises in a northerly direction from minus 1200 m to minus 1300 m (Figure 5.13).

The lower part of the sedimentary cover, which includes Devonian horizons lying on the surface of the crystalline basement, is characterised by tectonic fragmentation in blocks with the width of 3-5 km bounded by tectonic faults. It should be noted that tectonic faults were only formed during the rifting stage, which ended by the end of the Devonian period. Thus, the tectonic faults already in the Mesozoic evolutionary period (Permian –Triassic horizons) extending to a depth of 500 m were not tectonically unblocked (see Figure 5.14). This indicates a slight seismotectonic activation of the junction area of the Pripyat Trough and the Bragin-Loev Saddle within the territory studied for siting the radioactive wastes landfill.

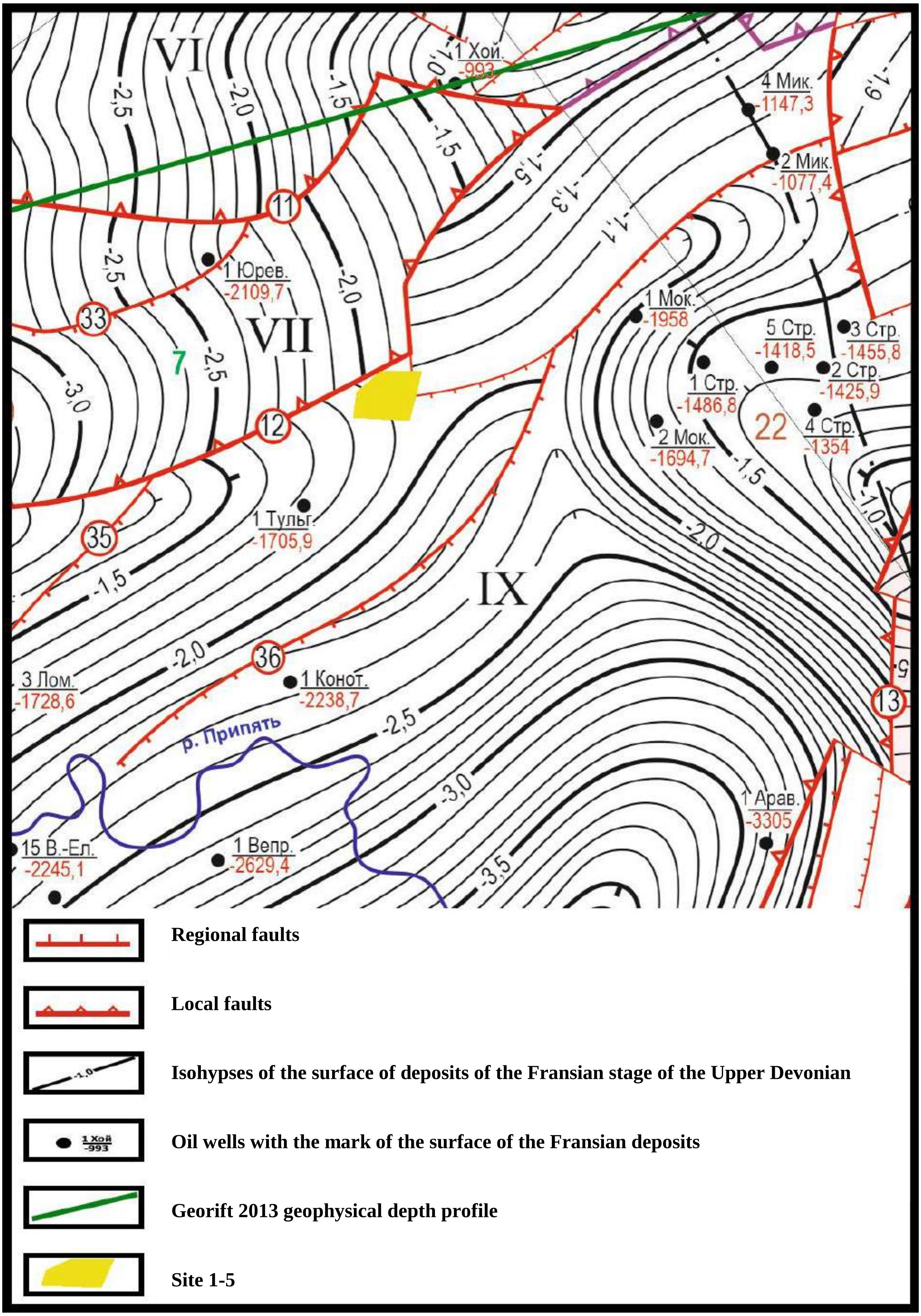
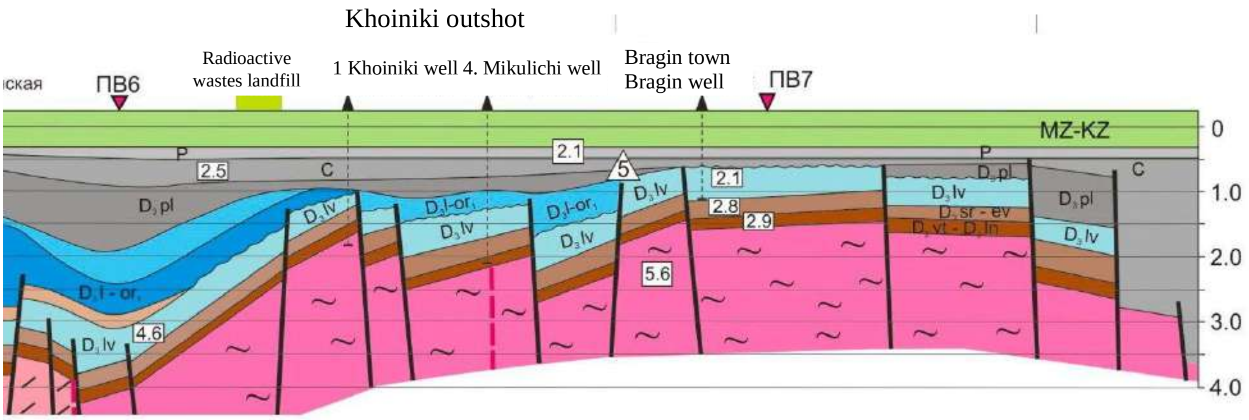
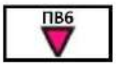


Figure 5.13 – Structural map of the surface of deposits of the Frasnian stage of the Upper Devonian of the Bragin-Loev Saddle and adjacent territories

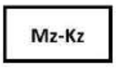


Legend

Deep wells for search for oil



Points of seismic explosions when performing the geophysic survey over the Georift-2013 profile



Stratigraphic boundaries of the section

Proposed place of the radioactive wastes landfill

Figure 5.14 – Fragment of the geo-seismic section of the sedimentary cover and upper part of the foundation over the profile of the Nesvizh-Bragin deep seismic sounding of the Georift-2013 Geotransect in the area of points PV6-PV7

Table 5.13 – Geological and tectonic characteristics of Site 1-5 in the Khoiniki District

No.	Geological and tectonic characteristics	Site
		1-5
1	Earth crust type	BC
2	Depth of occurrence of the basement rocks, m	1,200
3	Distance to the nearest deep-laid regional tectonic fault, km	10
4	Manifestation of active neotectonic blocks based on other research methods;	not established
5	Establishment of geotectonic faults from the research performed	not established
6	Establishment of geotectonic factors prohibiting the siting of the radioactive wastes landfill.	not established

The distance to the local, inactive Buinovichi-Narovlya fault (12) is about 5 km. Based on the materials of the analytical synthesis of geological data, the results of reconnaissance and detailed areal field studies by the informative geological and geophysical complex, it was found that there are no geological and tectonic factors, which would prohibit the siting of the radioactive wastes landfill within Site 1-5 in the Khoiniksky district [5].

Seismic conditions

The following 5 observation points have been selected for continuous round-the-clock seismological observations: 1-5.1 Babchin, 1-5.2 Borisovshchina, 1-5.3 Kurovoye, 1-5.4 Poselichi and 1-5.5 Verbovichi. These points are optimal in terms of the level of technogeneous noise, availability and quality of the mobile network for real-time data transmission (Figure 5.15).

According to the Map of the General Seismic Zoning of Northern Eurasia GSZ-97-D, the level of the maximum credible earthquake (MCE) with a recurrence of once every 10,000 years (the average annual risk is 10^{-4}) for the site is 6 points for medium-hard soils of the 2nd category; the strength-level earthquake (SLE) level is 5 points (Figure 5.16).

The maximum estimated intensity from a possible seismic event in the Gomel PSE subarea (M_{max}=4.5, H=10 km, Δ=0 km), within which the Site is located, is 6 points.

The maximum estimated intensity from a possible seismic event in the Vrancha area (Mmax = 8.2, H = 80 km, Δ = 600 km) is 6 points.

Among the registered regional earthquakes, the earthquake, which occurred in Romania on February 26, 2026 (17:21:52 UTC) with a magnitude *mb*=4.6, hypocentre depth of 100 km and epicentral distance to the Site of 705 km, made the greatest impact on the Site. The estimated magnitude at the Site was minus 0.1.

Among the nearest earthquakes, the Soligorsk earthquake, which occurred on February 26, 2026 (01:48:45 UTC) with the magnitude *mb* = 2.4, hypocentre depth of 48 km and epicentral distance to the Site of 113 km made the greatest impact on the Site. The estimated magnitude at the Site was minus 0.7.

The strongest historical earthquake closest to the Site occurred in the area of Mogilev City on November 12, 1896 with a magnitude of 4.0, epicentral distance to the Site of 230 km and predicted intensity of seismic impact on the Site of 2.3 points (Figure 5.10) [7].

Taking into account historical and instrumentally recorded earthquakes, the maximum predicted intensity of seismic impact on the Site does not exceed 6 points on the MSK-64 12-point scale for medium-hard soils of the 2nd category. For soils of the 3rd category as to seismic properties, the predicted intensity of seismic impact should be increased by 1 point [6].

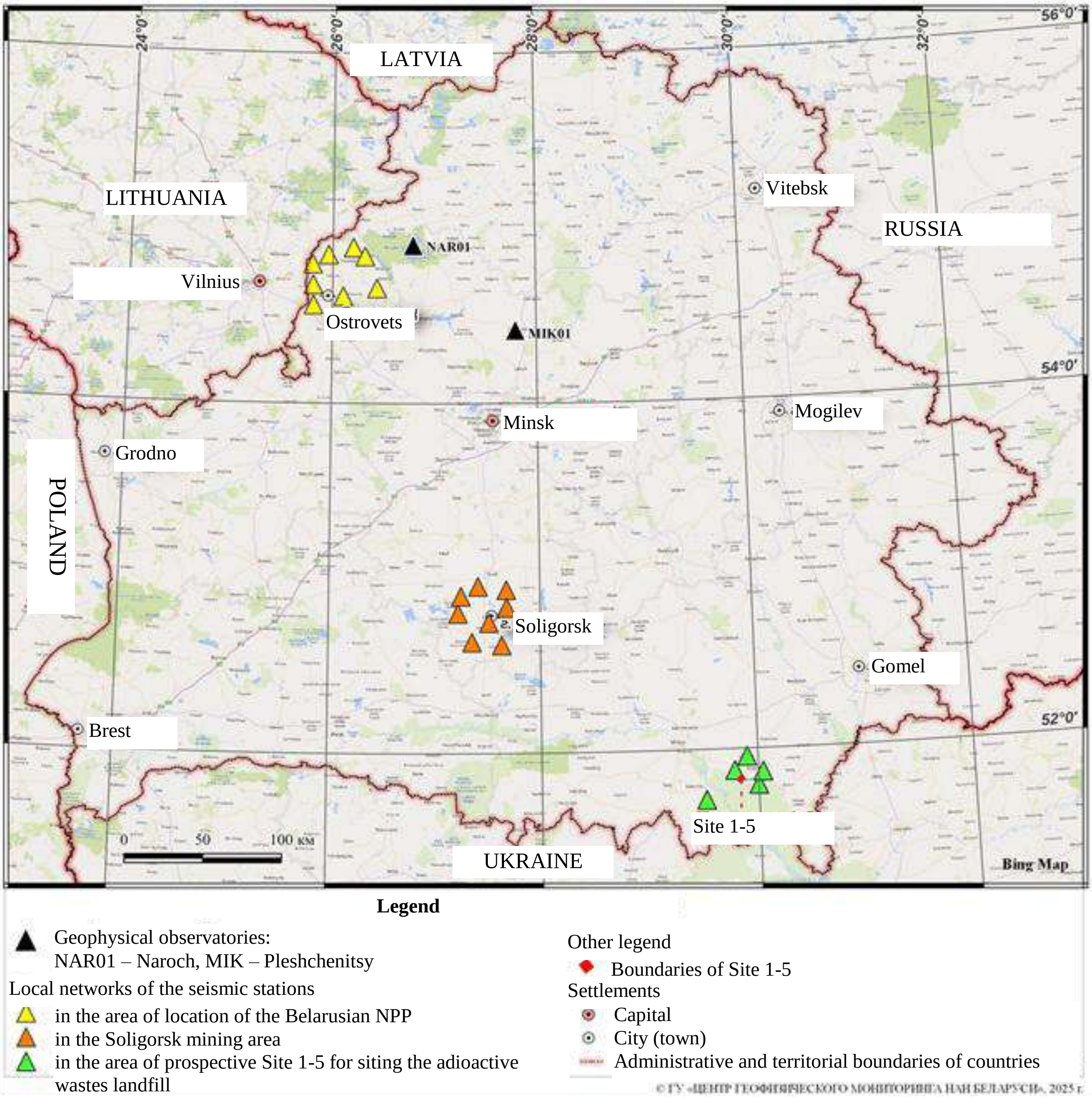


Figure 5.15 – Review scheme of arrangement of seismic stations in the territory of Belarus and in the area of Site 1-5 for siting the radioactive wastes landfill

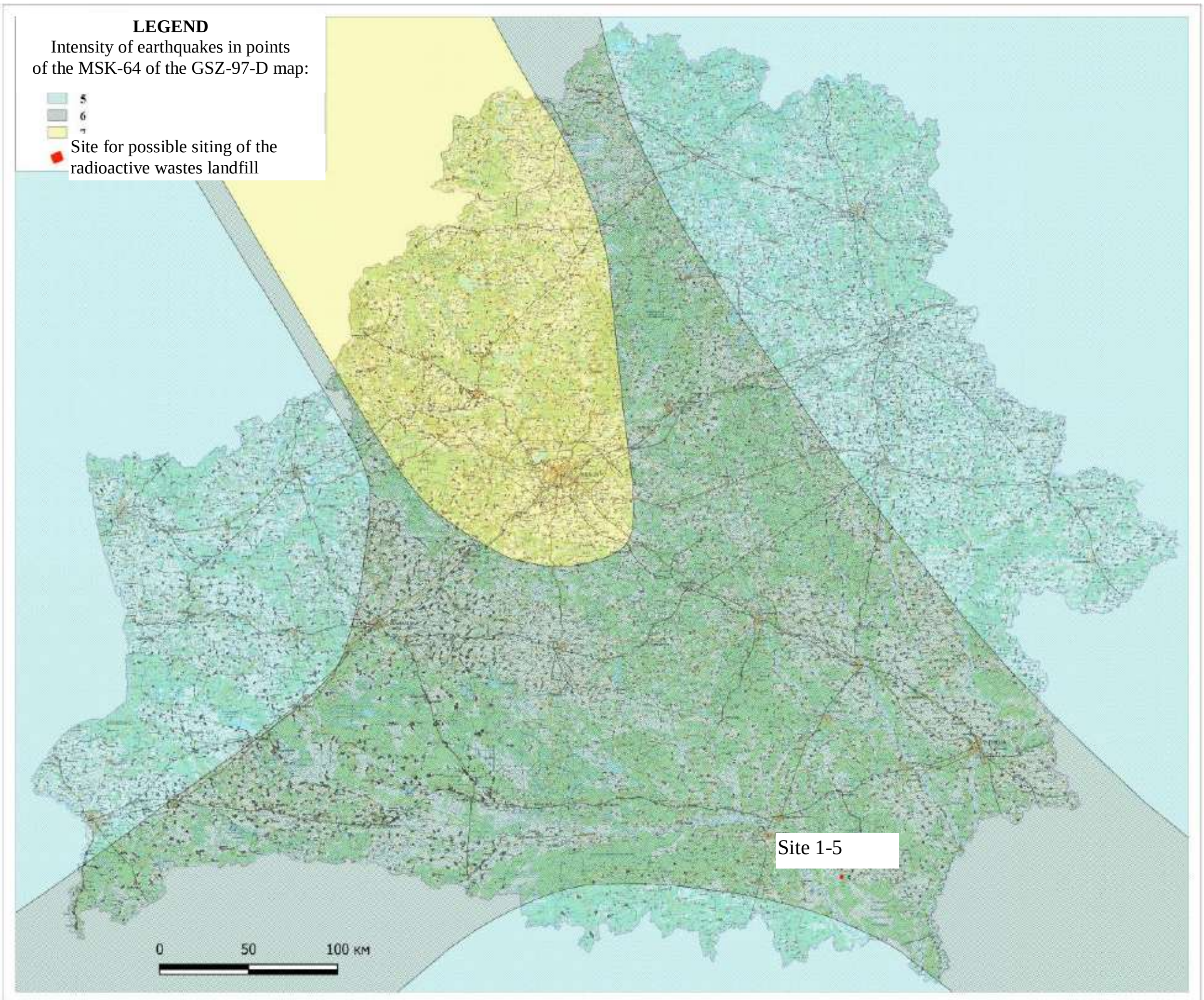


Figure 5.16 – Fragment of the GSZ-97-D map

Engineering and geological conditions

Sedimentary cover structure. Structurally and tectonically, the site is associated with the south-eastern part of the Pripyat Trough. The crystalline basement of the *Archean-Proterozoic* (AR-PP) age (granites, crystalline schists, amphibolites, gneisses) within the Pripyat Trough is divided by a fault system into blocks.

The deposits of the platform cover in this part of the Pripyat Trough are represented by Devonian, Carboniferous, Permian, Triassic, Jurassic, Cretaceous, Paleogene, Neogene, and Quaternary formations. In the territory under consideration, the salt dome tectonics can cause significant fluctuations in the depth of deposits from the Devonian to the Cretaceous.

In the section of the *Devonian system* (D) of the Site's area, limestones, marls, dolomites, and clays predominate; salt-bearing deposits, including rock salt strata, are developed in the upper part of the section. The depth of the roof and the thickness of the formations vary in a wide range. The thickness increases significantly in salt anticlines, while the depth of the roof in the arches of salt structures decreases.

The roof of the deposits of the *Carboniferous system* (C) is located at a depth of up to 960 m. Limestones and dolomites predominate.

The deposits of the *Permian system* (P) are represented by clays, marl, siltstones, sandstones, limestones, anhydrites and gypsum. Sediment thickness is up to 115 m, penetrated at a depth of up to 820 m.

The *Triassic system* (T) consists mainly of terrigenous deposits (clays, siltstones, sands, sandstones, gravelites); marls, limestones, and dolomites are found in the middle and upper parts of the section. They are penetrated at a depth of 250-570 m, their thickness is 200-535 m.

The *Jurassic system* (J) consists of clays, siltstones, sands, sandstones, marls, limestones. The bottom lies at a depth of 170-400 m. The thickness of deposits is up to 200 m.

The *Cretaceous system* (K): the deposits of the lower section are represented by terrigenous rocks (clays, siltstones, siltstones, sands, sandstones), the upper section – by carbonate ones (marl, chalk). They are penetrated at a depth of 70-150 m, theirthickness is 50-290 m.

The *Paleogene system* (Pg) is mainly represented by clays, siltstones, siltstones, sands and sandstones. Within the boundaries of the site where the engineering and geological reconnaissance was carried out, sediments were penetrated at a depth of 47 m (the absolute mark is 94.18 m). They are represented by powdery quartz-glauconite loams with traces of organic matter. The penetrated thickness is 5.0 m, the total thickness is considerably larger.

The depth of occurrence, age and lithological composition of the deposits of the pre-quaternary surface as well as the thickness of the quaternary deposits on the site should be specified during the engineering and geological survey. According to preliminary data, Pre-Quaternary sediments are ubiquitously represented by Paleogene argillo-arenaceous rocks.

Quaternary system (Q).

Berezina-Dnieper poorly defined horizon – aqueoglacial intermorainic (f,lgI*br*-II*d*) deposits: silty, fine, medium and clayey sands. They lie under morainic and naturally morainic sands and loamy sands at a depth of 8.7-25.2 m. They are underlain by the Paleogene. The bottom was penetrated during an engineering and geological reconnaissance at a depth of 47 m. Most of the wells have not been completely penetrated, the penetrated capacity is 12.2-33.9 m.

Dnieper horizon. Aqueoglacial super-moraine deposits (f,lgIId^S): fine (rarer silty) slightly wet clayey sands occurring from the surface under the vegetable ground and topsoil to a depth of 1.5-12.0 m. The thickness is 1.3-11.8 m.

Terminal morainic deposits (gtII*d*): fine (rarer silty and medium) sands (layers with the thickness of 1.5-3.1 m), loamy sands with gravel and pebbles up to 10-15%. They occurs from the surface under the vegetable ground layer. The bottom is penetrated at a depth of 8.7-17.2 m, the thickness is 8.3–17.0 m.

Morainic deposits (gII*d*): loamy sands, loams with gravel and pebbles up to 10-15%, with thin (up to 5-10 cm) intermediate layers of silty, fine and clayey sands. They occur under the aqueoglacial sands at a depth of 1.5-12.0 m and under the terminal morainic loamy sands at a depth of 9.9 m. The bottom is penetrated at a depth of 9.9-25.2 m, the thickness is 0.6-17.9 m.

According to the available data, the *Sudobl horizon* (holocene) on the Site includes the locally distributed technogenic formations. They are mainly associated with earth roads, extraction and filling sites. There is no data on the depth of the bottom of the bulk soils at the site of the Novoselki decontamination wastes landfill-III.

The thickness of the *vegetable ground and topsoil* in the wells was 0.05-0.25 m.

Engineering and geological conditions. The following EGEs are distinguished at a depth of up to 30-52 m (Table 5.14).

Quaternary system

Aqueoglacial super-moraine and intramorainic deposits

EGE-5. Strong silty sand
EGE-6a. Fine moderate-strength sand (q_c<3.0 MPa)
EGE-6. Fine moderate-strength sand (q_c≥3.0 MPa)
EGE-7. Strong fine sand
EGE-9a. Medium moderate-strength sand (q_c≥9.0 MPa)
EGE-10. Strong medium sand
Terminal morainic and morainic deposits
EGE-11. Weak loamy sand
EGE-12. Loamy moderate-strength sand
EGE-13. Strong loamy sand
EGE-14. Very strong loamy sand
EGE-14c. Very strong loamy sand (S_r<0.8)
Aqueoglacial intermorainic deposits
EGE-15. Strong silty sand
EGE-16. Fine moderate-strength sand
EGE-17. Strong fine sand
EGE-20. Medium moderate-strength sand (q_c≥9.0 MPa)
EGE-21. Strong medium sand
Palaeogene system
EGE-24. High-plastic loamy sand

Table 5.14 – **Estimated values of the soil characteristics**

EGE, soil	**Specific weight γ_n, kN/m³**	**Specific cohesion c_n, kPa**	**Internal friction angle φ_n, deg.**	**Modulus of deformation *E*, MPa**
EGE-5. Silty sand strong	17.6-18.9 / –	4-5	32-33	19-21 / 16-18
EGE-6a. Fine moderate-strength sand (q_c<3.0 MPa)	16.1-18.9 / 9.5-11.1	1	29-30	13-15
EGE-6. Fine moderate-strength sand (q_c≥3.0 MPa)	16.1-18.9 / 9.5-11.1	1-2	33-34	19-21
EGE-7. Strong fine sand	16.1-18.9 / –	2-3	34-35	23-25
EGE-9a. Medium moderate-strength sand (q_c≥9.0 MPa)	16.5-18.5 / 10.1-10.6	1-2	36-37	23-25
EGE-10. Strong medium sand	16.5-18.5 / –	2	38-39	28-30
EGE-11. Weak loamy sand	21.2-22.8	21-23	24-26	4-6
EGE-12. Loamy moderate-strength sand	21.2-22.8	25-27	26-27	8-10
EGE-13. Strong loamy sand	21.0-22.9	32-34	27-28	17-19
EGE-14. Very strong loamy sand	21.0-22.9	39-41	28-29	21-24
EGE-14c. Very strong loamy sand (S_r<0.8)	20.5-22.3 / 21.0-22.9	42-44 / 32-34	30-31 / 20-22	26-29 / 21-23
EGE-15. Strong silty sand	16.6-16.9 / 9.4 -10.0	5-6	33-34	30-32 / 25-27
EGE – fine moderate-strength sand	16.7-18.0 / 9.5-10.5	1-2	33-34	21-22
EGE-17. Strong fine sand	16.7-18.0 / 9.5-10.5	3-4	35-36	25-27

EGE, soil	**Specific weight** γ_n**, kN/m³**	**Specific cohesion** c_n**, kPa**	**Internal friction angle** φ_n**, deg.**	**Modulus of deformation** *E***, MPa**
EGE-20. Medium moderate-strength sand (q_c≥9.0 MPa)	$\frac{16.5\text{-}18.5}{10.1\text{-}10.6}$	1-2	36-37	23-25
EGE-21. Strong medium sand	$\frac{16.5\text{-}18.5}{10.1\text{-}10.6}$	2	38-39	28-30
EGE-24. High-plastic loamy sand	18.4-19.8	–	–	–

Remarks

1. The specific weight of sands above the horizontal bar corresponds to slightly wet and wet sands and that under the horizontal bar – to water-saturated ones taking into account the buoyant force of water;
2. The *E* value of silty sands of EGE-5, 15 above the horizontal bar corresponds to slightly wet sands and that under the horizontal bar – to water-saturated ones;
3. The γ, *c*, φ and *E* characteristics of loamy sand of EGE-14c above the horizontal bar corresponds to natural humidity, under the horizontal bar – full saturation with water

Up to a depth of 8.7-25.2 m, the structure of the section is lenticular, characterised by heterogeneity of compressibility of the soils composing it and represented by various types, kinds and varieties, including loamy sands morainic weak EGE-11 with a modulus of deformation of less than 5 MPa.

In case of additional saturation with water, the very strong loamy sands EGE-14c with degree of humidity Sr<0.8 reduce the strength and deformation characteristics. According to the experience of studying similar soils, the value of the modulus of deformation may decrease by 1.2-1.3 times, according to the results of shear tests, the strength characteristics (τ, c, φ) may decrease 1.1-1.8 times.

Water-saturated medium-strength sands may exhibit dynamic instability. Under dynamic loads, their liquefaction and deterioration of strength and deformation characteristics are possible [7].

The examples of geotechnical cross-sections intersecting the Site are presented in Appendices J, K and L.

Hydrogeological conditions

The thickness of the **aeration zone** is from 14.6 to more than 30 m. It is represented by clayey (loamy sands, loams) and sandy soils with various granulometric compositions. Argillaceous deposits predominate in the upper part of the section. During the engineering and geological survey, the data on the distribution and thickness of clay soils in the aeration zone will be updated.

Taking into account the higher sorption properties of clayey soils compared to sandy soils, the considerable thickness of clayey soils in the aeration zone is a favourable factor. It should be borne in mind that the ability of clay soils to retain radionuclide contamination is characterised by significant variability. Natural clay strata should be supplemented with artificial clay barriers.

According to the results of chemical analysis of water extraction of soils, in terms of the content of sulphates for concrete on Portland cement and in terms of the content of chlorides, all soils are non-aggressive to concrete of the W4, W6, W8, W12 grades. For concrete based on other cements, all soils are non-aggressive in terms of sulphate content.

The average values K_F clayed soils of the aeration zone are given according to the laboratory data (Table 5.15).

Table 5.15 – **Estimated values of the filtration coefficient**

Soil, EGE	K, m/day
EGE-11. Weak loamy sand	0.0012
EGE-12. Loamy moderate-strength sand	0.0012
EGE-13. Strong loamy sand	0.0011
EGE-14. Very strong loamy sand	0.0011
EGE-14c. Very strong loamy sand (S_r<0.8)	0.0011

Aquifers and water-bearing complexes.

In accordance with the geological structure and lithological composition of the soils at Site 1-5 to the studied depth of 100 m, according to the conditions of occurrence, the following are distinguished: perched water, sporadic-distribution waters, Berezina-Dnieper aqueoglacial complex and Buchak aquifer.

The *perched water* is met by a single well 52 at a depth of 3.9 m (the absolute mark is 144.01 m). The water-bearing soils consist of fine sands. The thickness of the water-bearing soils is 2.4 m. The lower water barrier is the argillaceous deposits of the Dnieper moraine. The perched water (groundwater) is recharged by infiltration of atmospheric precipitation and discharged by water migration into underlying aquifers. The water is non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures.

The *sporadic-distribution waters* (gII*d*) are associated with thin layers of sand in the clay moraine deposits of the Dnieper horizon. The thickness of water-saturated interlayers does not exceed 0.1 m. The static levels are recorded at a depth of 6.6–18.5 m (the absolute mark is 120.05-136.15 m). It is recharged by infiltration of atmospheric precipitation and discharged by water migration into underlying horizon. As regards their chemistry, the waters are non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures. They are fresh, the dry residue varies from 312 to 1,024 mg/dm³. The waters are weakly alkaline (the pH value varries from 7.3 to 7.9).

The *Berezina-Dnieper aqueoglacial water-bearing complex* (f,lgI*br*-II*d*) lies at a depth of 12.4–26.7 m (the absolute mark is 113.50–121.75 м). It is mainly unconfined. Within some sections, it is confined. The pressure head is 0.4-6.6 m. The static (piezometric) levels are set at a depth of 12.4–26.7 m (the absolute mark is 120.05–121.75 m). The aquifer has not been penetrates with individual wells (wells 35, 53) with a depth of 30 m.

The water-bearing soils are represented by silty, fine and middle sands. The thickness of the water-bearing soils varies from 27.4 to 33.2 m. The lower watertight stratum of the complex consists of loamy sands and loams of the Upper-Middle Paleogene, lying at a depth of 44.6–56.4 m (the absolute mark is 91.51-94.18 m). It is recharged by infiltration of atmospheric precipitation and water migration in the places of distribution of the upper levels (perch water and sporadic-distribution waters). The discharge occurs due to water migration into the underlying aquifer and drainage of the Pripyat and Vit Rivers.

As regards their chemistry, the waters are weakly alkaline (pH = 7.1–7.9), fresh (the dry residue is 301–987 mg/dm³), non-aggressive to concrete of any brand in terms of water resistance and moderately aggressive to metal structures. According to the data of laboratory work, the filtration coefficients of the soils vary from 0.1 to 21.0 m/day and according to the data of the Geological Information System – from 0.19 to 17.24 m/day (the average value is 5.0 m/day), and according to the data of aquifer testing – from 2.65 to 10.2 m/day (the average value is 6.4 m/day).

The *Buchak Mid-Paleogene aquifer* (P_2*bc*) has been penetrated at a depth of 86.0 to 96.0 m (the absolute mark is 51.3–52.1 m). It is confined. The upper watertight stratum consists of clayey deposits of Upper and Mid-Paleogene (loamy sands and loams). The thickness of the upper watertight stratum is 39.6–42.4 m. The water-bearing soils are presented by fine and middle sands. The penetrated thickness of the water-bearing soils reaches 1.4-12.4 m. There is no information about the site's horizon levels and heads.

At a distance of 3.6 km to the north and north-west of the Site, the piezometric level was recorded at a depth of 12.5 m (the absolute mark is 119.5 m) by exploration well 1977 (Kozeluzhye Village) The well flow rate was 7.2 m^3/h with a decrease in the level by 62.0 m (the specific flow rate was 0.12 m^3/h), the water is fresh with a mineralization of 0.2 g/dm^3.

The filtration coefficients of water-bearing soils according to the data of the Geological Information System vary from 1.65 to 9.42 m/day (the average value is 5.8 m/day). According to the data of hydro-geological investigations, the coefficient of permeability of the horizon varies from 221 to 516 m^2/day. The aquifer is used for water supply of the Khoiniki Town. The operational reserves of the aquifer in categories A+B in 1981 for the Gorodok and Vostochny water intakes were approved at an object to be 25,500 m^3/day. [3a].

Groundwater chemistry

The chemical composition of the groundwater of the Pripyat Polesie (with low mineralisation) is characterised by significant diversity in the ratio of the main ionic components: calcium bicarbonate waters; calcium bicarbonate waters with increased sodium and magnesium content; bicarbonate-chloride waters with increased calcium and magnesium content.

The formation of the chemical composition of groundwater is influenced by the composition of atmospheric precipitation, processes of interaction of water with the mineral part of the host rocks, introduction of quaternary sediments of deep highly mineralised pressure waters into the water-bearing complex, as well as human economic activity.

In general, the territory of Polesye is characterised by low-mineralised (from 15-50 to 500-700 mg/dm^3) subsoil waters of predominantly calcium bicarbonate composition; however, extensive territories characterised by a high content of iron, rarer manganese and boron as well as an almost all-round deficiency of fluorine, iodine and other trace elements are also known.

In many cases, along with iron, subsoil waters are enriched with manganese, the source of which, like iron, is mainly rocks and minerals of the morainic and fluvioglacial complex of glacial deposits.

In most cases, increased concentrations of fluorine, boron, and barium in freshwater are associated with the pull-up of deep fluorinated, boron and chloride-containing waters of the Upper Proterozoic water-bearing complex to the water intake wells [7].

As part of the work, the subsoil water quality of the Dnieper super-moraine aqueoglacial water-bearing complex (*f,lgIId*^{s}), Berezina-Dnieper aqueoglacial complex (*f,lgIbr-IId*) was studied, the results are shown in Table 5.16.

Table 5.16 – **Groundwater quality of phreatic aquifers**

Working number (sampling depth, m)	Ion concentration, mg/dm^3							Mineralisation, mg/dm^3
	HCO_3^-	CO_3^{2-}	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	NH_4^+	
Dnieper super-moraine aqueoglacial water-bearing complex (f,lgIIds)								
2/1 (3.7)	183.6	0	13.1	<10.0	30	7.7	0.11	264.5
4/1 (2.1)	154.3	0	51.90	11.0	49	14	0.22	384.0
6/1 (3.8)	174.5	0	16.1	<10	32	7.6	<0.1	292.0
Berezina-Dnieper aqueoglacial water-bearing complex (f,lgIbr-IId)								
4/2 (8.5)	154.9	0	48.4	13.0	48	15.0	0.10	366.0

5.4 Land resources

5.4.1. Condition of the land resources

Area of location of Site 2-1

The structure of the categories and types of land resources within Alternative Site 2-1 is presented in Tables 5.17 and 5.18.

Table 5.17 – **Structure of land use categories**

Land use category	**Area,**	
	ha	**%**
Agricultural lands	36.34	36.34
Industry, transport, communication, energy sector, defence and other-purpose lands	1.50	1.50
Forest reserve land	62.16	62.16
Total	**100.00**	**100.00**

Table 5.18 – **Structure of land types**

Land types	**Area,**	
	ha	**%**
Crop lands	36.13	36.13
Meadow lands	0.21	0.21
Wooded lands	61.16	61.16
Lands under tree and shrubbery vegetation (green planting)	1.00	1.00
Lands under roads and other transport communications	1.06	1.06
Building lands	<0.01	<0.01
Unused lands	0.44	0.44
Total	**100.00**	**100.00**

The dominant soils on Site 2-1 are sod-podzolic ones with various granulometric compositions, which account for 87.60% (32.78 ha) of the agricultural land area of the Site.

An analysis of arable soils by fertility score showed that a large proportion (56.35% or 20.63 ha) accounted for the group with an average soil fertility score (30.1-35.0 points) and 43.65% (15.98 ha) for the group with a lower-than-average (25.1-30.0 points) fertility of Alternative Site 2-1.

The structure of the categories of land resources of off-site networks is presented in Table 5.19.

Table 5.19 – **Structure of the categories of land resources of off-site networks**

Land use category	Area, ha	Percentage
External power supply networks		
agricultural lands	29.17	57.5
lands of settlements, horticultural partnerships and cottage building co-operatives	6.9	13.6
industry, transport, communication, energy sector, defence and other-purpose lands	1.23	2.4
forest reserve land	13.1	25.8
water reserve land	0.2	0.4
reserve lands	0.1	0.2
TOTAL:	**50.7**	**100.0**
Railway access roads		
industry, transport, communication, energy sector, defence and other-purpose lands	1.39	6.1
agricultural lands	17.97	78.7
forest reserve land	3.46	15.2
TOTAL:	**22.82**	**100.0**
Off-site water supply and disposal		
agricultural lands	29.0	94.0
forest reserve land	2.0	6.0
TOTAL:	**31.0**	**100.0**

Based on the results of monitoring studies in the territory adjacent to Alternative Site 2-1, it was established that:

- there are 2 ecoregions within Alternative Site 2-1, which have different degrees of resistance to man-made impacts (low and high).

Area of location of Site 3-3

The structure of the categories and types of land resources within Alternative Site 3-3 is presented in Tables 5.20 and 5.21.

Table 5.20 – **Structure of land use categories**

Repl.inv. No. | Signature and date | Inv. No. of orig

Land use category	Area,	
	ha	%
Agricultural lands	99.79	99.63
Industry, transport, communication, energy sector, defence and other-purpose lands	0.37	0.37
Total	**100.16**	**100**

Table 5.21 – **Structure of land types**

Land use category	Area,	
	ha	%
Crop lands	97.09	96.93
Meadow lands	0.35	0.35
Lands under tree and shrubbery vegetation (green planting)	2.33	2.33
Lands under roads and other transport communications	0.37	0.37
Unused lands	0.02	0.02
Total	**100.16**	**100.00**

Alternative Site 3-3 is mainly (99.63%) located on agricultural land, including 96.93% arable land. Sod-podzolic soils with various granulometric compositions are dominant on Alternative Site 3-3.

There are no forest reserve lands on Alternative Site 3-3.

The structure of the categories of land resources of off-site networks is presented in Table 5.22.

Table 5.22 – **Structure of the categories of land resources of off-site networks**

District	Land use category	Area, ha	Percentage, %
External power supply networks			
Mstislavl	agricultural lands	28.5	78.3
	lands of settlements, horticultural partnerships and cottage building co-operatives	1.7	4.7
	industry, transport, communication, energy sector, defence and other-purpose lands	2.4	6.6
	forest reserve land	3.5	9.6
	water reserve land	0.2	0.5
	reserve lands	0.1	0.3
	TOTAL:	**36.4**	**100.0**
Krichev	agricultural lands	58.71	85.0
	lands of settlements, horticultural partnerships and cottage building co-operatives	3.5	5.1
	industry, transport, communication, energy sector, defence and other-purpose lands	0.5	0.7
	lands used for nature protection, health-improving, recreational and historical and cultural purposes	5.6	8.1

District	Land use category	Area, ha	Percentage, %
	forest reserve land	0.34	0.5
	reserve lands	0.4	0.6
	TOTAL:	**69.05**	**100.0**
External railway roads			
Mstislavl	industry, transport, communication, energy sector, defence and other-purpose lands	2.83	**18.0**
	agricultural lands	13.01	**82.0**
	TOTAL:	**15.84**	**100**
Off-site water supply and disposal			
Mstislavl	agricultural lands	13	93.0
	forest reserve land	1	7.0
	TOTAL:	**14**	**100.0**

Thus, the Alternative Site 3-3 is suitable for the construction of a radioactive wastes landfill in terms of land resources and does not have significant complicating or prohibiting factors.

Area of location of Site 1-5

The structure of the categories and types of land resources within Alternative Site 1-5 is presented in Tables 5.23 and 5.24.

Table 5.23 – **Structure of land use categories**

Land use category	Area,	
	ha	%
Forest reserve land	248.37	99.11
Agricultural lands	2.23	0.89
Total	**250.60**	**100.00**

Table 5.24 – **Structure of land types**

Land types	Area,	
	ha	%
Wooded lands	248.37	99.11
Lands under tree and shrubbery vegetation of agricultural purpose	1.54	0.62
Unused agricultural lands	0.69	0.27
Total	**250.6**	**100.00**

On Alternative Site 1-5, there are only sod-podzolic soils of agricultural land, which occupy a small area in the extreme northern part, only 2.23 hectares. The rest consists of forest ewserve lands.

The structure of the categories of land resources of off-site networks is presented in Table 5.25.

Table 5.25 – Structure of the categories of land resources of off-site networks

District	Land use category	Area, ha	Percentage, %
External power supply networks			
Mozyr	agricultural lands	12.99	28.5
	industry, transport, communication, energy sector, defence and other-purpose lands	2.45	5.4
	forest reserve land	28.32	62.1
	water reserve land	0.61	1.3
	reserve lands	1.25	2.7
	TOTAL:	**45.62**	**100**
Kalinkovichi	agricultural lands	21.18	29.6
	industry, transport, communication, energy sector, defence and other-purpose lands	1.47	2.1
	lands used for nature protection, health-improving, recreational and historical and cultural purposes	15.88	22.2
	forest reserve land	32.3	45.2
	water reserve land	0.1	0.1
	reserve lands	0.58	0.8
	TOTAL:	**71.51**	**100**
Khoiniki	agricultural lands	145.87	62.8
	industry, transport, communication, energy sector, defence and other-purpose lands	0.98	0.4
	forest reserve land	84.91	36.5
	water reserve land	0.39	0.2
	reserve lands	0.28	0.1
	TOTAL:	**232.43**	**100**
Rechitsa	agricultural lands	76.36	40.9
	industry, transport, communication, energy sector, defence and other-purpose lands	1.24	0.7
	forest reserve land	106.53	57.1
	water reserve land	0.77	0.4
	reserve lands	1.7	0.9
	TOTAL:	**186.6**	**100.0**
External railway roads			
Khoiniki	industry, transport, communication, energy sector, defence and other-purpose lands	5.47	**5.4**
	agricultural lands	79.08	**77.8**
	forest reserve land	11.09	**10.9**
	reserve lands	5.95	**5.9**
	TOTAL:	**101.59**	**100**
Off-site water supply and disposal			

District	Land use category	Area, ha	Percentage, %
Khoiniki	agricultural lands	29	93.5
	forest reserve land	2	6.5
	TOTAL:	**31**	**100.0**

Thus, the Alternative Site 1-5 is suitable for the construction of a radioactive wastes landfill in terms of land resources and does not have significant complicating or prohibiting factors.

5.4.2. Soils

Area of location of Site 2-1

No wind and water erosion processes have been identified at Site 2-1. In the Ostrovets district, soil formation occurs in a temperate continental climate. The district's landscape is formed mainly by morainic and aqueoglacial deposits (loamy sands and sands) under coniferous and deciduous forests. It is dominated by turf, podzolic and swamp (gleyed) soil-forming processes, which most often occur in parallel and form the structure of the local soil.

At present, the soils of Site 2-1 are mostly unaffected by technogenesis.

According to the current data, the density of soil contamination with caesium-137 radionuclides is less than 3.7 kBq/m^2 within the boundaries of Alternative Site 2-1 [14].

The content of pollutants in soils in the background territories of the Ostrovets District in 2024 (the frequency of observations is once every 6 years) is shown in Table 5.26.

Table 5.26 – **Content of determinable ingredients in soils in the background territories of the Ostrovets District in 2024, mg/kg**

pH	Oil products	benz(a)pyrene	KCl	NO_3	SO_4	Cd	Zn	Pb	Cu	Ni	Cr	As	Hg
6.71	8.6	0.014	8.3	8.7	31.7	0.07	36.7	8.6	13.6	3.1	4.2	0.6	0.039

According to the data of the National System for Environmental Monitoring, the obtained values for the content of substances determined in the top soil horizons characterising the conditions of the land resources of the background territories, may indicate a weak impact of technogenesis on the lands of this Site.

The Institute of Experimental Botany of the National Academy of Sciences of Belarus carries out the monitoring studies on the territory adjacent to Alternative Site 2-1 taking into account, among other things, the content of heavy metals in forest and meadow biogeocenoses in the topsoil.

In the territory of Alternative Site 2-1 itself, the soil samples were taken in the topsoil in November 2025. The content of heavy metals in top soil horizons is presented in Table 5.27.

Table 5.27 – **Content of heavy metals in the topsoil cover on Site 2-1 in 2025**

Heavy metals	Lead, mg/kg	Arsenic, mg/kg	Cadmium, mg/kg	Mercury, µg/kg	Nickel, mg/kg	Zinc, mg/kg	Copper, mg/kg	Chromium, mg/kg	Manganese, mg/kg	Cobalt, mg/kg
Minimum	<3.0	<0.10	<0.25	<0.10	8.51	10.0	3.6	12.1	40.0	<2.5
Maximum	34.4	<0.10	<0.25	<0.10	25.3	39.0	13.4	26.6	1152	<2.5
Average value	13.5	<0.10	<0.25	<0.10	15.6	21.1	6.4	18.57	258	<2.5

Area of location of Site 3-3

No wind and water erosion processes have been identified at Site 3-3. The entire territory of the Mstislavl District is represented by sod-podzolic soils. Sod-podzolic soils are associated with watershed areas with deep groundwater and develop under the combined action of sod and podzolic processes on rocks with various granulometric compositions. The soils are predominantly loamy sands (63%), sandy soils (17%) and loams (20%).

At present, the soils of Site 3-3 are slightly unaffected by technogenesis.

According to the current data, the density of soil contamination with caesium-137 radionuclides within the boundaries of Alternative Site 2-3 is less than 3.7 kBq/m^3 [14]. To the south of the boundaries of Alternative Site 3-3, there is an increase in the density of soil contamination with caesium-137 radionuclides in the range from 10 to 37 kBq/m^2.

In accordance with the accepted standards, the boundaries of Alternative Site 3-3 and the territories adjacent to it are not included in the zone of radioactive contamination.

The content of pollutants in soils in the background territories of the Mstislavl District in 2024 (the frequency of observations is once every 6 years) is shown in Table 5.28.

Table 5.28 – **Content of determinable ingredients in soils in the background territories of the Mstislavl District in 2024, mg/kg**

Oil products	benz(a)pyrene	KCl	NO_3	SO_4	Cd	Zn	Pb	Cu	Ni	Cr	As	Hg
21.2	0.018	12.3	< deterction limit	91.3	0.15	17.2	15.0	3.4	2.8	1.7	0.1	< deterction limit

The values for the content of substances determined in the top soil horizons characterising the conditions of the land resources of the background territories, may indicate a weak impact of technogenesis on the lands of this Site.

The content of pollutants in the upper soil layers of the site under consideration, according to the tests carried out [8], is shown in Table 5.29.

Table 5.29 – Content of determinable ingredients in soils in the territory of Alternative Site 3-3 in 2025, mg/kg

Heavy metals	Lead, mg/kg	Arsenic, mg/kg	Cadmium, mg/kg	Mercury, μg/kg	Nickel, mg/kg	Zinc, mg/kg	Copper, mg/kg	Chromium, mg/kg	Manganese, mg/kg	Cobalt, mg/kg
Minimum	9.15	<0.10	<0.25	<0.10	13.9	14.8	9.99	15.2	301	<2.5
Maximum	13.4	<0.10	<0.25	<0.10	19.0	17.7	32.5	19.0	415	<2.5
Average value	11.28	<0.10	<0.25	<0.10	16.5	16.3	21.25	17.1	358	<2.5

Thus, the obtained values for the content of substances determined in the top soil horizons characterising the conditions of the land resources of the background territories, may indicate a weak impact of technogenesis on the lands of this Site.

Area of location of Site 1-5

No wind and water erosion processes have been identified at Site 1-5. The territory of Alternative Site 1-5 is related to convex high watersheds on sands and aqueoglacial loamy sands. The structure of soil cover of this ecoregion has the following generalised formula: sod-podzolic soils make up 65%, sod-podzolic temporarily excessively moistened soils – 30% and sod-podzolic gleyic soils – 5%.

At present, the soils of Site 1-5 are slightly unaffected by technogenesis.

According to the current data, the density of soil contamination with ^{137}Cs radionuclides within the boundaries of Alternative Site 2-5 is within the range from 185 to 555 kBq/m^2 [14]. To the north of the boundaries of Alternative Site 1-5, there is a decrease in the density of soil contamination with ^{137}Cs radionuclides within the range from 37 to 185 kBq/m^2. To the south of the boundaries of Alternative Site 1-5, there is an increase in the density of soil contamination with ^{137}Cs radionuclides within the range from 555 to 1,480 kBq/m^2. In accordance with the accepted standards, the boundaries of Alternative Site 1-5 are included in the territory of radioactive contamination.

The content of pollutants in soils in the background territories of the Khoiniki District in 2024 (the frequency of observations is once every 6 years) is shown in Table 5.28.

Table 5.30 – Content of determinable ingredients in soils in the background territories of the Khoiniki District in 2024, mg/kg

Oil products	benz(a)pyrene	KCl	NO_3	SO_4	Cd	Zn	Pb	Cu	Ni	Cr	As	Hg
14.8	–	17.0	81.3	36.5	0.16	7.8	–	5.0	5.2	3.2	0.9	0.035

According to the data of the National System for Environmental Monitoring, the obtained values for the content of substances determined in the top soil horizons characterising the conditions of the land resources of the background territories, may indicate a weak impact of technogenesis on the lands of this Site.

The content of pollutants in the upper soil layers of the site under consideration, according to the tests carried out [8], is shown in Table 5.31.

Table 5.31 – Content of determinable ingredients in soils in the territory of Alternative Site 1-5 in 2026, mg/kg

Heavy metals	Lead, mg/kg	Arsenic, mg/kg	Cadmium, mg/kg	Mercury, µg/kg	Nickel, mg/kg	Zinc, mg/kg	Copper, mg/kg	Chromium, mg/kg	Manganese, mg/kg	Cobalt, mg/kg
Minimum	<3.0	<1	<0.25	<0.010	2.15	<10	1.5	<3	60.3	<2.5
Maximum	4.51	<1	<0.25	0.0504	2.88	<10	1.66	<3	197	<2.5
Average value	3.76	<1	<0.25	0.0302	2.52	<10	1.58	<3	128.7	<2.5

Thus, the obtained values for the content of elements determined in the top soil horizons, which characterise the conditions of the land resources of the background territories and Alternative Site 1-5, may indicate a weak impact on them by the technogenesis of the lands. The ability of ecosystems and its components to self-purify depends to a large extent on their resistance to pollutants and their ability to cope with man-made loads.

5.5 Flora

Area of location of Site 2-1

Alternative Site 2-1 is located outside the boundaries of the elements of the National Ecological Network. The Site is located to the south-west of the boundaries of the Naroch Ecological Core (E8) and forms an integral part of a peripheral fragment of a large forest massif, the integral core of which belongs to the Vilia Ecological Corridor (CE2).

The position of Alternative Site 2-1 in the structure of the National Ecological Network of the Republic of Belarus is shown in Figure 5.17.

Forest vegetation

Within the area under consideration, the *forest vegetation* belongs mainly to the exploitable forests, which account for 90.9%, while the remaining 9.1% belong to the category of protective forests adjacent to the republican class highway P45.

There are no forests belonging to other categories (nature conservation and recreational forests) on the Site.

All forests on this site belong to the 25th block of the Vornyany forestry of the Ostrovetsky Forestry State Experimental Forest Management Institution.

The main forest massif is represented by productive stands of trees aged 60-75 years.

The floral composition of forest phytocenoses is characterised by considerable richness and is represented by 80 species of higher vascular plants and 7 species of mosses.

In the research territory, one plant species included in the "List of species of wild plants and fungi in need of preventive protection" was identified; it is squirrel-ear (*Goodyera repens*) belonging to the family of Orchids (*Orchidaceae*).

The studies show that pine and spruce forests of high productivity dominate generally in the territory under consideration, which is typical for such habitat conditions. No serious violations or destructive processes have been identified in terms of the formation of natural forests.

Meadow vegetation

The species composition of the meadow vegetation of Site 2-1 is represented by 52 species of vascular plants. The families being leading in terms of the number of species are: *Asteraceae, Poaceae, Fabaceae,* which make up 50% of coeno-flora under investigation. The remaining families·are represented by 1-2 species, indicating a high degree of anthropogenic disturbance.

The analysis of life forms revealed the dominance of polycarpous grasses (80%).

The geographical analysis has established that the largest number of species are represented by the Eurasian (31%), Euro-Siberian (28%) and Holarctic groups (21%) and indicates the dominance of species with a wide range of resistance to various climatic zones associated with the temperate zone.

29 species of valuable plants grow in the studied meadow phytocenoses: 20 medicinal plants, 6 forage plants, and 3 ornamental plants.

These meadow communities have no sociological value.

Riverside-water vegetation

Within the boundaries of the 10-kilometre buffer zone of Alternative Site 2-1, 10 aquatic ecosystems were surveyed and an inventory of species and phytocenotic diversity was carried out at each one.

81 species of vascular plants, grouped into 63 genera, 28 families, 28 orders, 3 classes, and 2 divisions, were recorded on Site 2-1. No rare species or species in need of protection have been identified. However, a large population of a dangerous invasive species, the Sosnowsky's hogweed, has been discovered.

Water vegetation

The partial flora of riverside phytocenoses in the territory under consideration includes 30 species of vascular plants, grouped into 25 genera, 17 families, 3 classes and 2 divisions. There is no pronounced predominance among the identified families and genera of flowering plants.

Several populations of the stalky berula (Siella erecta (Huds.) Coville), a species included in the Red Book of the Republic of Belarus (2015) with protection category III (VU) characterized by different living conditions have been identified.

Synanthrophic vegetation

The agrophytocenosis (a plant community created by humans through sowing or planting) of the area in question is represented by an agricultural crop – soft wheat (Triticum aestivum) and a number of weedy (segetal) plants: *Tripleurospermum inodorum, Viola arvensis, Melandrium album, Centaurea cyanus.* Soil: sod-podzolic loamy sand. The previous crop was corn (*Zea mays*). The blockage of the studied area is 35%, and there is no evidence of shrubbiness, hillock or mossiness of the site.

Algal flora

151 taxa of diatoms were identified in the studied samples of phytoplankton, phytobenthos and phytoperiphyton of reservoirs and watercourses of the Ostovets

district, taken within a 10-kilometre radius around Alternative Site 2-1. No species included in the Red Book of the Republic of Belarus have been found.

No wild plants belonging to the species included in the Red Book of the Republic of Belarus have been identified within the boundaries of Alternative Site 2-1, and there are no growing sites for plants belonging to the species whose distribution and abundance are subject to regulation.

No natural formations or complexes characterised by unique, rare or properties being important for landscape and biological diversity, which would cause difficulties or restrictions for the construction of radioactive wastes landfill, have been identified.

There are no public green areas (parks and forest parks, squares, boulevards, urban forests adapted for mass recreation) on Site 2-1.

Area of location of Site 3-3

Forest vegetation

There is no forest vegetation within the boundaries of Alternative Site 3-3.

Meadow vegetation

As a result of the reclamation measures carried out on the meadow lands of Site 3-3, a significant proportion of the grassy cover has been destroyed, and the remaining areas with vegetation cover represent communities of synanthropic vegetation.

Riverside-water vegetation

Within the boundaries of the 10-kilometre buffer zone within the boundaries of the radioactive wastes landfill of Alternative Site 3-3, 25 aquatic ecosystems were surveyed: 12 ponds, 1 quarry, 12 watercourses with varying degrees of channel transformation in 30 test areas.

The partial flora of riverside phytocenoses in the territory of Site 3-3 includes 59 species of vascular plants, grouped into 46 genera, 27 families, 3 classes and 2 divisions.

No rare species or those in need of protection have been identified.

Synanthrophic vegetation

No natural meadow lands have been identified in the study area. The grassy vegetation of Site 3-3 is represented exclusively by synanthropic communities: both agrophytocenoses – soft or summer wheat crops with a complex of weedy field (segetal) species, and ruderal (garbage) communities localized along the margins of fields, roadsides, outflow dishes and depressions.

Water vegetation

Within the boundaries of the 10-kilometre buffer zone within Alternative Site 3-3, 25 aquatic ecosystems (12 ponds, 1 quarry, 12 watercourses with varying degrees of channel transformation) were surveyed, and the work for inventory of species and phytocenotic diversity at each site was carried out.

The partial flora of riverside phytocenoses includes 25 species of vascular plants, grouped into 21 genera, 18 families, 3 classes and 2 divisions. No rare species or those in need of protection have been identified.

Algal flora

Currently, 39 taxa with a rank below the genus (38 species and 1 variety) have been identified in the studied samples from reservoirs and watercourses of the 10-kilometre zone within the boundaries of the radioactive waste landfill of Alternative Site 3-3. The list includes species of microalgae found in plankton and macroalgae from aquatic and ground habitats. The identified taxa belong to 6 divisions (*Cyanobacteriophyta, Charophyta, Chlorophyta, Euglenophyta, Heterokontophyta and Rhodophyta*), 12 classes, 18 orders, 23 families and 34 genera.

Only one of the identified species is Batrachospermum gelatinosum (Linnaeus) De Candolle is included in the Red Book of the Republic of Belarus (category IV of environmental significance). The blades were found in the Sorochinka River near the Sorochino settlement.

On the territory of site 3-3, only one plant species, wild mock cucumber – Echinocystis lobata (Michx.) Torr.& A.Gray., which is subject to control and destruction according to the Resolution of the Council of Ministers of the Republic of Belarus “On certain issues of regulating the distribution and abundance of plant species”, was recorded. The coverage of echinocystis is minimal: 1% in each community of tuberous sunflower and community of Canadian fleabane.

Area of location of Site 1-5

Almost the entire territory of the site of Alternative Site 1-5 belongs to the forest fund (lands of the Glinishche forestry department of the Khoiniksky Forestry State Fores Management Institution). The site outside the forest fund is represented by agricultural lands. The land user of this site is the Sudkovo Municipal Agricultural Unitary Enterprise.

Within the area under consideration, all forests are classified as exploitable forests.

The forest vegetation of Alternative Site 1-5 is quite diverse and mainly represented by communities of mixed pine forests of different age groups of mossy and bracken forest types with high diversity in floristic terms for these conditions.

141 species of higher vascular plants and 7 species of green frondiferous mosses were recorded in the flora of forest phytocenoses on the territory of Site 1-5. Higher vascular plants belong to 118 genera, 45 families, 43 orders, 5 classes, 4 divisions. Among them, the species included in the Red Book of the Republic of Belarus is Cervaria rivinii related to category III of national conservation significance. It also identifies species belonging to the "List of species of wild plants and fungi in need of preventive protection". Among them: Finland pink, Atocion lithuanicum (Silene lithuanica), large-flowered foxglove, broad-leaved helleborine and butterfly orchid. 9 stranger species were noted: maple ash, Washington lupine, European red elder, impatiens glandulifera, European evening primrose, Canadian fleabane, bootjack bur and Canadian goldenrod. Of these species, the most invasible species transformers are maple ash and Canadian goldenrod, which can transform ecotopes, displacing native plant species.

No rare or typical biotopes have been identified among the forest communities.

The surveyed area is a forest massif, in which the main part is occupied by plantations with pine as the predominant species. The structure of the massif is formed by different age categories of pine forests: maturing, middle-aged and ripe, which together form more than 60% of the area.

Soft-wooded broadleaved species such as birch and aspen are widely represented in the structure of the plantings. Hard-leaved species are represented by oak. These indicators characterise the massif as a collection of mixed coniferous and deciduous stands, where deciduous species are included in the majority of pine allotments without forming large independent contours.

A significant proportion is occupied by young trees and areas not covered by forests.

Meadow vegetation

There is no meadow vegetation within the limits of the radioactive wastes landfill of Alternative Site 1-5.

Riverside-water vegetation

Within the boundaries of the 10-kilometre buffer zone within the boundaries of the radioactive wastes landfill of Alternative Site 1-5, 8 aquatic ecosystems were surveyed: 6 ponds, 2 medium-length watercourses (the Vita River and the Kozhukhov Channel).

According to the analysis, 40 species of vascular plants were found in riverside-aquatic phytocenoses, grouped into 32 genera, 19 families, 3 classes and 2 divisions.

The families being leading in terms of the number of species are: Sedge family (Cyperaceae) and grass family (Poaceae), which account for 35.0% of the species and 28.0% of the generic diversity of the studied coenoflora. The remaining families are represented by 1-3 species. Among the genera of vascular plants, the genus rush (Juncus) and willow (Salix) are the most representative.

Water vegetation

There are 12 species of vascular plants in aquatic phytocenoses, grouped into 9 genera, 7 families, 2 classes and 1 division of Angiosperms (Magnoliophyta), of which 3 species belong to the Dicotyledonous class (Magnoliopsida), and 9 species belong to the Monocotyledonous class (Liliopsida).

There are 5 types of economically valuable plants in the studied aquatic phytocenoses: ornamental, technical and forage plants.

Ornamental: yellow pond lily (Nuphar lutea).

Forage: water manna grass (Glyceria fluitans), reed sweet grass (Glyceria maxima) and common duckweed (Lemna minor).

Technical: common reed grass (Phragmites australis).

Synanthrophic vegetation

There is no synanthropic vegetation within Alternative Site 1-5.

Algal flora

36 taxa (35 species and 1 variety) have been identified in reservoirs and watercourses of the 10-kilometre zone within Alternative Site 1-5.

Among the identified taxa, there are no species included in the Red Book of the Republic of Belarus.

Two plant species, the distribution and abundance of which are subject to regulation – maple ash and Canadian goldenrod, have been identified at site 1-5. They do not form separate communities, but are represented singly or at the very edge of the boundaries of the surveyed area.

5.6 Fauna

Area of location of Site 2-1

The species composition of insects living on Site 2-1 is characterised by a large number of widespread species and pests of forest and agricultural crops.

Two habitats of the protected species have been identified – the violet ground beetle (*Carabus violaceus*) in the Orlyakov birch forest (*Betuletum pteridiosum*) and in the sorrel-family spruce forest. This species is included in the Red Book of the Republic of Belarus.

The forest fragment planned for deforestation is relatively small in area, and the dynamic density of the protected species in this biotope is low.

The reptiles of the studied territory are represented by the following species: common northern viper (*Vipera berus*), common grass snake (*Natrix*), deaf adder (*Anguis fragilis*), sand lizard (*Lacerta agilis*) and viviparous lizard (*Zootoca vivipara*). The dominant species on the site are the common toad, grass frog and sand lizard.

The ornithofauna of the territory under consideration is represented by massive, widespread species; the densities of nesting birds are relatively low. The background species for this territory are sky lark (*Alauda arvensis*) and whinchat (*Saxicola rubetra*) being typical inhabitants of dry open spaces including grain fields and hayfields; for forest plantations – chaffinch (*Fringilla coelebs*), chiffchaff (*Phylloscopus collybita*) and robin (*Erithacus rubecula*).

One bird species included in the Red Book of the Republic of Belarus has been identified, corn crake (*Crex crex*), which prefers to nest in open habitats, in this case on agricultural landscapes. The abundance of this species at Alternative Site 2-1 is extremely low and insignificant for the region as a whole. Breeding zones of this type are unstable (depend on crop rotation) and this species easily changes them from year to year.

At least 21 species of wild mammals live on the territory of the immediate location of Alternative Site 2-1 and in the nearest biotopes and infrastructure facilities adjacent to it.

No permanent habitats of mammalian species included in the Red Book of the Republic of Belarus have been identified directly on Alternative Site 2-1.

The ichthyofauna of the Gozovka River is characterised by a small species diversity of fish (5-7 species), which includes the rarest and most protected species. There are permanent habitats and spawning grounds for 2 species of fish included in the Red Book of the Republic of Belarus with a high status of conservation importance: river trout (Salmo trutta morpha fario) (protection category II) and spawning grounds for trout species migrating from the Baltic Sea, sea trout (Salmo trutta) (protection category I (CR));

No permanent habitat of the mammal species included in the Red Book of the Republic of Belarus has been identified directly at Construction Site 2-1; however, there are traces of badger's activity (digging) as well as Eurasian lynx and brown bear on the western edge of the forest area, in which the Construction Site is located.

Thus, the fauna within the localities is characterised by low diversity and is represented by widespread species, no protected species have been identified on the site itself.

Animals and birds having nature-protection significance

Insects

As mentioned earlier, one species of insects, violet ground beetle (Carabus violaceus), which is included in the Red Book of the Republic of Belarus, has been identified. Carabus violaceus is European and Kazakstani xerophilous forest species.

The protected species Carabus violaceus is located outside the boundaries of the planned economic activity, therefore, there is no immediate threat to the existence of this species population.

Birds

In the territory under consideration there is one bird species included in the Red Book of the Republic of Belarus, crake (*Crex crex*).

Since the identified habitats are not permanent nesting sites, as they are not registered during the breeding season, this territory is not subject to protection.

Area of location of Site 3-3

As a result of the research, 31 species of ground beetles and 36 species of staphylinid beetles were identified. The species *Philonthus cognatus, Philonthus varius, Oxypoda exoleta, Aloconota gregaria, Gyrohypnus angustatus* and *Tachyporus chrysomelinus* are dominating.

No rare or protected species have been identified among invertebrates.

The species diversity of the herpetofauna of Alternative Site 3-3 includes up to 5 of their species, these are 4 species of amphibians and 1 species of reptiles – common spadefoot (*Pelobatus fuscus*), European common toad (*Bufo bufo*), moor frog (*Rana arvalis*), grass frog (*Rana temporaria*) and sand lizard (*Lacerta agilis*).

The dominant species in this agricultural area are the grass frog and the European common toad.

No amphibian and reptile species included in the Red Book of the Republic of Belarus have been identified in the area of Alternative Site 3-3.

Nesting of 19 bird species belonging to 2 orders was revealed directly at Alternative Site 3-3.

Four species of diurnal feathered predators of the order hawk-like (*Accipitriformes*), which nest in other suitable places, visit this territory for foraging. In the warm season, marsh harrier (*Circus aeruginosus*) and common buzzard (*Buteo buteo*) feed on mouse-like rodents here, sparrowhawk (*Accipiter nisus*) can fly in year-round for foraging, and rough-legged buzzard (*Buteo lagopus*) can migrate in winter. The lapwing (*Vanellus vanellus*) from the order of shore birds (*Charadriiformes*) also lives in this territory in summer.

No bird species included in the Red Book of the Republic of Belarus have been identified, but species with European protected status (SPEC) have been registered.

At least 14 species of wild mammals live on Alternative Site 3-3 or visit periodically it.

There are traces of activity of European brown hare (*Lepus europaeus*), three species of ungulates: European roe (*Capreolus capreolus*) and occasionally the elk (*Alces alces*) and wild boar (*Sus scrofa*), which enter the fields for foraging.

From the of carnivores (*Carnivora*) order, traces of the presence of 3 species from the canines (*Canidae*) family, which do not live here permanently, have been noted: traces of a fox (*Vulpes vulpes*) and a raccoon dog (*Nyctereutes procyonoides*) have been repeatedly noted as well as information about periodic visits by a wolf (*Canis lupus*) have been obtained. In such anthropogenically altered conditions, a weasel (Mustela nivalis) can live more or less permanently and European polecat (Mustela putorius) lives near populated areas (in 2024, an animal overridden on the road was revealed), but no traces of their presence were found.

No habitats of mammalian species included in the Red Book of the Republic of Belarus have been identified directly on Alternative Site 3-3.

There are 16 species of fish in the Chernaya Natopa River area, with a significant predominance of the group of freshwater ones (81%).

No fish species included in the Red Book of the Republic of Belarus) were found in the Chernaya Natopa River and an unnamed stream near the Volovniki settlement.

Area of location of Site 1-5

The animals and birds being present on the territory of Alternative Site 1-5 are as follows.

Invertebrate:

- 22 species of ground beetles in pineries;
- 31 species of spiders, the species *Trochosa terricola* is dominating.

No rare or protected species of invertebrates belonging to the species included in the Red Book of the Republic of Belarus have been identified on Alternative Site 1-5.

The species composition of the herpetofauna:

- three species of the amphibians: European common toad *(Bufo bufo),* moor frog (*Rana arvalis)* and grass frog (*Rana temporaria);*
- *two species of reptiles:* - deaf adder (*Anguis fragilis)* andsand lizard *(Lacerta agilis)*

No species included in the Red Book of the Republic of Belarus have been found.

24 bird species belonging to 3 orders have been identified as nesting directly at Alternative Site 1-5: *Passeriformes, Cuculiformes* and *Piciformes*.

No bird species included in the Red Book of the Republic of Belarus have been revealed.

4 species of birds with European protected status have been identified in the described territory.

At least 18 species of wild mammals live on the territory of Alternative Site 1-5 and in the nearest adjacent biotopes.

The mammalian species belong to 6 orders: insectivores (3 species), rodents (5 species), bats (2 species), hares (1 species), ungulates (Cetartiodactyla) (5 species) and predatory (2 species).

There are 2 species of small rodents in forest biotopes: red-backed vole and yellow-necked field mouse and 4 species in open biotopes – young pine plantations: common vole, field mouse, yellow-necked field mouse and red-backed vole.

A small (9-12 animals) herd of bison (*Bison bonasus*) periodically inhabits on Site 1-5.

The bison is a species of mammals included in the Red Book of the Republic of Belarus. Animals use this area for movement and for recreation.

Numerous traces of activity of 4 more species of the Cetartiodactyla family of Cetaceans have been noted: red deer (*Cervus elaphus*), European roe deer (*Capreolus capreolus*), and occasionally wild boar (*Sus scrofa*) and elk (*Alces alces*).

The following 5 species of mammals live on Alternative Site 1-5 or visit it periodically: northern white-breasted hedgehog (*Erinaceus roumanicus*) of the hedgehog family Erinaceidae, brown hare (*Lepus europaeus*) of the order double-toothed rodents (*Lagomorpha*), very rarely – squirrel (*Sciurus vulgaris*) of the order

Rodent Rodentia order and wolf (Canis lupus) of the order carnivores (Carnivora) and fox (Vulpes vulpes).

No permanent habitats of mammalian species included in the Red Book of the Republic of Belarus have been identified directly on Alternative Site 1-5, but only traces of periodic passage of bison have been noted.

5.7 Natural Complexes and Natural Features

Area of Location of Site 2-1

Based on the investigation results, no natural systems or natural features of conservation value have been identified within the territory of Site 2-1.

Planned Off-site Infrastructure Facilities of the Radioactive Waste Disposal Facility (RWDF) are located near and within the territory of natural complexes and natural features with a special protection regime (Figure 5.17). These include the following components of the National Ecological Network: the Vileyka Ecological Corridor of international importance (CE2) and the Naroch Ecological Core of international importance (E8).

The Vileyka Ecological Corridor of international importance (CE2) is located 1.4 km northwest of the boundaries of alternative Site 2-1 (Figure 5.17). A planned treated wastewater discharge pipeline to the Viliya River passes through the territory of the ecological corridor. A planned communication cable running from Goza Village to the RWDF originates near the boundaries of the ecological corridor.

The Naroch Ecological Core of international importance (CE6) is located 4.2 km northeast of the boundaries of alternative Site 2-1 (Figure 5.17). The infrastructure objects planned closest to the ecological core are the 1st stage water conduits (3.5 km to the southwest) and the I&C cable (3.5 km to the southwest).

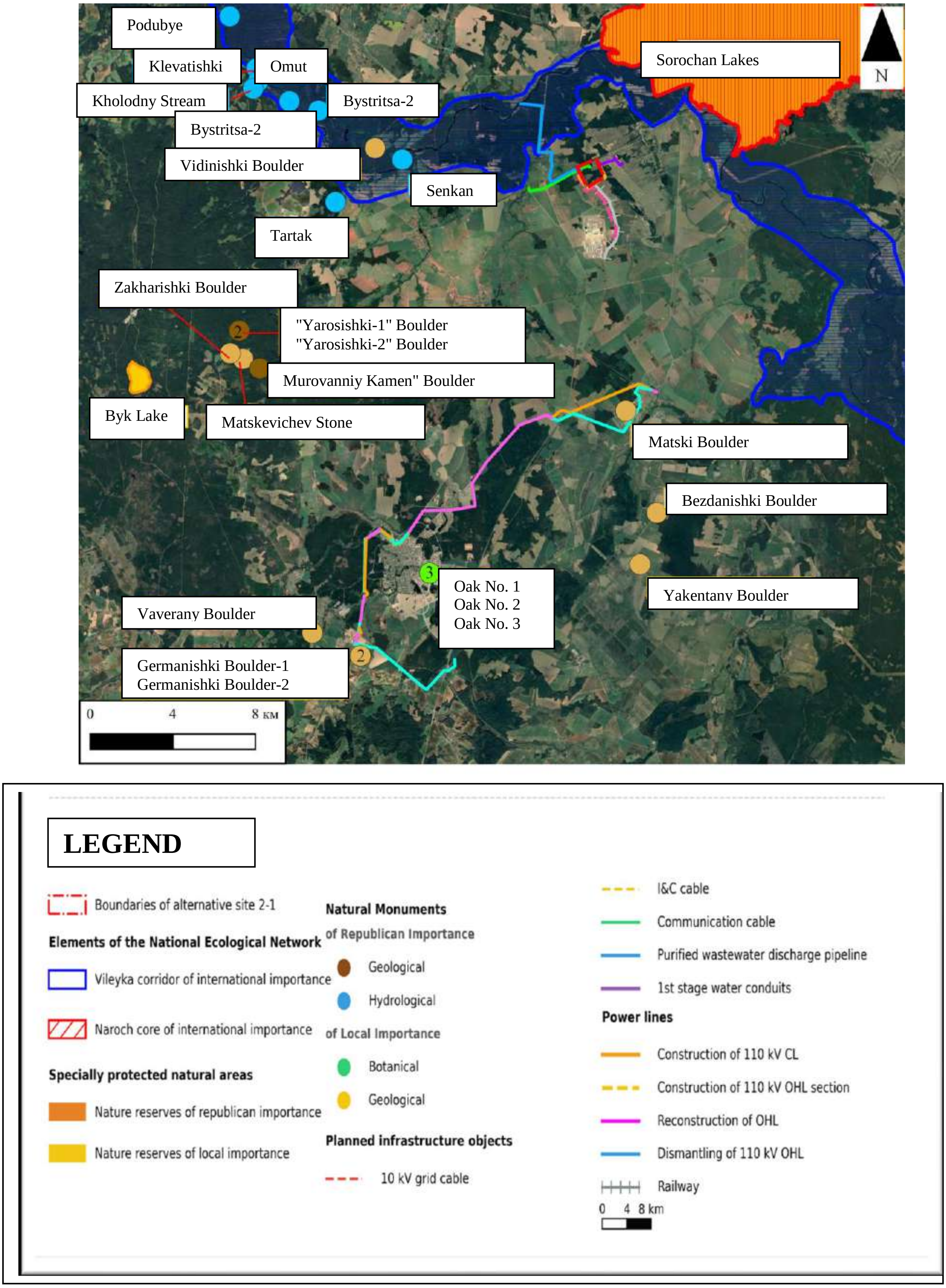


Figure 5.17 – Natural complexes and natural features with a special protection regime near alternative Site 2-1 and planned infrastructure facilities

Planned infrastructure facilities for the operation of the RWDF are not located within specially protected natural territories.

In accordance with the Scheme for the Rational Allocation of Specially Protected Natural Territories of Republican Significance until 01.01.2035, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 787 dated October 23, 2024, no establishment of Specially Protected Natural Areas (SPNAs) of republican significance is planned within the Ostrovets District.

As of 01.01.2026, according to open data sources of the Ostrovets District Inspection of Natural Resources and Environmental Protection, there are no planned SPNAs of local significance to be established.

Area of Location of Site 3-3

The assessment of natural complexes and natural features indicated that within the boundaries of alternative Site 3-3 (Figure 5.18):

1) elements of the National Ecological Network are absent;
2) SPNAs are absent;
3) reserved SPNAs are absent;
4) rare and typical biotopes are absent.

Accordingly, it can be noted that there are no natural complexes or natural features subject to special protection within the territory of alternative Site 3-3.

Planned infrastructure facilities for the operation of the RWDF are located near and within the territory of natural complexes and natural features with a special protection regime. These include:

1)The "Shirina and Podrechie" Nature Reserve of local significance, located 9.4 km northeast of the boundaries of alternative Site 3-3.

The nature reserve is situated in the Mstislavl District of the Mogilev Region. It was established on a fen-type peat deposit in the Molotovnya River floodplain to conserve and restore water bodies and their associated ecological systems within the peat deposit.

The closest planned infrastructure facilities to the nature reserve are the railway tracks running from the RWDF to the Krichev–Orsha line, located 8.0 km to the west.

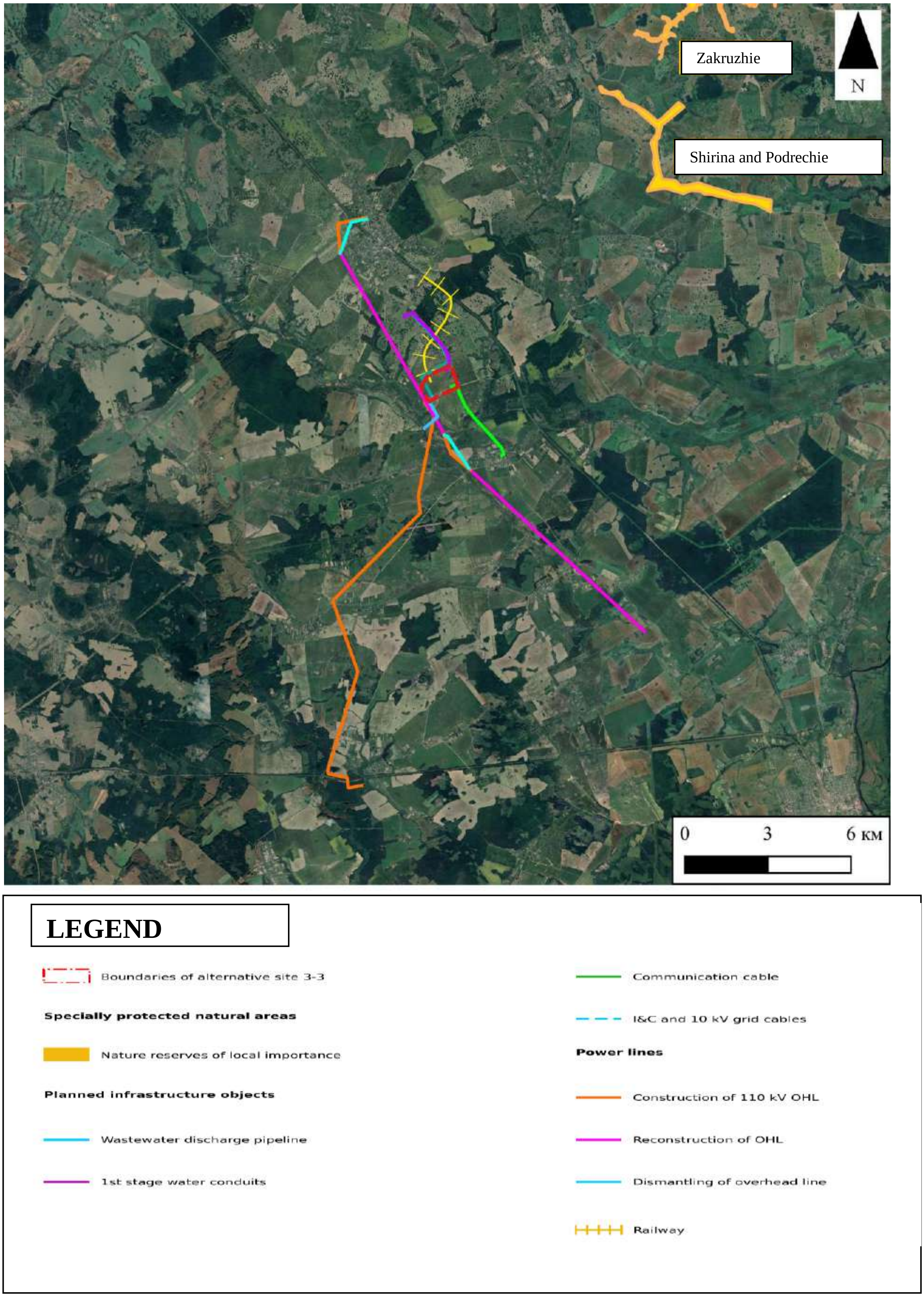


Figure 5.18 – Natural complexes and natural features with a special protection regime near alternative Site 2-1 and planned infrastructure facilities

2)The "Zakruzhie" Nature Reserve of local significance is located 13.4 km northeast of the boundaries of alternative Site 3-3. It was established to conserve and restore water bodies and their associated ecological systems within the peat deposit. To the north of the nature reserve, near Sutoki Village, there is a local recreation area by a local pond.

The closest planned infrastructure facilities to the nature reserve are the dismantled and constructed 110 kV OHLs (Overhead Lines) located 12.0 km to the southeast.

Planned infrastructure facilities for the operation of the RWDF are not located within SPNAs.

In accordance with the Scheme for the Rational Allocation of Specially Protected Natural Territories of Republican Significance until 01.01.2035, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 787 dated October 23, 2024, no establishment of SPNAs of republican significance is planned within the Mstislavl District.

As of 01.01.2026, according to open data sources of the Mstislavl District Inspection of Natural Resources and Environmental Protection, there are no planned SPNAs of local significance to be established.

Area of Location of Site 1-5

The assessment of natural complexes and natural features indicated that within the boundaries of alternative Site 1-5 (Figure 5.19):

1) elements of the National Ecological Network are absent;
2) SPNAs are absent;
3) reserved SPNAs are absent;
4) rare and typical biotopes are absent.

Planned infrastructure facilities for the operation of the RWDF are located near and within the territory of natural complexes and natural features with a special protection regime. These include:

1) The National Ecological Network: the Strelsk Ecological Core of regional importance (R15) and the Pripyat Ecological Corridor of international importance (CE6).
2) SPNAs: nature reserves of republican importance "Strelsky" and "Mozyr Ravines", botanical natural monuments of local importance "Dubrava", "Pine 'Koroleva'", "Pine Plantations", "Two Oaks", "Ancient Trees of Rechytsa Forestry".

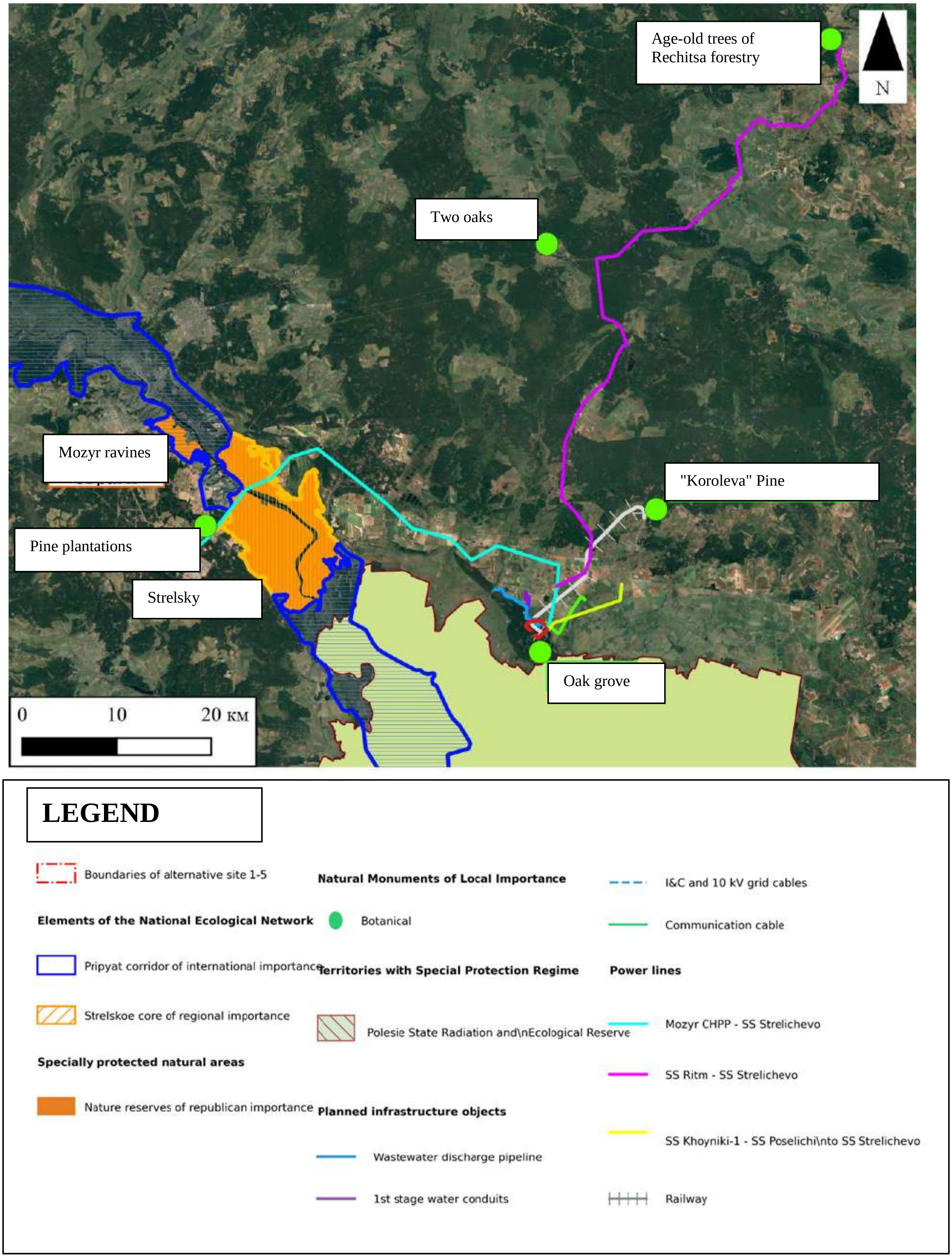


Figure 5.19 – Natural complexes and natural features with a special protection regime near alternative Site 1-5 and planned infrastructure facilities

Planned infrastructure facilities for the operation of the RWDF are not located within the territory of the Polesie State Radiation and Ecological Reserve.

In accordance with the Scheme for the Rational Allocation of Specially Protected Natural Territories of Republican Significance until 01.01.2035, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 787 dated October 23, 2024, no establishment of SPNAs of republican significance is planned within the Khoiniki District.

As of 01.01.2026, according to open data sources of the Khoiniki District Inspection of Natural Resources and Environmental Protection, there are no planned SPNAs of local significance to be established.

The "Emerald Network of Ukraine" SPNA is located at a distance of 33 km from Site 1-5.

5.8 Physical Impacts, Including Radiation, Thermal and Electromagnetic Impacts, Noise and Vibration Levels

Area of Location of Site 2-1

There are no sources of noise impact, vibration sources, or sources of thermal and electromagnetic impact in the considered area.

The investigation of radiological conditions in the area of Site 2-1 location was performed based on the analysis of historical radiation monitoring data within the National Environmental Monitoring System (NEMS).

Two observation points (hereinafter referred to as OP) for surface water radiation monitoring and four soil observation points—a landscape-geochemical testing ground (hereinafter referred to as LGTP)—have been identified in the Ostrovets District.

The analysis of the existing radiation status of ambient air was carried out based on available radiation monitoring data from three ambient air OPs within the area of impact of the Belarusian NPP—Oshmyany, Naroch, and Lyntupy. It also utilized data from the Automated Radiation Situation Control System of the Belarusian NPP (hereinafter referred to as ARSCS of the BelNPP), installed in 2018, regarding gamma radiation dose rate (hereinafter referred to as DR) metrics at ten automatic measurement stations (hereinafter referred to as AMS)—Ostrovets, Oshmyany, Gervyaty, Kotlovka, Gudogay, Naroch, Lyntupy, Trokeniki, Mikhalishki, and Kemelishki. This allows for a broader assessment of the radiation situation in the region as a whole.

Ambient air observation data within the area of impact of the Belarusian NPP at the Oshmyany, Naroch, and Lyntupy OPs for the period 2021–2025 were reviewed using the following indicators:

- gamma radiation DR;
- total beta activity of aerosols in the surface layer of the atmosphere (Bq/m³) and natural deposition from the surface layer of the atmosphere (Bq/(m²·day));
- volumetric activity of gamma-emitting radionuclides Cs-137 and Pb-210 (Bq/m³);
- volumetric activity of strontium-90 (Bq/m³).

The analysis of data over the 5-year period from the ambient air radiation monitoring OPs within the area of impact of the Belarusian NPP allows for the conclusion that multi-year DR indicators are stable. There are some seasonal fluctuations in the total beta activity indicators in radioactive aerosols of the surface atmospheric layer, showing an increase during the winter-spring period and a decrease during the summer-autumn period.

Regarding surface water radiation monitoring, data were analyzed from two surface water radiation monitoring OPs located within a 30-kilometer radius of Region No. 2 (Ostrovets)—the Svir Lake (Svir) OP and the Viliya River (Bystritsa) OP.

The following parameters are determined at the specified surface water radiation monitoring OPs:

- total alpha and beta activity (Bq/dm³) (since 2022);
- volumetric activity of cesium-137 and strontium-90 in surface water (Bq/dm³), as well as specific activity of cesium-137 and strontium-90 in bottom sediments (Bq/kg).

At the Svir Lake (Svir) OP, measurements of total alpha and beta activity, as well as cesium-137 and strontium-90 activity, are performed quarterly, while cesium-137 and strontium-90 activity in bottom sediments is measured once a year.

The Viliya River (Bystritsa) OP is transboundary. Parameter measurements in surface water are performed five times a year during the main phases of the river's water regime.

Cesium-137 and strontium-90 activity levels in surface water at these observation points varied within narrow ranges, and the results were significantly below the reference level for radionuclide content in drinking water established by the Hygienic Standard "Criteria for Radiation Impact Assessment" (the reference level is 10 Bq/L (10 Bq/dm³) for cesium-137 and strontium-90).

Volumetric total alpha and beta activity at the OPs within the 30-kilometer radius of the competitive site has been measured only since 2022 and did not exceed the reference levels for total alpha and beta activity in drinking water established by legislation.

Cesium-137 and strontium-90 activity levels in bottom sediments varied widely across the OPs—cesium-137 ranged from 1 to 9.8 Bq/kg, and strontium-90 ranged from 1 to 21 Bq/kg, without a steady upward trend in radionuclide activity over the years.

In the Ostrovets District, data analysis was conducted for four OPs (Bystritsa, Kemelishki, Gudogay, Svir) at the LGTP (assessment of radionuclide distribution along the vertical soil profile) for 2021–2025.

The analysis of the data obtained in 2021–2025 for all four LGTP OPs indicates that the vertical migration of radionuclides in the soil within the territory not classified as affected by the Chernobyl NPP disaster is within the established multi-year values. These values correspond to the level of global fallout caused by nuclear weapons testing in the middle of the last century.

Area of Location of Site 3-3

There are no sources of noise impact, vibration sources, or sources of thermal and electromagnetic impact in the considered area.

The following stationary radiation monitoring OPs within the NEMS have been identified in the area of Site 3-3 location:

- OP – ambient air;
- 1 OP – surface water;
- OP – RP soil.

There are also 65 radiation control settlements classified as radioactive contamination zones resulting from the Chernobyl NPP disaster. This number also includes settlements of neighboring administrative districts—Kostyukovichy and Krichev.

The radiation situation assessment was conducted based on radiation monitoring data from the past 5 years (2019–2023) and historical data from the RECONT database (since 1986) regarding soil radionuclide contamination density.

A comparative and systemic analysis of ambient air monitoring data for the 2019–2023 period at two OPs (Mstislavl and Kostyukovichy) demonstrated that the results generally correspond to the established reference levels and/or established multi-year values. Isolated, one-off, and usually seasonal fluctuations in values were observed, none of which indicate a trend toward a steady deterioration of the radiation situation in the area of the considered competitive sites.

The total beta activity values in composite monthly aerosol samples from the surface layer of the atmosphere at the Mstislavl OP in 2019–2023 ranged within 8.4–35.1·10^{-5} Bq/m³.

The total beta activity values of natural deposition from the surface layer of the atmosphere at the Mstislavl OP ranged within 0.5–5.0 Bq/(m²·day), and at the Kostyukovichy OP within 0.5–4.5 Bq/(m²·day).

The cesium-137 activity in aerosols of the surface layer of the atmosphere at the Mstislavl OP in 2019–2023 ranged from <0.1·10^{-5} Bq/m³ to 1.73·10^{-5} Bq/m³, and strontium-90 ranged from <0.004·10^{-5} Bq/m³ to 0.365·10^{-5} Bq/m³.

The upper ranges of values for cesium-137 (1.73·10^{-5} Bq/m³) and strontium-90 (0.365·10^{-5} Bq/m³) were recorded in 2020 and 2021, respectively. In the subsequent two years of observation (2022–2023), they showed significantly lower values: 0.24·10^{-5} Bq/m³ for cesium-137 and 0.093·10^{-5} Bq/m³ for strontium-90.

Cesium-137 and strontium-90 activity indicators in surface water at the Sozh River (Koskovo) OP in 2019–2023 varied within narrow limits, and the results were significantly below the reference level for radionuclide content in drinking water established by the Hygienic Standard "Criteria for Radiation Impact Assessment" (the reference level is 10 Bq/L (10 Bq/dm³) for cesium-137 and strontium-90).

The assessment of long-term changes in the radiation situation at reference points (hereinafter referred to as RP) is carried out by analyzing changes in the main radiation parameters (gamma radiation DR, radioactive contamination density).

Forty years after the Chernobyl NPP accident, the radiation situation in the contaminated territories is well-studied and steadily improving. There is a decrease in radionuclide activity in the soil due to natural physical processes (radioactive decay of radionuclides, horizontal and vertical migration, weathering, and airborne transport processes) and human economic activities (implementation of protective measures).

Soil radiation monitoring data from the RP network indicate that the radiation situation is stable in the territories affected by the Chernobyl NPP disaster. The results of radionuclide content measurements in soil samples over the last 5-year period showed no deviations from long-term processes or new trends related to the presence of radionuclides in the soil. The obtained data on the specific activity of radionuclides in the soil at the specified RPs correlate well with the soil radioactive contamination data used to classify the settlements where the RPs are located into radioactive contamination zones.

According to the effective List of Settlements and Facilities Located in Radioactive Contamination Zones, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 75 dated February 9, 2021, there are 36 settlements with soil contamination by cesium-137 within the territory of the considered region (in the Klimovichi and Mstislavl Districts, as well as the neighboring Kostyukovichy and Krichev Districts) of the Mogilev Region.

In accordance with Article 5 of Law No. 385-Z dated May 26, 2012 "On the Legal Regime of Territories Subject to Radioactive Contamination Resulting from the Chernobyl NPP Disaster" (hereinafter referred to as the Law), the radioactive contamination territory includes a part of the territory with a soil contamination density of cesium-137, strontium-90, or plutonium-238, 239, 240 radionuclides equal to 37, 5.55, and 0.37 kBq/m² (1.0, 0.15, and 0.01 Ci/km²) or more, respectively, as well as other territories where the average annual effective population radiation dose may exceed 1 mSv (above the natural and technological background level).

It should be noted that according to current forecasts, most of the presented settlements will continue to remain in radioactive contamination zones for decades to come.

According to historical data from the RECONT database, there is 1 uninhabited settlement in the Mstislavl District and 4 in the Krichev District, from which the population was evacuated at various periods due to high contamination levels and dose rates resulting from the consequences of the Chernobyl NPP disaster.

Area of Location of Site 1-5

There are no sources of noise impact, vibration sources, or sources of thermal and electromagnetic impact in the considered area.

Site 1-5 is located in the center of the Khoiniki District, the territory of which is situated within the radioactive contamination zone resulting from the Chernobyl NPP disaster. Distance from Site 1-5 to the nearest populated area (hereinafter referred to as the PA) —Novoselki Village—is approximately 2.5 km, while the distances to the town of Khoiniki, the settlement of Strelichevo, and the settlement of Veliky Bor are 14.5 km, 10.6 km, and 24 km, respectively. The distance to the border with Ukraine is 35 km, to the border with Polesie State Radiation and Ecological Reserve State Environmental Scientific Research Institution (hereinafter referred to as PSRER) is 4.5 km, and to the Pripyat River is 13.8 km.

Only Novoselki Village, with a population of 29 people, is located within a 5-km radius of the site, while 12 PAs are located at a distance of 5–10 km. In total, 13 PAs with a total population of 2,216 people are located within a 10-km radius of Site 1-5, including 7 PAs (the settlement of Khrapkov, Dvorishche Village, Borisovshchina Village, the settlement of Sudkovo, Vit Village, Kozeluzhie Village, and Ezapov Village) with a population of over 100 people each, totaling 2,087 people.

Novoselki Village is located within the zone with the right to resettlement; the radioactive contamination density of the territory is: ^{137}Cs – 280.5 kBq/m², ^{90}Sr – 25.2 kBq/m², ^{238,239,240}Pu – 1.12 kBq/m², and ^{241}Am – 2.57 kBq/m². This is determined by the List of Settlements and Facilities Located in Radioactive Contamination Zones, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 75 dated February 8, 2021.

Within a 10-km radius, 9 PAs are located in the zone of residence with periodic radiation control, and 4 PAs are located in the zone with the right to resettlement.

In the 9 PAs located within the zone of residence with periodic radiation control, the radionuclide contamination densities were:

– ^{137}Cs – 76.22–138.01 kBq/m² (2.06–3.73 Ci/km²)
– ^{90}Sr – 9.9–21.83 kBq/m² (0.27–0.59 Ci/km²)
– ^{238,239,240}Pu – 0.3404–0.5994 kBq/m² (0.0092–0.0162 Ci/km²)
– ^{241}Am – 0.5254–1.3986 kBq/m² (0.0142–0.0378 Ci/km²)

In the 4 PAs located within the zone with the right to resettlement, the radionuclide contamination densities were:

– ^{137}Cs – 202.76–280.46 kBq/m² (5.48–7.58 Ci/km²)
– ^{90}Sr – 24.79–35.15 kBq/m² (0.67–0.95 Ci/km²)
– ^{238,239,240}Pu – 1.1211–1.4911 kBq/m² (0.0303–0.0403 Ci/km²)
– ^{241}Am – 1.4652–2.5715 kBq/m² (0.0396–0.0695 Ci/km²).

Radiation monitoring of surface waters is conducted within the territories adjacent to the area of the RWDF zone of influence for alternative Site 1-5, on the Pripyat (town of Mozyr) and Nizhnyaya Braginka (village of Gden) rivers. Currently, the radiation situation on the monitored rivers remains stable, and the average annual concentrations of ^{137}Cs and ^{90}Sr do not exceed radiation safety standards. In 2022, the ^{137}Cs content in the Pripyat River (town of Mozyr) ranged from 2 to 4 Bq/m³, and ^{90}Sr ranged from 6 to 11 Bq/m³. In the water of the Nizhnyaya Braginka River, the catchment area of which is partially located within the territory of the Chernobyl NPP exclusion zone, radioactive contamination levels are significantly higher than in the Pripyat River: in 2022, ^{137}Cs concentrations reached 208 Bq/m³, and ^{90}Sr reached 746 Bq/m³.

Forty years after the Chernobyl NPP accident, the radiation situation in the contaminated territories is well-studied. A decrease in radionuclide activity in the soil is observed due to natural physical processes (radioactive decay of radionuclides, horizontal and vertical migration, weathering, and airborne transport processes) and human economic activities (implementation of protective measures).

Soil radiation monitoring data from the RP network indicate that the radiation situation is stable in the territories affected by the Chernobyl NPP disaster. The results of radionuclide content measurements in soil samples over the last 5-year period showed no deviations from long-term processes or new trends related to the presence of radionuclides in the soil.

5.9 Waste Management

Area of Location of Site 2-1

According to information from the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus (the register of waste utilization facilities and the register of waste storage, disposal, and treatment facilities), there are no waste treatment facilities within the territory of the Ostrovets District.

There are two waste utilization facilities located within the territory of the Ostrovets District.

According to data from the State Waste Cadastre, the total volume of waste generation in the Ostrovets District for 2024 amounts to 15,540 tons, of which 10,300 tons are directed for utilization. According to data for 2024, the disposal of industrial waste in the district amounted to 5,150 tons. In addition to this, municipal solid waste is received for disposal.

Among industrial waste, the largest disposal volumes consist of industrial waste similar to municipal waste (code 9120400) – 4,153 tons in 2024.

There is one operating Municipal Solid Waste (MSW) landfill within the territory of the Ostrovets District. The operation of the landfill began in 2022. The design capacity of the landfill is 100 thousand m³ per year.

Area of Location of Site 3-3

According to data from the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, no waste utilization facilities are registered in the Mstislavl District within the register of waste utilization facilities.

According to information from the State Waste Cadastre, the total volume of waste generation in the Mstislavl District for 2024 amounts to 6,450 tons, of which 4,060 tons are directed for utilization.

There is one operating MSW landfill within the territory of the Mstislavl District.

The Mstislavl municipal solid waste landfill is located 200 meters west of the Mstislavl–Mushino road and 1.5 km south of Kalinovka Village, Mstislavl District.

The design capacity of the landfill is 10.0 thousand tons/year. The total area of the facility is 4.1 hectares. The year of commissioning of the facility is 1991.

Area of Location of Site 1-5

According to information from the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus (the register of waste utilization facilities and the register of waste storage, disposal, and treatment facilities), there are no waste treatment facilities within the territory of the Khoiniki District.

There are two waste utilization facilities located in the Khoiniki District.

The generation volumes of industrial waste in the Khoiniki District range from 26.3 thousand tons (in 2020; of which 12 thousand tons are slab wood, batten waste, stump-grubbing waste, and waste from boughs, branches, and tops) to 13.8 thousand tons (in 2023, of which 5 thousand tons are for the corresponding items). In 2020, the utilization volume amounted to 7.4 thousand tons; in 2021 – 4.0 thousand tons; in 2022 – 9.7 thousand tons; in 2023 – 12.2 thousand tons; and in 2024 – 26.8 thousand tons.

The municipal solid waste landfill is located 8 km northwest of the town of Khoiniki and 0.8 km southwest of the Kurovoye settlement. It was commissioned in 1976. The design capacity of the Kurovoye settlement MSW landfill is 5.4 thousand tons/year (22.0 thousand m³/year).

5.10 Socio-Economic and Other Conditions

Area of Location of Site 2-1

The Ostrovets District is a border district. In the north and west, it borders the Republic of Lithuania; in the northeast, it borders the Postavy District of the Vitebsk Region and the Myadel District of the Minsk Region; in the east and south, it borders the Smorgon District, and in the south, the Oshmyany District of the Grodno Region.

The distance from Site 2-1 to the border with:

– the Republic of Lithuania is 20 km;
– the Republic of Latvia is 108 km;
– the Republic of Poland is 191 km;
– Ukraine is 316 km.

The administrative center of the district, Ostrovets, is located on the Losha River. Among the district centers of the Grodno Region, it is the most distant (240 km) from the regional center, the city of Grodno. There are 365 rural settlements and 5 rural councils in the district: Vornyany, Gervyaty, Gudogay, Mikhalishki, and Rytan.

International border crossings are located within the territory of the district: the "Kotlovka" and "Losha" road checkpoints, and the "Gudogay" railway checkpoint.

According to data from the National Statistical Committee of the Republic of Belarus, the population of the Ostrovets District at the end of 2024 amounted to 28,500 people, including an urban population of 15,265 people (54.0% of the district's population) and a rural population of 13,235 people (46.0% of the district's population).

The Ostrovets District accounts for 2.9% of the total population of the Grodno Region [14].

The number of people employed in the economy of the Ostrovets District at the end of 2024 amounted to 12,691 people, or 96.1% compared to the level of the same period in 2020.

The Ostrovets District is classified among the districts of the Grodno Region with a medium level of socio-economic development. The leading industries in the Ostrovets District are the forestry, woodworking, and food industries.

The agricultural sector of the district's economy is represented by five agricultural enterprises and 6 privately owned farms. During the 2021–2024 period, 2 modern dairy complexes were constructed, one dairy complex was reconstructed, and another one is currently under construction. Additionally, 2 rapeseed processing workshops were built.

The energy sector of the Ostrovets District of Belarus is inextricably linked with the Belarusian NPP (BelNPP), which transformed the district from an agricultural area into the energy capital of the country, significantly increasing tax revenues, creating jobs, and stimulating infrastructure development, including social facilities and housing, thereby making the district a leader in wage levels and quality of life.

There are 18 institutions operating in the district that implement the pre-school education curriculum: 6 nursery-kindergartens, 5 kindergartens, 1 pre-school child development center, 2 "nursery-kindergarten–secondary school" educational complexes, 2 "kindergarten–secondary school" educational complexes, 1 "kindergarten–basic school" educational complex, and 1 "kindergarten–primary school" educational complex.

There are 85 groups operating within the pre-school education institutions, including: 16 mixed-age groups, 4 sanatorium-type groups, 5 special groups for children with severe speech disorders, and 21 integrated learning and education groups.

A total of 266 children receive assistance at 9 centers for correctional and pedagogical support.

The system of general secondary education institutions in the current academic year is represented by 16 educational institutions: 1 gymnasium, 6 educational complexes, and 9 secondary schools.

The development of culture in the district is supported by the State Institution "Ostrovets District Center of Culture and Folk Art," which includes the town Center of Culture and 7 rural club branches, including 1 branch designated as the "Rymdyuny Rural Club-Library." A total of 125 core employees and 11 external part-time employees work at the Center of Culture. Among them, 60 are managers and specialists, 32 hold higher education degrees (including 9 with higher specialized degrees), and 18 hold specialized secondary education degrees (including 12 with specialized vocational degrees).

Medico-Demographic Situation

Site 2-1 is located in the Ostrovets District at a distance of 3.8 km from the Belarusian NPP site. In total, 4,323 people live within a 10-km radius of Site 2-1, which corresponds to a population density of 13.8 people/km².

As of 01.01.2025, there are 292 PAs located within the territory of the Ostrovets District, with a total population of 28,500 people, including 15,265 people in the town of Ostrovets and 13,235 people in the remaining PAs of the district. In addition to the town of Ostrovets, there are 22 PAs with a population of over 100 people each located in the district, housing a total of 7,899 people.

In the total population of the Ostrovets District, the shares of men and women are practically equal (49.6% and 50.4% of the total population, respectively). The shares of the urban and rural population are 53.6% and 46.4% of the total district population, respectively; the share of the working-age population stands at 60.0%.

Adult Morbidity in the Ostrovets District

During the 2020–2024 period, the primary morbidity structure of the adult population in the Ostrovets District was dominated by the following diseases: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the circulatory system, diseases of the musculoskeletal system and connective tissue, and diseases of the genitourinary system. These disease classes contributed 60–70% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 adult population of the district was as follows:

– diseases of the respiratory system – 18,067.8 cases (36.1%);

– certain infectious and parasitic diseases – 5,514.5 cases (4.4%);

– diseases of the circulatory system – 4,192.3 cases (8.4%);

– diseases of the musculoskeletal system and connective tissue – 2,907.1 cases (5.8%);

– diseases of the genitourinary system – 3,689.6 cases (7.4%).

The following trends have been established:

– a decrease in the morbidity rate for certain infectious and parasitic diseases from 17.5% in 2020 to 4.4% in 2024, which was associated with the end of the COVID-19 pandemic;

– respiratory system diseases consistently account for the largest share in the morbidity structure.

Over the five-year period, the primary morbidity of malignant neoplasms of all sites in the district population ranged from 397.2 to 545.9 cases per 100,000 population. The growth rate of morbidity for malignant neoplasms of all sites amounted to 25.0%.

In the structure of primary oncological morbidity of the adult population, the largest contribution was made by skin cancer, followed by lung cancer, breast cancer, and prostate cancer.

Multi-year fluctuations in the primary morbidity of malignant neoplasms among the adult population of the Ostrovets District were negligible, amounting to just a few cases annually, and were largely driven by population aging.

Child Morbidity in the Ostrovets District

During the 2020–2024 period, the primary morbidity structure of children and adolescents in the Ostrovets District was dominated by the following diseases: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the eye and adnexa, diseases of the digestive system, and diseases of the ear and mastoid process. These disease classes contributed more than 80.0% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 children and adolescents of the district was as follows:

– diseases of the respiratory system – 108,832.8 cases (71.1%);
– certain infectious and parasitic diseases – 9,060.6 cases (5.9%);
– diseases of the eye and adnexa – 8,272.0 cases (5.4%);
– diseases of the digestive system – 5,327.7 cases (3.5%);
– diseases of the ear and mastoid process – 3,908.2 cases (2.6%).

The overall morbidity rate of children and adolescents per 100,000 population in the Ostrovets District was 107,998.6 cases in 2020, 107,195.0 cases in 2021, 131,231.7 cases in 2022, 134,248.2 cases in 2023, and 153,137.0 cases in 2024. The growth rate of the morbidity level amounted to 41.8%.

The following trends were noted:

– for the class of diseases of the digestive system, the growth amounted to 234.5% in 2024 compared to 2020;
– for the class of diseases of the eye and adnexa, the growth amounted to 220.2% in 2024 compared to 2020;
– for the class of neoplasms, the growth amounted to 36.2% in 2024 (192.8 cases per 100,000 population) compared to 2020 (141.6 cases per 100,000 population).

Area of Location of Site 3-3

The Mstislavl District is classified among the districts of the Mogilev Region with a socio-economic potential below the medium level.

The distance from Site 3-3 to the border with:

– the Republic of Lithuania is 340 km;
– the Republic of Latvia is 328 km;
– the Republic of Poland is 510 km;
– Ukraine is 194 km.

The distance from the regional center is 100 kilometers. The district borders the Gorki, Dribin, Krichev, and Chausy Districts of the Mogilev Region, as well as the Monastyrshchina, Khislavichi, and Shumyachi Districts of the Smolensk Region of the Russian Federation. The district comprises 1 town and 157 rural settlements, including 13 settlements. Administratively, the district is divided into 8 rural councils.

The railway of the Orsha–Krichev line and highways to Mogilev, Krichev, Gorki, and Smolensk pass through the district.

According to data from the National Statistical Committee of the Republic of Belarus, the population of the Mstislavl District at the end of 2024 amounted to 17,910 people, including an urban population of 9,951 people (56.0% of the district's population) and a rural population of 7,959 people (44.0% of the district's population).

The Mstislavl District accounts for 1.0% of the total population of the Mogilev Region.

The Mstislavl District is characterized by a population decline, predominantly driven by a steady decrease in the rural population, which is due to low birth rates and high mortality rates.

The number of people employed in the economy of the Mstislavl District in 2024 amounted to 6,741 people, or 95.8% compared to the level of the same period in 2023.

The main enterprises of the district are located in Mstislavl:

– "Mstislavlmoloko" Production Unitary Enterprise, a branch of "Babushkina Krynka" Holding;

– Mstislavl Bakery, a branch of Domochay Bakery and Confectionery Company JSC;

– A branch of Pochinkovskaya Garment Factory LLC;

– Mstislavllen JSC — produces flax fiber from local fiber flax for the needs of the Orsha Linen Mill.

There are 9 state-owned enterprises involved in the agricultural sector.

There are 18 pre-school education institutions in the district (including "kindergarten–school" complexes).

The district center houses the Mstislavl Special General Education Boarding School for Children with Severe Speech Disorders—the only institution of its kind in the Mogilev Region. The Mstislavl State Construction College is also located in Mstislavl.

The Mstislavl District Historical and Archaeological Museum operates in the district center, housing more than 12.7 thousand museum items in its main collection (ranking 5th among the museums of the Mogilev Region).

Medico-Demographic Situation

Site 3-3 is located in the Mstislavl District, in the southern part of the Khodosy rural council (selsoviet), which borders three rural councils (Molyatichi, Belsky, and Botvinovsky) of the Krichev District; therefore, the PAs surrounding Site 3-3 belong to both the Mstislavl and Krichev Districts.

The distance from Site 3-3 to the two nearest PAs of the Mstislavl District—Volovniki Village and Sychevka Village—is approximately 2 km. The distance from Site 3-3 to the boundaries of the nearest district centers of the Mogilev Region is 18 km to the town of Mstislavl and 17 km to the town of Krichev. The distance to the border with the Russian Federation is about 17 km, and to Tikhil, the nearest PA in the Russian Federation, is about 20 km.

In total, 3,164 people live within a 10-km radius of Site 3-3, which corresponds to a population density of 10.1 people/km².

As of 01.01.2025, there are 134 PAs located within the territory of the Mstislavl District, with a total population of 17,910 people, including 9,951 people in the town of Mstislavl and 7,959 people in the remaining PAs. In addition to the town of Mstislavl, there are 23 PAs with a population of over 100 people each located in the district, housing a total of 7,735 people.

In the total population of the Mstislavl District, the shares of men and women are practically equal (47.5% and 52.5% of the total population, respectively). The shares of the urban and rural population are 55.6% and 44.4% of the total district population, respectively; the share of the working-age population stands at 52.0%.

Adult Morbidity in the Mstislavl District

During the 2020–2024 period, the primary morbidity structure of the adult population in the Mstislavl District was dominated by the following diseases: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the circulatory system, neoplasms, and diseases of the genitourinary system. These disease classes contributed 60–70% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 adult population of the district was as follows:

– diseases of the respiratory system – 17,527.2 cases (46.3%);

– certain infectious and parasitic diseases – 821.6 cases (2.2%);

– diseases of the circulatory system – 2,765.3 cases (7.3%);

– neoplasms – 1,062.1 cases (2.8%);

– diseases of the genitourinary system – 1,295.8 cases (3.4%).

The following trends were noted:

– a decrease in the morbidity rate for certain infectious and parasitic diseases from 19.8% in 2020 to 2.2% in 2024, which was associated with the end of the COVID-19 pandemic;

– respiratory system diseases consistently account for a large share in the morbidity structure.

Over the five-year period, the primary morbidity of malignant neoplasms of all sites in the district population ranged from 419.3 (2020) to 639.1 (2023) cases per 100,000 population. The growth rate of morbidity for malignant neoplasms of all sites amounted to 49.0%.

When considering the primary morbidity of the population by specific sites, a pronounced trend toward an increase in lung cancer cases over the five-year period was established in the district. The morbidity rate for lung cancer ranged from 30.3 (2020) cases to 99.5 (2024) cases per 100,000 population. The growth rate of this morbidity level amounted to 228.4%. Lung cancer morbidity in the overall structure of oncological diseases accounted for between 7.2% in 2020 and 15.9% in 2021. However, making a definitive conclusion regarding the increase in lung cancer morbidity at the district level is not possible due to the small size of the observed population group (fewer than 15 thousand adults).

In the structure of primary oncological morbidity of the adult population, the largest contribution was made by skin cancer, followed by lung cancer, breast cancer, and prostate cancer.

Multi-year fluctuations in the primary morbidity of malignant neoplasms among the adult population of the Mstislavl District were negligible, amounting to just a few cases annually, and were largely driven by population aging.

Child Morbidity in the Mstislavl District

During the 2020–2024 period, the primary morbidity structure of children and adolescents in the Mstislavl District was dominated by the following diseases: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the eye and adnexa, diseases of the digestive system, and diseases of the ear and mastoid process. These disease classes contributed more than 90.0% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 children and adolescents of the district was as follows:

– diseases of the respiratory system – 116,196.0 cases (84.1%);

– certain infectious and parasitic diseases – 3,405.0 cases (2.5%);

– diseases of the eye and adnexa – 3,497.0 cases (2.5%);

– diseases of the digestive system – 3,589.0 cases (2.6%);

– diseases of the ear and mastoid process – 552.0 cases (0.4%).

The overall morbidity rate of children and adolescents per 100,000 population in the Mstislavl District was 102,534.0 cases in 2020, 103,251.0 cases in 2021, 115,361.0 cases in 2022, 130,661.0 cases in 2023, and 138,098.0 cases in 2024.

The growth rate of the morbidity level amounted to 34.7%.The following trends were noted:

– respiratory system diseases consistently account for a large share in the morbidity structure;

– for the class of diseases of the digestive system, the growth amounted to 65.5% in 2024 (3,589.0 cases per 100,000 population) compared to 2020 (2,168.0 cases per 100,000 population);

– for the class of diseases of the eye and adnexa, the growth amounted to 59.2% in 2024 (3,497.0 cases per 100,000 population) compared to 2020 (2,197.0 cases per 100,000 population);

– for the class of certain infectious and parasitic diseases, the growth amounted to -32.8% in 2024 (3,405.0 cases per 100,000 population) compared to 2020 (5,068.0 cases per 100,000 population).

Area of Location of Site 1-5

The Khoiniki District is located in the southeastern part of the Gomel Region of Belarus. It borders:

– in the north, the Rechitsa District of the Gomel Region;
– in the east, the Loev and Bragin Districts of the Gomel Region;
– in the west, the Kalinkovichi and Narovlya Districts of the Gomel Region;
– in the south, the state border runs with Ukraine (Kyiv Region).

The distance from Site 1-5 to the border with:

– the Republic of Lithuania is 376 km;
– the Republic of Latvia is 474 km;
– the Republic of Poland is 423 km;
– Ukraine is 34 km.

The district center, the town of Khoiniki, is located 105 km southwest of Gomel and 57 km from the border with Ukraine. Administratively, the district is divided into 6 rural councils .

According to data from the National Statistical Committee of the Republic of Belarus, the population of the Khoiniki District at the end of 2024 amounted to 18,054 people, including an urban population of 13,001 people (72.0% of the district's population) and a rural population of 5,053 people (28.0% of the district's population). The Khoiniki District accounts for 1.4% of the total population of the Gomel Region.

The educational system of the district comprises 25 educational institutions, including 10 pre-school education institutions, 10 general secondary education institutions, 1 gymnasium, 1 institution for the additional education of children and youth, 1 special education institution, 1 socio-pedagogical institution, and 1 vocational and technical education institution.

Medico-Demographic Situation

Site 1-5 is located in the center of the Khoiniki District, the territory of which is situated within the radioactive contamination zone resulting from the Chernobyl NPP disaster. The distance from Site 1-5 to the nearest PA—Novoselki Village—is approximately 2.5 km, while the distances to the town of Khoiniki, the settlement of Strelichevo, and the settlement of Veliky Bor are 14.5 km, 10.6 km, and 24 km, respectively. The distance to the border with Ukraine is 35 km, to the border with Polesie State Radiation and Ecological Reserve State Environmental Scientific Research Institution (hereinafter referred to as PSRER) is 4.5 km, and to the Pripyat River is 13.8 km.

The territory of the Khoiniki District is contaminated with radionuclides of Chernobyl origin (^{137}Cs, ^{90}Sr, ^{238},^{239},^{240}Pu, and ^{241}Am). The vast majority of the population of the Khoiniki District (including the town of Khoiniki) lives in PAs with a ^{137}Cs contamination density of 74–111 kBq/m² (76.0% of the total population); 1,252 people in 14 PAs (7.0%) live in areas with 37–74 kBq/m², and 770 people (4.0%) live in 2 PAs with a ^{137}Cs contamination density of 222–259 kBq/m².

Adult Morbidity in the Khoiniki District

During the 2020–2024 period, the primary morbidity structure of the adult population in the Khoiniki District was dominated by the following disease classes: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the musculoskeletal system and connective tissue, diseases of the eye and adnexa, and diseases of the circulatory system. These disease classes contributed more than 60.0% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 adult population of the district was as follows:

– diseases of the respiratory system – 14,837.3 cases (29.1%);
– certain infectious and parasitic diseases – 769.4 cases (1.5%);
– diseases of the circulatory system – 3,854.0 cases (7.6%);
– diseases of the musculoskeletal system and connective tissue – 5,477.5 cases (10.7%);
– diseases of the eye and adnexa – 4,383.4 cases (8.6%).

The following trends were noted over the considered five-year period:

– a decrease in the morbidity rate for certain infectious and parasitic diseases from 10.3% in 2020 to 1.5% in 2024, which was associated with the end of the COVID-19 pandemic;

– respiratory system diseases consistently account for a large share in the morbidity structure.

The analysis of the primary morbidity structure of malignant neoplasms of all sites among the adult population of the Khoiniki District for 2020–2024 demonstrated that the largest contribution was made by skin cancer, followed by lung cancer, breast cancer, and prostate cancer.

When evaluating the dynamics of primary oncological morbidity of all sites among the adult population of the district, it can be noted that the rates over the five-year period in the district ranged from 532.8 to 701.9 cases per 100,000 population.

Multi-year fluctuations in the primary morbidity of malignant neoplasms among the adult population of the Khoiniki District were negligible, abandoning just a few cases annually, and were largely driven by population aging.

Child Morbidity in the Khoiniki District

During the 2020–2024 period, the primary morbidity structure of children and adolescents in the Khoiniki District was dominated by the following diseases: diseases of the respiratory system, certain infectious and parasitic diseases, diseases of the eye and adnexa, diseases of the skin and subcutaneous tissue, and diseases of the ear and mastoid process. These disease classes contributed more than 80.0% to the overall morbidity structure.

In 2024, the morbidity rate per 100,000 children and adolescents of the district was as follows:

– diseases of the respiratory system – 96,027.5 cases (67.4%);
– certain infectious and parasitic diseases – 7,650.8 cases (5.4%);
– diseases of the eye and adnexa – 9,269.2 cases (6.5%);
– diseases of the skin and subcutaneous tissue – 4,095.6 cases (2.9%);
– diseases of the ear and mastoid process – 3,359.5 cases (2.4%).

The overall morbidity rate of children and adolescents per 100,000 population in the Khoiniki District was 112,252.3 cases in 2020, 130,676.1 cases in 2021, 126,643.4 cases in 2022, 126,404.4 cases in 2023, and 142,520.8 cases in 2024. The growth rate of the morbidity level amounted to 27.0%.

The following trends were noted:

– for the class of diseases of the eye and adnexa, the growth amounted to 124.9% in 2024 compared to 2020;

– for the class of neoplasms, a decrease in the number of detected cases was observed, with the negative growth amounting to -18.3% in 2024 (441.4 cases per 100,000 population) compared to 2020 (540.5 cases per 100,000 population).

5.11 Technological Hazards

Area of Location of Site 2-1

Within the territory of alternative Site 2-1 and a two-kilometer radius from it, there are a number of facilities of potential technological hazard (Figure 5.20).

Forest lands. Within the two-kilometer radius, they are located mainly in the central and northern parts. Within the boundaries of alternative Site 2-1, the largest part of the territory has a certain natural fire resistance class, with a predominance of Class 3 (medium resistance). The weighted average fire resistance score of vegetation within the boundaries of alternative Site 2-1 is 2.86.

Residential areas. Within the two-kilometer radius of the alternative site, there are residential areas of the following settlements: Katenovichi, Vada, Matskely, Mislyany, Legavtsy, Goza, Aveny, Shulniki, and Novodrozki.

Water surfaces. These are represented by the Polpe River (in the southeast), unnamed channels, and technological reservoirs (near the Belarusian NPP). There are no oil slicks on the water surfaces.

Highways. These are represented by a wide network, but public roads include the Mikhalishki–Vorona section of the R-45 republican highway Polotsk – Glubokoye – border of the Republic of Lithuania (Kotlovka), the roads branching off from it near the site toward the villages of Katenovichi, Legavtsy, Mislyany, Matskely, Aveny, and Novodrozki, as well as the R-52 Goza (from the R-45 highway) – Ostrovets – Oshmyany. The rest of the roads are country roads.

Industrial enterprises. The Belarusian NPP is located in the southern part of the two-kilometer radius.

Other facilities of potential technological hazard. There are no warehouses for flammable substances (solid, liquid, or gaseous), peatlands, main gas, oil, or product pipelines, railways, river or sea routes, airfields, airways or flight routes, or coal and peat mining operations within the entire area of the radius

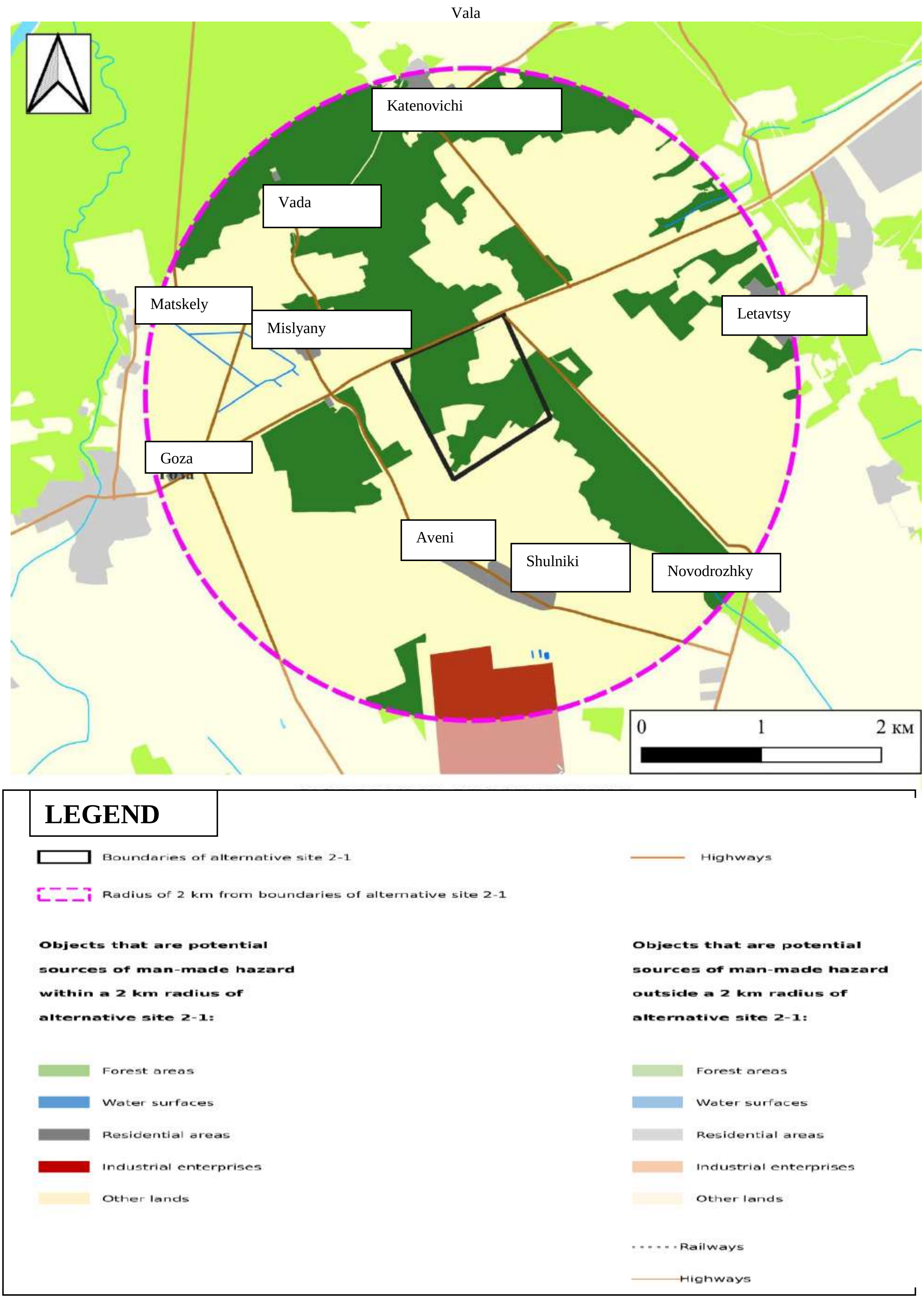


Figure 5.20 – Facilities of potential technological hazard within a two-kilometer radius from the boundaries of alternative Site 2-1

Area of Location of Site 3-3

Within the territory of alternative Site 3-3 and a two-kilometer radius from it, there are a number of facilities of potential technological hazard (Figure 5.21).

Forest lands. Within the two-kilometer radius, they are located sporadically and do not occupy a dominant position.

Residential areas. Within the two-kilometer radius of the alternative site, there are residential areas of the villages of Sychevka, Yushkovichi, Volovniki, and the extreme northern part of the Molyatichi settlement.

Peatlands. In the southern part of the radius, there is an unexploited peatland named Chernaya Natopa (cadastral No. 312) with a peat deposit depth of 1.65 m.

Water surfaces. These are represented by the Chernaya Natopa, Sorochinka, and Mertvitsa rivers (in the south) and the Chernotopka river (in the east), unnamed channels along the Chernaya Natopa river, and ponds, the highest concentration of which is noted near Sychevka Village and Volovniki Village on the Chernaya Natopa river. There are no oil slicks on the water surfaces.

Highways. These are represented by a wide network, but public roads include the Khodosy–Molyatichi section of the N-10827 local highway Krichev – Khodosy – Kurmanovo – Rubanovka and the road branching off from it near the site toward Sychevka Village, as well as the N-11135 Mstislavl – Mushino – Volovniki highway. The rest of the roads are country roads.

Railways. These are located in the eastern part of the two-kilometer radius, running in the Krichev–Orsha direction.

Other facilities of potential technological hazard. There are no warehouses for flammable substances (solid, liquid, or gaseous), main gas, oil, or product pipelines, river or sea routes, airfields, airways or flight routes, industrial enterprises, or coal and peat mining operations within the entire area of the radius.

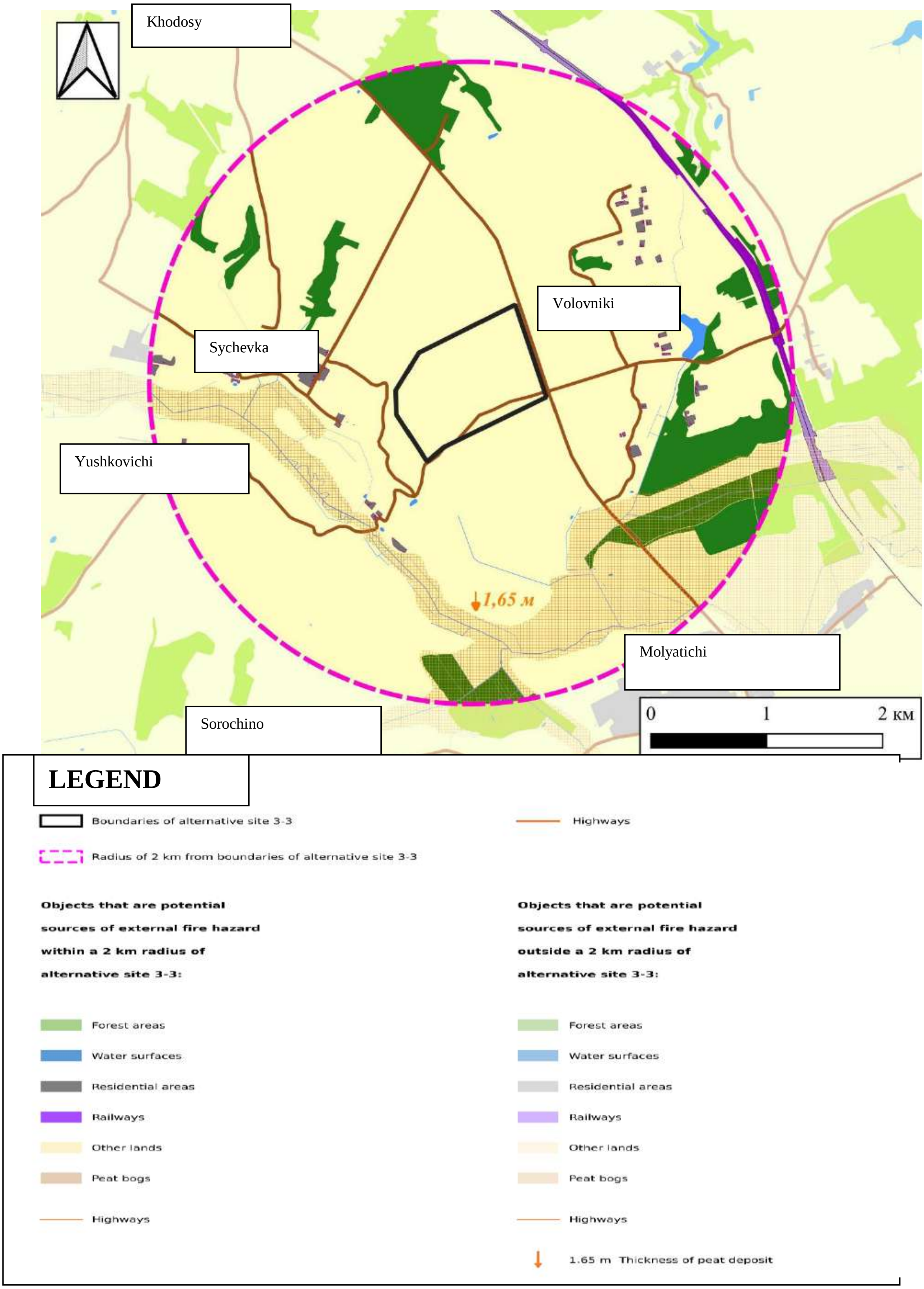


Figure 5.21 – Facilities of potential technological hazard within a two-kilometer radius from the boundaries of alternative Site 3-3

In accordance with the adopted standards, the boundaries of alternative Site 3-3 and its adjacent territories are not included in the radioactive contamination zone.

Area of Location of Site 1-5

Within the territory of alternative Site 1-5 and a two-kilometer radius from it, there are a number of facilities of potential technological hazard (Figure 5.22).

Forest lands. They occupy a dominant position among all features within the two-kilometer radius from the boundaries of alternative Site 1-5. The weighted average fire resistance score of vegetation within the boundaries of alternative Site 1-5 is 2.32.

Residential areas. Within the two-kilometer radius of the alternative site, there are residential areas of Novoselki Village.

Water surfaces. These are rarely represented and are concentrated near Novoselki Village in the form of a series of channels that further discharge into the Kozhushkovsky Channel, as well as a pond. There are no oil slicks on the water surfaces.

Highways. The highway network is not highly developed and is characterized by the presence of only one public road, the N-4581 Khoiniki–Tulgovichi highway, and a number of street roadways branching off from it within Novoselki Village, along with country roads running toward the Polesie State Radiation and Ecological Reserve and Khrapkov Village. The rest of the roads are country roads.

Other facilities of potential technological hazard. There are no warehouses for flammable substances (solid, liquid, or gaseous), main gas, oil, or product pipelines, railways, river or sea routes, airfields, airways or flight routes, industrial enterprises, coal and peat mining operations, or peatlands within the entire area of the radius.

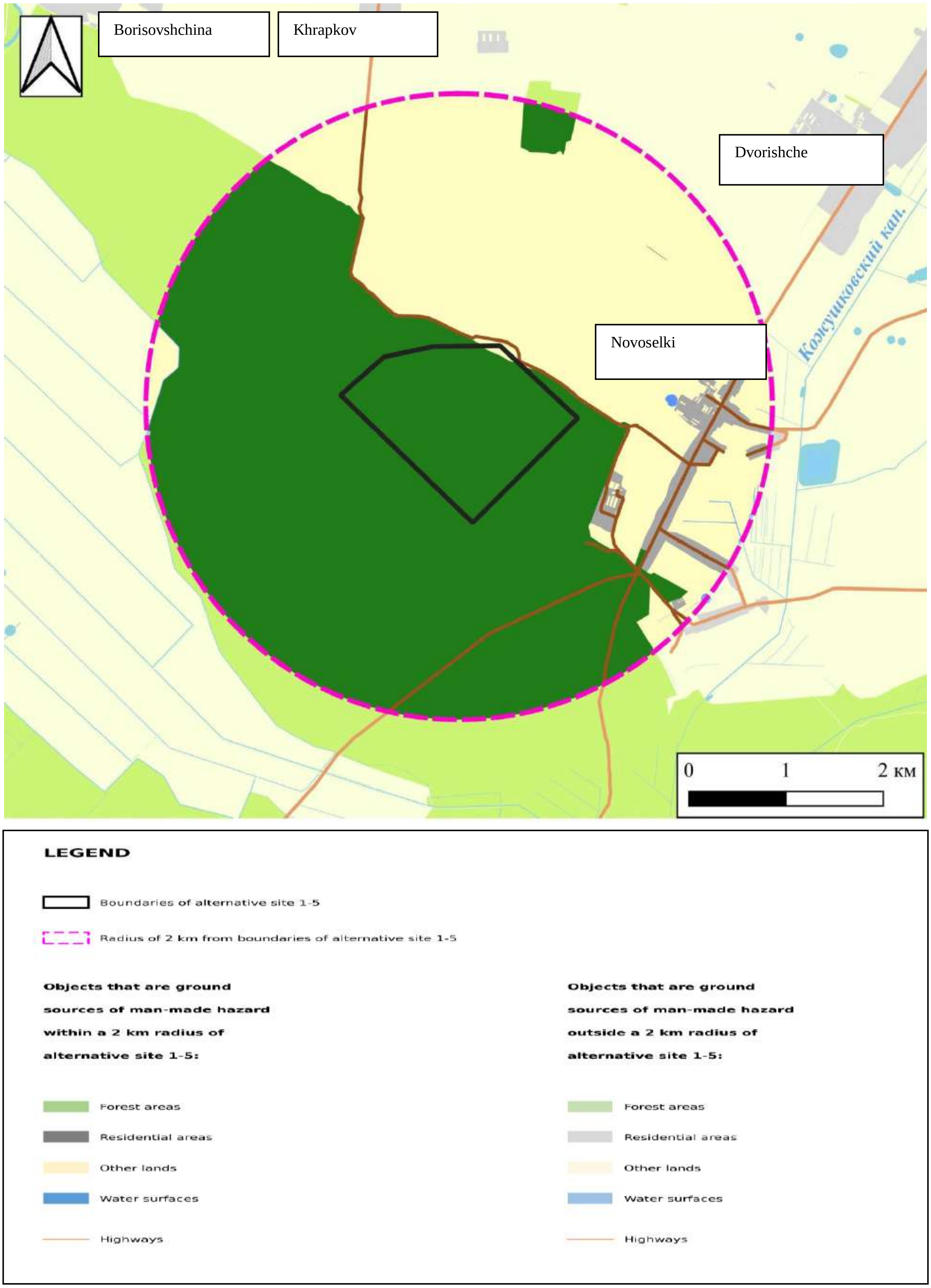


Figure 5.22 – Facilities of potential technological hazard within a two-kilometer radius from the boundaries of alternative Site 1-5

In accordance with the adopted standards, the boundaries of alternative Site 1-5 are included in the radioactive contamination territories.

Bibliography / References

1. National Academy of Sciences of Belarus. State Scientific Institution "Institute for Environmental Management of the National Academy of Sciences of Belarus" (Institute for Environmental Management of the NAS of Belarus). Construction of a near-surface disposal and temporary storage facility for radioactive waste. Pre-project documentation. Environmental impact assessment materials. Section 6. To conduct an environmental impact assessment (with regard to ambient air, including climate and meteorological conditions) of the planned radioactive waste disposal activities. Book 3. Existing state of ambient air according to the requirements of technical regulatory legal acts in the area of Site 2-1 (Grodno Region), 2184-ППЗ-ОВОС6.3, Volume 7.6.3, Minsk, 2025;

2. National Academy of Sciences of Belarus. State Scientific Institution "Institute for Environmental Management of the National Academy of Sciences of Belarus" (Institute for Environmental Management of the NAS of Belarus). Construction of a near-surface disposal and temporary storage facility for radioactive waste. Pre-project documentation. Environmental impact assessment materials. Section 6. To conduct an environmental impact assessment (with regard to ambient air, including climate and meteorological conditions) of the planned radioactive waste disposal activities. Book 4. Existing state of ambient air according to the requirements of technical regulatory legal acts in the area of Site 3-3 (Mogilev Region), 2184-ППЗ-ОВОС6.4, Volume 7.6.4, Minsk, 2026.

3. National Academy of Sciences of Belarus. State Scientific Institution "Institute for Environmental Management of the National Academy of Sciences of Belarus" (Institute for Environmental Management of the NAS of Belarus). Construction of a near-surface disposal and temporary storage facility for radioactive waste. Pre-project documentation. Environmental impact assessment materials. Section 6. To conduct an environmental impact assessment (with regard to ambient air, including climate and meteorological conditions) of the planned radioactive waste disposal activities. Book 5. Existing state of ambient air according to the requirements of technical regulatory legal acts in the area of Site 1-5 (Gomel Region), 2184-ППЗ-ОВОС6.5, Volume 7.6.5, Minsk, 2026.

4. RUE "Central Research Institute for Complex Management of Water Resources" (RUE "CRICMWR"). Construction of a near-surface disposal and temporary storage facility for radioactive waste. Pre-project documentation. Environmental impact assessment materials. Section 10. To conduct an environmental impact assessment (with regard to the impact on surface waters) of the planned radioactive waste disposal activities. Book 7. Prediction and assessment of the state of surface waters in the area of alternative Site 2-1 Region No. 2 – Ostrovets under possible emergency and beyond-design-basis accident scenarios during the RWDF operation and development of measures to prevent, minimize, or compensate for the harmful impact of the RWDF (final stage), 2184-ППЗ-ОВОС10.7, Volume 7.10.7, Minsk, 2026;

5. National Academy of Sciences of Belarus. State Scientific Institution "Institute for Environmental Management of the National Academy of Sciences of Belarus" (Institute for Environmental Management of the NAS of Belarus). Construction of a disposal facility for class 3 and 4 radioactive waste and long-term storage for class 2 radioactive waste. Pre-project documentation. Execution of a comprehensive set of research and survey works for the selection of priority sites for the allocation of a radioactive waste disposal facility. Report: Determination of geological and geomorphological characteristics of the sites (synthesis of materials). 2184-PZ-PP2. Volume 4.5.4. Minsk, 2024;

6. National Academy of Sciences of Belarus. State Scientific Institution "Institute for Environmental Management of the National Academy of Sciences of Belarus" (Institute for Environmental Management of the NAS of Belarus). Construction of a disposal facility for class

3 and 4 radioactive waste and long-term storage for class 2 radioactive waste. Pre-project documentation. Execution of a comprehensive set of research and survey works for the selection of priority sites for the allocation of a radioactive waste disposal facility. REPORT: Execution of a comprehensive set of geological and geophysical investigations (synthesis of materials). 2184-PZ-PP2. Volume 4.6.4. Minsk, 2024;

7. Ministry of Natural Resources and Environmental Protection of the Republic of Belarus, State Enterprise "Scientific and Practical Center for Geology". Branch "Belarusian Complex Geological Exploration Expedition (BCGEE)", Geophysical Party (GP) "Construction of a radioactive waste disposal facility. Pre-project documentation". Execution of a comprehensive set of research and survey works for the selection of priority sites for the allocation of a radioactive waste disposal facility. REPORT Stage 4.3.2.2 - Determination of engineering and geophysical conditions for allocation. 2184-PZ-PP2. Volume 4.3.2.2. Minsk, 2024;

8. National Academy of Sciences of Belarus. State Scientific Institution "V.F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus". Construction of a near-surface disposal and temporary storage facility for radioactive waste. Pre-project documentation. Environmental impact assessment materials. Section 8. To conduct an environmental impact assessment (with regard to land resources, natural complexes, and natural features) of the planned radioactive waste disposal activities. Book 8. Development of EIA with regard to land resources, natural complexes, and natural features. Final report. 2184-ППЗ-ОВОС8.8. Volume 7.8.8. Minsk, 2026;

9. Form of state statistical reporting 1-Waste (Ministry of Natural Resources);

10. Schematic map of cesium-137 radionuclide contamination of the territory of the Republic of Belarus. URL: https://chernobyl.mchs.gov.by/upload/iblock/bfd/karta_rb_2020.jpg

6 DESCRIPTION OF THE MAIN SOURCES AND POTENTIAL TYPES OF ENVIRONMENTAL IMPACT

The main operational processes to be carried out at the RWDF during its operation include:

- incoming inspection and characterisation (certification) of RW packages;
- RW processing, conditioning, and preparation to meet waste acceptance criteria for disposal;
- temporary storage of intermediate-level long-lived waste and high-level waste;
- temporary storage of disused sealed ionising radiation sources of Categories 1 and 2 according to the radiation hazard scale;
- disposal of very low-level, low-level, and short-lived intermediate-level radioactive waste;
- disposal of disused sealed ionising radiation sources of Categories 3–5 according to the radiation hazard scale;
- disposal of very low-level, low-level, and short-lived intermediate-level radioactive waste in the form of large-sized and long-length items that are difficult to segment, as well as other waste types;
- temporary storage of waste resulting from SNF reprocessing at the Belarusian Nuclear Power Plant.

Based on the RWDF's design capacity and throughput, the required technological equipment has been specified.

The zoning of the RWDF site and the layouts of its buildings and structures will ensure compliance with sanitary rules and regulations for radioactive waste management activities.

The layout of the proposed RWDF buildings and structures on the general layout (hereinafter referred to as the General Layout (GL)) is presented in Appendix A. An analysis of the proposed economic activity has been carried out, and the sources of impact on environmental components have been identified.

<u>Item 1.1 on the GL – Administrative and Amenity Building</u>

The Administrative and Amenity Building is intended to accommodate administrative and management personnel and to receive official delegations. No activities involving ionising radiation sources are conducted within this building; therefore, personnel are not exposed to radiation-related factors.

<u>Item 1.2 on the GL – Combined Amenity Building</u>

The Combined Amenity Building is intended to accommodate personnel responsible for operating the RWDF's technological and engineering systems, as well as amenity and auxiliary facilities.

<u>Item 2 on the GL – Process Building</u>

The purpose of the Process Building is to conduct incoming inspections of radioactive waste packages delivered for disposal and temporary storage, excluding waste generated during SNF reprocessing.

The Process Building includes:

- an unloading area for specialised transport vehicles;

- an area for radiation monitoring of packages and vehicles;
- two areas for spectrometric monitoring of waste packages;
- a temporary storage area for high- and intermediate-level waste packages prior to completion of incoming inspection;
- a temporary storage area for low-level and very low-level waste packages prior to completion of incoming inspection;
- a storage area for lifting and handling equipment;
- a temporary storage area for empty containers;
- a collection area for secondary SRW.

The Process Building is equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

Item 3 on the GL: Municipal Waste Collection Area

To ensure the organised collection of non-radioactive waste generated during RWDF operation, two municipal solid waste collection areas are provided within the site structures.

Item 4 on the GL: Dewar Flask Shelter for Liquid Nitrogen Storage

Liquid nitrogen required for the spectrometric equipment in the Process Building is stored under the shelter in a dedicated container (cryocylinder). The containers are delivered and stored in a sealed condition.

Item 5 on the GL: Forklift Garage

The forklift garage is a building with individual garage-type bays designed to house forklifts operating at the RWDF site. No forklift maintenance is carried out in this building.

Item 6 on the GL: Materials Storage Shelter

The shelter is intended for the covered storage of materials used in RWDF operations, providing protection from precipitation, direct sunlight, wind, and dust.

Item 7 on the GL: Materials Storage Yard

The facility is intended for the storage, under an unheated shelter, of buffer materials (including bentonite mats) used in constructing engineered containment barriers. It provides complete protection from atmospheric precipitation, and no heating system is required.

Item 8 on the GL: Heavy Equipment Storage Area

This area is designated for the temporary parking of heavy machinery used in radioactive waste transportation and site maintenance.

Item 9 on the GL: Decontamination Facility

The facility is intended for decontaminating vehicles and equipment (including empty containers) when radioactive contamination is detected on their surfaces.

The decontamination facility is equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

Item 10 on the GL: Inspection Area for Special-Purpose Vehicles and Construction Equipment

This unheated structure comprises a carport with an inspection area for vehicles and a hard-surfaced pavement to enable vehicle access. No potable or domestic water supply system is provided, and no recycling water supply is envisaged. The facility is not permanently staffed.

Item 11 on the GL: Mobile Fuel Station Area

This is an open paved area intended for the placement of a mobile fuel station mounted on a wheeled chassis. The mobile fuel station consists of a fuel storage tank and fuel-dispensing equipment installed on a trailer.

Item 12 on the GL: Transformer Substation

The purpose of the transformer substation is to ensure a reliable power supply to the RWDF site facilities and to provide the required voltage levels for all electrical consumers.

Item 13 on the GL: Local Surface Water Run-Off Treatment Facility

The facility is intended for the collection, storage, and treatment of surface water (rainwater and snowmelt) run-off generated within the proposed facility.

Item 14 on the GL: Industrial and Firefighting Water Supply Pumping Station with Storage Tanks

The facility is intended to provide water for both external and internal firefighting systems serving the buildings and structures of the proposed RWDF site. The pumping station includes the following:

Item 15 on the GL: Radioactive Waste Disposal Modules

Provision is made for the construction of ten identical radioactive waste disposal modules, each with a gross capacity of at least 15,000 m³.

The modules are designed as fully-in-ground monolithic reinforced-concrete structures. They serve as near-surface disposal facilities for SRW containers and are unheated structures divided by internal walls into enclosed compartments. The bottom of each compartment is 5.5 m below ground level.

After the compartments have been filled, the voids between the containers and the compartment walls are backfilled with inert material, followed by the placement of an upper cementitious layer. Once all modules are filled, the hangars are dismantled, and the final engineered cover system is installed.

The disposal modules are equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

Item 16 on the GL: Domestic Wastewater Treatment Plant

The facility is intended for the collection and treatment of domestic wastewater generated by the buildings within the proposed facility. Wastewater is treated to meet regulatory standards, then the treated effluent is discharged into off-site mains and subsequently into receiving surface water bodies.

Item 17 on the GL: Radioactive Waste Processing Facility (RWPF)

The purpose of the facility is to process and condition radioactive waste received at the RWDF, thereby reducing the volume of waste requiring disposal.

SRW is delivered to the RWPF in a pre-sorted form and separated into combustible waste, non-combustible compactable waste and non-combustible non-processable waste.

The following operations are performed at the RWPF:

1. SRW sorting and size reduction;
2. High-pressure compaction;
3. LRW concentration;
4. Cementation;
5. Spent IRS treatment;
6. Incineration.

The incineration facility is designed to reduce the volume of combustible solid and liquid radioactive waste by combustion, followed by ash removal and multi-stage off-gas treatment.

7. RW certification.

The RWPF is equipped with two spectrometer units:

- for SRW certification prior to disposal or transfer to temporary storage;
- for the characterisation of spent IRS during sorting operations in the Hot Cell.

The RWPF is equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

<u>Item 18 on the GL: Secured Perimeter with Three Access Control Checkpoints (ACCs)</u>

The purpose of the secured perimeter is to provide physical protection for the RWDF, ensure site security, and prevent unauthorised access.

A buffer area is established around the facility. The distance between the inner and outer security fences is 10 m. Three entrance points to the RWDF site are provided, each equipped with a sliding gate in the outer fence with a clear opening width of 7 m.

<u>Item 19 on the GL: Special-Purpose Vehicle Garage</u>

The special-purpose vehicle garage is a heated facility for vehicle maintenance. The facility includes a pit for vehicle inspection and storage space for tools and special process equipment.

<u>Item 20 on the GL: Protective Shelters (2 Units)</u>

The facility includes two identical protective shelters: one within the site's protected area and the other outside the perimeter of the protected area. The shelters are intended to provide protection for personnel during emergencies. Each shelter is an underground, single-storey, heated structure equipped with utility and auxiliary rooms.

<u>Item 21 on the GL – Water Treatment Plant (WTP) Area</u>

To provide the RWDF facilities with potable and domestic water for on-site needs, provision is made for a designated area for the WTP.

<u>Item 22 on the GL – Storage Area for RW from SNF Reprocessing</u>

Purpose: temporary storage of RW containers delivered to the RWDF.

The facility is equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

<u>Item 23 on the GL – SRW Storage Facility</u>

The purpose of the SRW storage facility is to provide temporary storage for incoming high- and intermediate-level RW packages (Class II according to the Radiation Hazard Scale) containing long-lived radionuclides, as well as disused sealed IRS of Categories 1 and 2 (according to the Radiation Hazard Scale), in reinforced-concrete containers of the KMZ-RNI-RADON type.

The facility is equipped with a centralised supply-and-exhaust ventilation system with natural and mechanical draft. Air passing through the ventilation system is treated with High-Efficiency Particulate Air (HEPA) filters, providing filtration efficiency of at least 99.95%.

<u>Item 24 on the GL – Inspection Area</u>

The inspection area is intended for inspecting vehicles entering and leaving the facility site.

<u>Item 25 on the GL – SKAT-Type Charging Stations</u>

SKAT-type charging stations are provided to charge electric vehicles used for servicing the RWDF facilities.

<u>Item 26 on the GL – Battery Energy Storage System (BESS), 10 MW / 3 h</u>

To ensure an uninterrupted power supply to the RWDF site consumers during an emergency involving a total loss of external power to the transformer substation, a 10 MW BESS (3 hours) is provided until the emergency is resolved.

<u>Item 27 Technological supporting structures, 8 pcs.</u>

<u>Item 28 on the GL – Area for Diesel Generator Units (5 × 500 kW)</u>

An area is provided for the installation of five diesel generator units to ensure an uninterrupted power supply if all other external power supply systems become unavailable and the outage exceeds three hours, after which the Battery Energy Storage System (BESS) will have exhausted its stored energy.

The generators are intended for emergency use only and will operate under continuous supervision.

<u>Item 29 on the GL – Sludge Dump for WTP Backwash Water</u>

A sludge dump measuring 40 × 10 m and 3 m deep is provided to allow the settling of iron-containing wastewater from the water treatment plant. Clarified water is then discharged into the industrial and stormwater drainage system at a flow rate of 6 m^3/h. The quality of the clarified water matches that of the raw water supplied to the WTP.

<u>Item 30 on the GL – Special-Purpose Area</u>

A fenced area measuring 10 × 10 m is provided for deploying unmanned aerial vehicles (UAVs) with vertical take-off and landing capability, intended for visual monitoring of the RWDF site.

<u>Item 31 on the GL – Electric Boiler House</u>

Provision is made for an electric boiler house equipped with two electric hot-water boilers, with a total electrical capacity of 20 MW, to heat district water using heat generated by electricity consumption.

7 ENVIRONMENTAL FORECAST AND ASSESSMENT OF CHANGES IN ENVIRONMENT

The impact of the planned economic activity on environmental components is considered taking into account the entire life cycle of the RWDF existence: construction, operation, and the post-closure period.

7.1 Assessment of impact on ambient air, including climate

The impact on ambient air during construction works will be mainly determined by:

– emissions from construction vehicles and machinery operating on the construction site;

– dust emission associated with soil movement during excavation works;

– emissions from motor transport during the transportation of construction waste and delivery of goods;

– emissions during welding and painting works.

The impact assessment of the planned facility on ambient air at each alternative site, performed taking into account the simultaneous operation of emission sources located and functioning on the territory of the construction site during the period of construction and installation works, allows for the following conclusions:

– according to the calculation results, the maximum ground-level concentration of pollutants at the boundary of residential areas will not exceed the established ambient air quality standards;

– ambient air pollution during the construction process will be short-term, local, and insignificant.

Thus, during the construction period of the designed facility, the effective regulatory requirements for the ambient air quality of populated areas at the boundary of the residential zone will be complied with.

During the RWDF operation, the organization of 43 emission sources is provided for, including 32 channeled emission sources and 11 fugitive emission sources. The total emission values of the facility are presented in Table 7.1.

Table 7.1 – Total gross emissions

Code	Substance name	Proposed condition	
		g/s	t/year
0301	Nitrogen (IV) oxide (nitrogen dioxide)	1.8604	1.1569
0304	Nitrogen (II) oxide (nitrogen oxide)	0.0011	0.1528
0328	Carbon black (soot)	0.2365	0.1199
0330	Sulfur dioxide (sulfurous anhydride, sulfur (IV) oxide, sulfurous gas)	0.3536	0.1878
0337	Carbon oxide (carbon monoxide, carbon monoxide gas)	3.271	2.6769
2754	Aliphatic saturated hydrocarbons $C_{11} – C_{19}$	1.031	0.3217
0401	Aliphatic saturated hydrocarbons $C_1 – C_{10}$	0.1587	0.0718
2908	Inorganic dust containing silicon dioxide: less than 70%	1.2537	0.3648
2902	Solid particles (dust/aerosol undifferentiated by composition)	0.0141	0.0201
0303	Ammonia	0.0064	0.0079
0333	Hydrogen sulfide	0.0000019	0.000021
0410	Methane	0.0019	0.0283
2936	Wood dust	0.0231	0.0029
2930	Abrasive dust (corundum, monocorundum)	0.0231	0.0029
0183	Mercury and its compounds Hg (in terms of mercury)	0.000016	0.000019
0316	Hydrogen chloride	0.000285	0.004770

Code	Substance name	Proposed condition	
		g/s	t/year
	Polycyclic hydrocarbons*	0.000032	0.000039
	Heavy metals*	0.0002	0.0002
	Total organic carbon*	0.0159	0.0195
	Benzo/a/pyrene (3,4-benzopyrene)	0.000000	0.000000
	Formaldehyde (methanal)	0.0048	0.0001
TOTAL		**8.2558349**	**5.139349**

* Upon calculating emissions from the RWDF RWTP waste incineration plant, the requirements of Table 4.14 of Appendix 4 to EcoNiP were taken into account.

To assess the impact on ambient air at each alternative site, the pollution caused by the facility's emission sources was determined. Reference points were established for each site at the boundary of the production site and within the nearest residential zone:

– alternative Site 2-1:

RP1–RP8 – reference points at the boundary of the production site; RP9 – Mislyany Village; RP10 – Aveny Village; RP11 – Legavtsy Village;

– alternative Site 3-3:

RP1–RP8 – reference points at the boundary of the production site; RP9, RP10 – Volovniki Village; RP11, RP12 – Sychevka Village;

– alternative Site 1-5:

RP1–RP8 – reference points at the boundary of the production site; RP9 – Novoselki Village; RP10 – Dvorishche Village;

Based on the dispersion calculation results during the facility operation period at each alternative site, the maximum ground-level concentration of pollutants in the ambient air at the boundary of the production site and the nearest residential areas will not exceed the established standards; the facility's pollutant emissions will not have a negative impact on the environment and the population.

The radiation impact on ambient air during the RWDF operation period will be insignificant, as the RWDF buildings and structures where radioactive waste management takes place are equipped with supply and exhaust ventilation with mechanical and natural induction. The air passing through the ventilation system is purified using high-efficiency particulate air filters (HEPA filters) with an air purification efficiency of at least 99.95%.

During the operation of the radioactive waste processing facility, emission of radioactive substances into the atmosphere from the ventilation systems of the building may occur after treatment in specialized gas purification units. Based on data from the similar facility (radioactive waste processing facility RADON FSUE (Sergiev Posad, Moscow Region) the expected release of beta- and gamma-emitting radionuclides, following the removal of radioactive aerosols, is expected to be 2.65×10^6 Bq.

The height of the vent stack ensures the reduction of the radioactive concentration in the ambient air at the point of plume touchdown to levels not exceeding the public dose limit established by the legal and technical regulatory acts of the Republic of Belarus.

The radionuclide composition and activity of atmospheric emissions depend on the radionuclide composition of the RW, entering the RWPF for treatment.

Table 7.2 – Radioactive emission from RWPF.

Radionuclide composition			Emission of radioactive substances taking into account gas treatment, Bq/year
Radionuclide	Type of radiation	%	
^{137}Cs	β-, γ-radiation	53,15	$1,41*10^6$
^{60}Co	β-, γ- radiation	15,19	$4,03*10^5$
^{3}H	β- radiation	0,15	$3,90*10^3$
^{14}C	β- radiation	~ 0,00	$4,38*10^1$
^{63}Ni	β- radiation	~ 0,00	$4,38*10^1$
^{90}Sr	β- radiation	0,30	$7,88*10^3$
Other β-, γ-radiants	β-, γ- radiation	30,72	$8,15*10^5$
Total β-, γ-radiants		100	$2,65*10^6$
Notes: The emission values and activity are preliminary, based on data from similar projects, and will be finalized during the project documentation design stage.			

Safe operation limits for the emission of radioactive substances into the atmospheric air will be established in the design and operational documentation.

7.2 Assessment of impact on surface water bodies and groundwater

7.2.1 Surface water bodies

The water supply source for the RWDF allocation site for household, drinking, and industrial water supply is provided as autonomous from an underground water intake (artesian wells).

Water from the system of household, drinking, and industrial water supply pipelines is supplied to sanitary fixtures (washbasin, toilet, shower head) of the designed buildings and structures on the RWDF site, for the industrial needs of the water-consuming equipment of the laboratory in the water treatment building, for the preparation of a decontaminating solution, for the needs of the canteen, for the makeup of a closed cooling circuit, and for floor washing.

Wastewater discharge is carried out into a water body. The receiving water body for household-domestic and surface runoff wastewater will be the Vilia River for Site 2-1, the Vit River for Site 1-5, and the Chernaya Natopa River for Site 3-3.Table 7.3 presents the balance of water consumption and wastewater discharge of the designed facility.

Table 7.3 – Water consumption and wastewater discharge balance of the designed facility

Name of consumers			**Water consumption**	**Wastewater discharge**	
			Domestic-drinking and industrial water supply pipeline	**Domestic sewerage**	**Industrial and stormwater sewerage**
1	Domestic and drinking needs	m³/day m³/year	48.238 17,606.870	52.123 19,024.895	-

2 Industrial needs		361.385 1,775.525	-	357.500 357.500
Total:		409.623 19,382.395	52.123 19,024.895	357.500 357.500

The estimated volume of wastewater from the site of the designed facility amounts to:

– surface runoff: 4,700 m³/day, 95,500 m³/year;

– household-domestic wastewater: 52.123 m³/day, 19,024.9 m³/year.

The discharge of industrial wastewater together with domestic or surface runoff is not provided for, except for the routine draining (during maintenance or servicing works) of water-filled equipment of the process building in a volume of up to 357.5 m³/day, with the quality of the drained water corresponding to the quality of the drinking water used in the RWDF household-drinking water supply system.

The design solutions provide for the following wastewater treatment facilities:

– WWTF (K1) domestic wastewater treatment plant (with a design capacity of up to 60 m³/day);

– WWTF (K2) local treatment complex for receiving and treating surface runoff (stormwater and meltwater) from the site of the designed RWDF (with a design capacity of 60 l/s). The RWDF technology does not imply the ingress of radioactive substances into the surface runoff.

The main pollutants in the surface runoff are suspended solids and petroleum products. The concentration of pollutants in the raw surface runoff entering the wastewater treatment facilities is adopted in accordance with the requirements of Building Regulations of the Republic of Belarus PA 4.01.02-2019 for meltwater. The solutions of this work provide for the diversion of 100.0% of the annual runoff volume for treatment.The provided complex of wastewater treatment facilities will ensure the required degree of wastewater treatment across all main chemical contamination indicators for discharge into a surface water body.The construction of a sludge lagoon for iron-bearing wastewater from the WTP is provided for at the RWDF site. The clarified water from the sludge lagoon is diverted into the industrial and stormwater sewerage system. The quality of the clarified water corresponds to the quality of the raw water for the WTP.

The calculation of limits for permissible discharges of chemical and other substances within wastewater was performed in accordance with the requirements established in:

– EcoNiP 17.06.02-002-2021 "Environmental protection and nature management. Hydrosphere. Rules for calculating limits for permissible discharges of chemical and other substances within wastewater" (as amended on April 26, 2024);

– "Instruction on the procedure for establishing limits for permissible discharges of chemical and other substances within wastewater", approved by the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated May 26, 2017, No. 16 (as amended on April 26, 2024);

– EcoNiP 17.06.01-006-2023 "Environmental protection and nature management. Hydrosphere. Water quality standards for surface water bodies", approved by the decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated December 15, 2023, No. 15-T.

The list of regulated pollutants within household-domestic wastewater, as well as their mixture with other types of wastewater, is provided in Clause 1 of the Appendix to the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 16. In accordance with Clause 3 of the Appendix to the Decree of the Ministry of Natural

Resources and Environmental Protection of the Republic of Belarus No. 16, a list of regulated indicators is defined for surface runoff.

The purified domestic wastewater is discharged together with the purified surface runoff, blending them in the sewage pumping station for the transfer of purified wastewater. The total planned discharge volume of purified household-domestic and surface runoff wastewater will amount to about 4,752.123 m³/day (0.055 m³/s), and taking into account routine maintenance and the discharge of industrial wastewater as well, it will reach 5,109.623 m³/day (0.059 m³/s). No other wastewater discharge facilities are planned from the RWDF site.

Table 7.4 presents the qualitative characteristics of wastewater (permissible concentration of pollutants and maximum permissible mass of pollutants) discharged into a surface water body (a single outlet of household-domestic and surface runoff wastewater).

Table 7.4 – Qualitative characteristics of wastewater discharged into a surface water body

No.	Name of pollutants (quality indicators)	Permissible concentration of pollutants within wastewater discharged into a surface water body, mg/dm³	Maximum permissible mass of pollutants within wastewater discharged into a surface water body, t/year
1	pH value	6.5 – 8.5	-
2	BOD_5 Biochemical Oxygen Demand	25[1]	0.476
3	COD Chemical Oxygen Demand	125[1]	2.378
4	Suspended solids	30[1]	2.481
5	Total nitrogen	14.054[2] (not regulated)	0.267
6	Ammonium ion	25[1]	0.476
7	Total phosphorus	0.2[2] (not regulated)	0.004
8	Surfactants anionic	0.1[2]	0.002
9	Mineralization	1,000[2]	19.025
10	Chloride ion	300[2]	5.707
11	Sulfate ion	100[2]	1.902
12	Petroleum products	0.3	0.029

[1] - according to Appendix 1 to the Decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated May 26, 2017, No. 16 (as amended on April 26, 2024) at a population equivalent of up to 500 people;

[2] - according to the water quality standards for surface water bodies established by the Decree of EcoNiP 17.06.01-006-2023 "Environmental protection and nature management. Hydrosphere. Water quality standards for surface water bodies" (approved by the decree of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus dated December 15, 2023, No. 15-T)

Subject to compliance with the proposed limits for discharges of chemical and other substances within wastewater, the impact on the water body is forecast to be within permissible limits. Radioactive contamination of surface water bodies by the RWDF wastewater is excluded by the technological water systems.

7.2.2 Assessment of impact on groundwater

Under natural conditions, groundwater is characterized by an undisturbed (natural) filtration regime, which is formed under the influence of meteorological, hydrological, and geological factors. Seasonal fluctuations in the groundwater level are caused by the unevenness of precipitation and changes in air temperature throughout the year.

The change in the hydrodynamic conditions of the research territory during the RWDF operation can be caused by the result of two main technological impacts. Firstly, to ensure technological processes and economic needs, organized water abstraction from production wells is carried out. This creates local but intensive cones of depression that redistribute natural filtration flows. Secondly, the construction of buildings, structures, and impermeable pavements forms an extensive technological shield on the surface.

This leads to an almost complete cessation of atmospheric precipitation infiltration in the built-up area, which causes a steady reduction in the recharge of aquifers and a general lowering of groundwater levels.

The combined action of these factors—the disruption of natural recharge and the creation of concentrated water intakes—leads to a transformation of the hydrodynamic regime of the territory.

7.2.2.1 Assessment of changes in hydrodynamic conditions under the influence of groundwater abstraction

The exploitation of groundwater has a significant impact on the hydrogeological situation of the adjacent territory. Under the influence of the water intake operation in the exploited aquifer, a decrease in levels and the formation of a cone of depression with a radius of up to several hundred meters occurs. The decrease in levels in the central part of the cone of depression, depending on the amount of abstraction, can reach up to 10 meters or more.

In the study area, the Dnieper-Sozh aquifer has the widest distribution among the confined aquifers of Quaternary sediments. The groundwater of the horizon is used for domestic and drinking water supply and is mainly operated by single wells.

The domestic and drinking water supply of the designed RWDF is planned to be carried out through groundwater abstraction. The Dnieper-Sozh aquifer was considered as the source.

To assess the impact of water abstraction on the natural groundwater regime, predictive modeling was performed on the developed geofiltration model.

The location of the designed water well varied taking into account the structure of the natural regional flow.Modeling was performed for two allocation layouts relative to the RWDF contour: upstream and on both sides of the main flow direction. This approach allows evaluating how the water intake location affects the formation of the cone of depression and the redistribution of filtration flows.

For each variant, a steady-state filtration regime was modeled at a given well yield (preliminarily 1,260 m³/day).

The results of the predictive calculations demonstrate the formation of stable local cones of depression and their areas of influence.

An analysis of the modeling results made it possible to establish that at the given yield, the radius of the area of influence for each of the considered wells does not exceed 1 km. The maximum drawdown in the immediate vicinity of the well (in the center of the cone) is forecast to be 7–8 meters.

Directly within the boundaries of the RWDF site, no significant drawdown is forecast.

7.3 Assessment of impact on subsoil (including geological, hydrogeological, engineering-geological, and other conditions)

The type of subsoil use is the construction and operation of underground structures.

Site 2-1

The following scenarios of potential mutual influence between the RWDF structures and the geological environment that could lead to the contamination of the latter are considered:

1.Breach of the integrity of the RWDF engineering barriers, as well as the integrity of natural geological barriers, with subsequent contamination of the geological environment, occurring as a result of active (hazardous) engineering-geological (geomorphological) processes. Site 2-1 belongs to an area with low and very low probability of extreme geomorphological processes occurrence. Relief stability to technological loads is estimated at 90–95%. During the surveys of 2024–2025, no active (hazardous) geological processes were observed at the site.

2.The impact of the RWDF structures and activities associated with them on the geological environment, including:

– changes in the geological environment caused by site preparation, construction, and other works at the site;

– changes in the geological environment that could occur in connection with the RWDF operation;

– changes in the geological environment after the decommissioning of the RWDF;

– changes in the geological environment during emergency (beyond-design-basis) situations.

Changes in the state of the geological environment (subsoil) caused by other technological reasons or a combination of technological and natural reasons.

In all the listed variants, the potential contamination of the geological environment, the source of which may be the designed facility, will develop primarily through the water migration of pollutants along the soils of the vadose zone, as well as with groundwater. The primary boundaries of the potential contamination spread along the soils of the vadose zone and by means of the near-surface forms of groundwater (perched water, sporadically distributed water in the vadose zone, water table groundwater) will be determined, among other things, by the geometry of the adjacent hydrographic network. It is assumed that the contamination spreading along the soils of the vadose zone, as well as with water table groundwater, which has not completely infiltrated into deeper sediments, will enter the watercourses belonging to the Vilia River basin and their alluvial horizons.

According to the published data, the general direction of infiltration groundwater movement within the territory including Site 2-1 is oriented mainly to the north and north-northwest, toward the Vilia River.

The factors of potential changes in the existing state of the geological environment (subsoil), which could potentially lead to a breach of integrity or a reduction in the efficiency of natural and artificial (engineering) protective barriers, are considered below.

Deformations of foundation soils. Changes in the characteristics of foundation soils. According to the engineering-geological survey data, clay soils with a degree of moisture of less than 0.8 are present at Site 2-1 and are classified into engineering-geological unit (EGU) 14a. Upon water saturation, a reduction in the strength and deformation characteristics of these soils is possible.

During the construction and operation of structures, it is necessary to avoid the overmoistening of foundation soils. The collection and diversion of atmospheric precipitation water (meltwater, stormwater), as well as technological water from
the RWDF site, must be organized. For potentially flooded areas, if any, drainage should be provided.

It should also be taken into account during designing that according to the results of plate load tests of soils of EGU-2, 4, 12, two linear intervals of the dependency of the plate settlement on pressure were noted in a part of the experiments: from the overburden pressure up to 0.30 MPa and from the pressure of 0.30 MPa up to the final pressure in the experiment of 0.50 MPa. The deformation modulus calculated for the second interval of the graph within the pressure range of 0.30–0.50 MPa decreases by 2–3 times.

To eliminate non-uniform or excessive deformations capable of creating prerequisites for a breach of the integrity of the RWDF structures, buildings, and facilities, as well as engineering protective barriers, the results of engineering-geological surveys performed in accordance with TRLAs at the site of each of the RWDF buildings and facilities must be fully taken into account. Control over the development of deformations should be carried out during geotechnical monitoring.

Waterlogging and flooding have not been detected at Site 2-1. According to the engineering-geological survey data, the formation of perched water is possible on the top of clay layers within the vadose zone, being seasonal or associated with intensive atmospheric precipitation.

The possibility of waterlogging and potential areas of its development within the boundaries of the facility under long-term climate change toward humidification and reduced evaporation should be specified after the final determination of the RWDF structures allocation.

Taking into account the hydrogeological observations of 2024–2025, as well as according to the data of the preliminary assessment of seasonal fluctuations in water table groundwater levels, the rise in levels is expected to be no more than 1 m relative to the data specified in the engineering-geological survey report.

The creation of closed depressions underlain by low-permeability soils, artificial barriers, and other obstacles to surface or near-surface runoff should be avoided. Drainage should be provided where necessary.

The configuration of the permanent hydrogeological observation network to control potential flooding must be determined after defining the necessary parameters, including the critical flooding groundwater levels, the moisture content of the foundation soils of the RWDF buildings and structures, areas of potential perched water formation, technological groundwater aquifers, and other prerequisites for flooding, depending on the specific allocation of structures, the embedment depth and types of foundations, and the estimated volume of water consumed by the designed facility.

Changes in hydrogeological parameters, including groundwater levels and heads, over a long period of time can affect the condition and efficiency of protective barriers in various ways. Among the potential reasons for a decrease in groundwater levels and a reduction in their heads in the area of the considered sites are:

– a significant intensification of water intake facilities operation in the adjacent populated areas during the creation of new enterprises or modernization of existing ones;
– dewatering during the excavation of pits, quarries, and construction;
– other reasons.

The reaction of the geological environment can potentially consist in the additional compaction of sandy soils currently being in a water-saturated state, their additional compression under the load from the RWDF structures, in surface subsidence, and in the manifestation of suffosion processes.

Among the potential reasons for **a rise** in groundwater levels and heads in the area of Site 2-1 are:

– discharge (leaks) of technological water onto the surface or into the soil thickness, including at the Belarus NPP facilities near Site 2-1;

– a long-term increase in precipitation and climate humidity, and a decrease in temperature, contributing to groundwater replenishment through additional infiltration into soils;

– damming by the embedded parts of the RWDF structures, foundations, and geomasses (barrage effect);

– disruption of surface runoff and inefficient operation of drainage systems;– other reasons.

It is necessary to take into account the potential possibility of:

– an increase in soil moisture content due to damming by hydraulic structures in the event of their construction on the Vilia River or its tributaries skirting Site 2-1;

– an increase in soil moisture content due to damming of the Vilia River and its tributaries as a result of gravitational processes (landslides, etc.).

It is important to take into account that the long-term evolution of the hydrogeological situation in the area of the facility allocation is determined by heterogeneous variable factors and cannot be predicted precisely. The only way to reduce the uncertainty of models and forecasts is the regularity and continuity of field observations, supplemented, if necessary, by new surveys and investigations.

Surface subsidence of the site due to undermining during mining operations. Mineral deposits directly at Site 2-1 have not been detected. Undermining of the territory must be excluded in the event of choosing the site for the RWDF construction.

In accordance with the State Balances of Mineral Reserves of the Republic of Belarus as of January 1, 2021, the nearest explored unexploited mineral deposit is the "Vorony" ("Voronskoye") clay raw materials deposit. It is located at a distance of about 7.5 km to the West-South-West from Site 2-1, near Vorona Village of Ostrovets District, Grodno Region.

The impact of groundwater abstraction on the condition of the site surface should be controlled by means of permanent hydrogeological observations and geotechnical monitoring.

The impact of aggressive properties of soils and groundwater. Long-term exposure to aggressive environments can have a destructive effect on structures and reduce the efficiency of engineering protective barriers.

According to the data of laboratory determinations of the corrosive aggressiveness of groundwater and soils, the following manifestations of environment aggressiveness were detected at Site 2-1:

– sporadically distributed water in sandy layers of the clay stratum of the vadose zone – medium aggressiveness to metallic structures;

– aquifer of the Sozh end-moraine deposits (gtIIsž) – moderate aggressiveness of groundwater to metallic structures.

In the area of Site 2-1, a varying, including high, corrosive aggressiveness of soils to steel, and a weak and moderate aggressiveness of soils to concrete were previously noted.

When making design decisions, constructing, and operating structures, it is necessary to take into account the existing aggressiveness of the environments, as well as to exclude technological impacts that could lead to its increase.

Soil erosion. There are no watercourses at Site 2-1, which excludes the eroding activity of flowing waters.

During the preparation of the site for construction, in the course of the excavation of construction pits, and during the construction of buildings and structures, it is necessary to carry out measures to prevent technological erosion processes.

Karst processes that could pose a threat to the designed structures and lead to the contamination of the geological environment have not been detected, and their manifestation is not expected as long as the existing state of the subsoil is maintained.

The territory of Site 2-1 does not belong to areas of karst development. The reasons and conditions contributing to karst development have not been detected at the site or near it. Surface manifestations of active karst processes (sinkholes, subsidence troughs, etc.) are not observed. In this regard, the stability category with respect to karst sinkholes of the Site 2-1 alArea of

Location must be assessed as "VI" according to according to the Belarusian Building Norms SN 1.02.01-2019: the possibility of sinkholes is excluded.

Given the nature of the planned activity, the penetration of Silurian carbonate sediments by construction pits is not provided for, and therefore, the emergence of prerequisites for technologically induced karst is not forecast.

Collapsibility. Soils exhibiting collapsible properties (loess-like soils) were not encountered during the engineering-geological surveys. According to the published data, loess-like deposits are absent in the area of Site 2-1. Thus, no prerequisites for the manifestation of collapsibility capable of posing a threat to the designed structures and leading to the contamination of the geological environment have been detected.

Soil liquefaction. Seismic phenomena (see "endogenous processes") can be classified among the causes potentially capable of leading to soil liquefaction. When choosing the RWDF site and during the design process, the recommendations of specialized organizations based on the assessment of the seismic factor must be taken into account. Intensive technological dynamic loads capable of disrupting the existing state of foundation soils should be avoided at the site.

Technological changes in natural protective barriers. At the time of compiling this report, a significant part of the site is covered by forest. In this regard, among the artificial reasons for a reduction in the protective qualities of natural barriers, the possibility of changes in the upper part of the geological section after tree cutting in the forested areas of the site should be provided for. The removal of root systems and the gradual destruction of their unremoved remains can increase the permeability of clay soils to potential contamination. The permeability of such areas is recommended to be controlled by permanent hydrogeological observations during the site preparation for construction, as well as during the initial period of the RWDF operation. The elimination of excessive permeability to block potential migration pathways of pollutants can be achieved by creating an artificial clay shield.

To avoid additional technological disruption of the aquitards' integrity, strict compliance with the established rules for the abandonment of workings is required during the abandonment of wells and other workings of any purpose.

It cannot be ruled out that the cutting of forest massifs may lead to the overmoistening of soils previously partially drained through transpiration (evaporation by trees). Observations of the moisture dynamics of foundation soils can be performed during monitoring.

When grading the territory, constructing embankments, engineering clay shields, and carrying out other measures that can lead to the obstruction of evaporation, the possibility of the formation of vaporous moisture accumulations and its condensation, potentially affecting the moisture content of clay foundation soils and changing their strength and deformation characteristics, should be taken into account. In necessary places, it is recommended to provide drainage and ventilation of soils for the removal and evaporation of excess moisture.

Endogenous geological processes

Seismicity. The maximum design earthquake level with a recurrence interval of once in 10,000 years (average annual risk – 10^{-4}) for the site is 7 points.

The maximum design intensity from a potential seismic event in the nearest Oshmyany zone of potential earthquake focus (Mmax = 4.5, H = 5 km, Δ = 30 km) is 5 points.

The maximum design intensity from a potential seismic event in the Vrancea zone (Mmax = 8.2, H = 80 km, Δ = 885 km) is 5 points.

Vertical movements of the Earth's crust. Against the general background of average annual velocity changes of about -1 mm/year, local values can range from +1 to +2 to -1 to -2 mm/year. Within the zones of faults active at the latest stage, the velocity amplitude reaches 12–

20 mm/year. The direction of the Earth's surface displacement changes according to observation data from different years. The long-term average values do not exceed the first few millimeters. Archival data on modern vertical movements of the Earth's crust (MVMEC) for the period of 1913–1979 show that in the area of the Belarus NPP, the velocity of modern movements of the Earth's crust is approximately -0.1 mm/year (a trend toward slight subsidence).

Horizontal movements of the Earth's crust. According to observations in the adjacent territory—within the Volozhin Graben—the velocity of movements along the Korelichi Fault is about 40 mm/year. Horizontal displacements of the Earth's crust blocks can also occur along other faults.

Preliminary forecast of water migration of contamination with water table groundwater. The site is located in a groundwater recharge zone. A downward movement of groundwater is noted—a leakage of water from upper horizons into lower ones: the absolute marks of sporadically distributed water levels in the vadose zone are 172–173 m, of water table groundwater are 162–164 m, and of the first confined aquifer is 147.61 m.

Natural protection of water table groundwater from contamination is due to the thickness of clay soils of end-moraine deposits, which lies in the upper part of the section. The greater the thickness of the clay stratum and the lower its filtration coefficients, the higher the protective properties. In this regard, the highest protection of water table groundwater is noted in the central part of the site, where the thickness of the clay stratum exceeds 12.5 m. The average value of the filtration coefficient according to laboratory data is 0.0076 m/day.

The value of the clay stratum filtration coefficient is confirmed by the data of water infiltration tests into pits and wells at the adjacent Belarus NPP site (0.0067 m/day).

A preliminary calculation of the penetration time of pollutants under a varying water layer from the surface into the water table groundwater, performed for the adjacent Belarus NPP site, amounted to 410 days. Given the similarity of the hydrogeological conditions, this value can be adopted as an estimated one for Site 2-1.

Based on the survey results currently available for Site 2-1, a preliminary forecast of the direction and velocity of potential contamination spread can be provided.

Upon the release of pollutants beyond the artificial (engineering) and natural barriers and their ingress into the water table groundwater, the pollutants begin preferential movement along the flow to the northwest toward the Gozovka and Vilia rivers. As a result of the downward water leakage, partial contamination of the Dnieper-Sozh glaciofluvial aquifer complex is also possible. In the process of water infiltration, movement of water table groundwater along the flow, and leakage into the lower horizon, partial self-purification of groundwater from pollutants will occur.

In relation to the hydrographic network, Site 2-1 is located inside a large bend of the Vilia River. The distance from the river is about 4 km in the northwest of the site, 5 km in the north, and 6 km in the east. At a distance of about 2.5 km to the west-northwest is the Gozovka River, a left tributary of the Vilia River.

Based on the available results of aquifer testing, within Site 2-1, the calculation of the actual velocity of water table groundwater movement toward the Gozovka River was performed, which is equal to 0.48 m/day.

In accordance with the preliminary research results, the period for contaminated water table groundwater from the RWDF to reach the Gozovka River closest to the facility will be about 14 years.

This velocity was determined from the assumption of pollutants entering the water table groundwater upon a breach of natural and artificial barriers located above the water table level.

Geological barriers at Site 2-1 in connection with potential contamination of the geological environment. In accordance with the main principles of the RWDF design, the safety of the radioactive waste disposal system (long-term safety) must be ensured based on the implementation of the multi-barrier principle. The main geological barriers are listed below. Among the factors determining the protective properties of geological barriers are their lithological composition, thickness, and soil filtration coefficients.

In the event that pollutants overcome engineering barriers, the first natural barrier on the way of their ingress into the water table groundwater is the horizon of clay soils of the Sozh end-moraine deposits located within the vadose zone. According to preliminary estimates, the penetration of pollutants through this barrier will take at least 1 year. A part of the radionuclide contamination will be retained by clay soils.

The protective properties of sandy soils within the vadose zone can be neglected, assuming that, according to preliminary estimates, the penetration of pollutants through them due to high filtration properties may take up to 10–15 days. At the same time, given the clay content of sandy soils and the sorption properties of sands, a part of the radionuclide contamination will be retained by sandy soils.

Upon the penetration of pollutants through the vadose zone into the water table groundwater horizon, their movement will be directed toward the nearest watercourse draining these deposits—the Gozovka River. The soil stratum along which the groundwater flow moves can be considered as the second natural barrier. Taking into account the filtration properties of soils, the gradient of the groundwater flow, and the distance to the watercourse, the estimated travel time will be 14.5 years. A part of the radionuclide contamination will be retained by the water-bearing soils.

Taking into account the downward movement of groundwater, the third natural barrier consists of the soils of the Sozh ground moraine, which separate the water table groundwater and the first confined aquifer. According to the data of engineering-geological surveys and hydrogeological investigations (infiltration tests, nested pumping tests) at the adjacent Belarus NPP site, loams and clays are distributed in the upper part of the aquitard (5–10 m), which are characterized by lower filtration and higher protective properties than the underlying loamy sands.

The fourth natural barrier on the way of the downward groundwater flow consists of the clay moraine deposits of the Dnieper horizon.

The fifth natural barrier consists of the clay moraine deposits of the Berezina horizon and the deposits of the Antopol horizon of the Neogene.

The sixth natural barrier consists of the clayey marls of the Silurian-Devonian deposits.

At a depth of more than 180 m, water exchange is retarded; the zone of mineralized waters begins.

The filtration properties of the third to sixth barriers were studied in detail at the adjacent Belarus NPP site. According to the data of experimental nested pumping tests, the values of leakage coefficients were obtained, which under similar hydrogeological conditions can be adopted as estimated ones when creating geofiltration and geomigration models for Site 2-1.

Natural protection of water intakes. The first, as well as the third to sixth barriers, protect from contamination the groundwater in production wells at the Belarus NPP site, Zagoz Village, and at the "Ostrovets" water intake.

The first, third, and fourth barriers protect the "Gervyaty" and "Degenevo" water intakes from contamination.

The first and third barriers are on the pathway of contaminated groundwater penetration into the production wells of Shulniki, Matskely, and Podvorantsy villages.

Site 3-3

The variants of potential mutual influence between the RWDF structures and the geological environment at Site 3-3 are considered similar to Site 2-1. The area of the site is characterized by a degree of extreme geomorphological processes manifestation from very low to medium, and the relief stability to technological loads is 90–95%. According to the National Academy of Sciences of Belarus, the probability of modern geological processes occurrence in this area is medium and increased (10.1–20.0 points out of 24.9 or more). The geomorphological risk for the area under consideration is defined as high.

Potential contamination from the planned facility will propagate primarily via water migration through the vadose zone and groundwater, with spread in these zones influenced by the adjacent hydrographic network.

This hydrological forecast ensures a consistent, academically accurate terminology across the assessment, focusing on the movement of pollutants within the near-surface geological environment. It is assumed that the contamination spreading along the soils of the vadose zone, as well as with groundwater, which has not completely infiltrated into deeper sediments and has not been completely sorbed by the soils, will enter the watercourses and alluvial horizons of the Chernaya Natopa River basin, and subsequently, the Sozh River.

Deformations of foundation soils. Changes in the characteristics of foundation soils. To eliminate soil deformations capable of causing a breach of the integrity of the RWDF structures, buildings, and facilities, as well as protective barriers, the results of engineering-geological surveys at the site of each of the RWDF buildings and facilities must be fully taken into account. Control over the deformations of foundation soils should be carried out during geotechnical monitoring.

Waterlogging and flooding have not been detected at Site 3-3. The surface runoff conditions are satisfactory.

Taking into account the hydrogeological observations of 2024–2025, while maintaining the existing geological and hydrometeorological conditions, the rise in groundwater (including water table groundwater) levels is expected to be no more than 1 m.

The formation of perched water and sporadically distributed water is not ruled out within the vadose zone. In the hollow (on the southern boundary of the site), the accumulation of meltwater and atmospheric precipitation is possible.

The possibility of waterlogging and flooding, as well as potential areas of their development within the boundaries of the facility under long-term climate change toward humidification and reduced evaporation, should be assessed after the final determination of the RWDF structures allocation.

It is necessary to provide for the potential possibility of technologically induced flooding, including:

– upon the creation of surface runoff disruptions during construction works and after the facility commissioning, water accumulations in relief depressions, and within layers and lenses of sandy soils of the vadose zone;

– by means of groundwater flow damming by the underground parts of structures (barrage effect);– upon the disruption of natural drains or backfilling during territory grading of natural depressions that served as pathways for surface water runoff (these include the runoff hollow, the upper reaches of which cross Site 3-3 from east to southwest).

Changes in hydrogeological parameters, including groundwater levels and heads, over a long period of time can affect the condition and efficiency of protective barriers in various ways.

Among the potential reasons for a reduction in heads and a decrease in groundwater levels in the area of the site are:

– a significant intensification of water intake facilities operation in the adjacent territory, primarily to the north and northeast of the site, in the interfluve of the Chernaya and Belaya Natopa rivers;

– dewatering during the excavation of pits, quarries, and construction.

The reaction of the geological environment can consist in a change in the state of foundation soils, including sandy soils currently being in a water-saturated state, their additional compaction and compression, in surface subsidence, and in the manifestation of suffosion processes.

Among the potential reasons for a rise in groundwater levels and heads in the area of the site are:

– a long-term increase in precipitation and climate humidity, and a decrease in temperature, contributing to groundwater replenishment (additional infiltration into soils);

– discharge (leaks) of technological water;

– disruption of surface runoff and damming by the embedded parts of the RWDF structures, foundations, and geomasses (barrage effect);

– inefficient operation of drainage systems.

A rise in groundwater levels and heads can lead to additional saturation of clay soils, a certain reduction in their strength and deformation characteristics, and an increase in the aggressiveness of environments.

The aforementioned factors can affect the natural and engineering barriers that limit the migration of potential contamination, and therefore, they must be the subject of observations.

Other technological reasons for changes in hydrogeological conditions, surface water infiltration into soils, and soil moisture content may include the secondary flooding of depleted peat workings in the floodplain of the Chernaya Natopa River, the construction of ponds, dams, etc., on the Chernaya Natopa River, and the construction of canals and irrigation systems.

It is necessary to take into account the presence of explored phosphorite deposits in Mstislavl District. The nearest of them—the Lobkovichskoye deposit—is located approximately 14.0–15.0 km southeast of the site. Given the conditions of the mineral occurrence, the development of the deposit may require the organization of dewatering, which will affect the Dnieper-Sozh, Berezina-Dnieper, Cretaceous carbonate, and terrigenous aquifers and complexes in the adjacent territory. To assess the potential impact of mineral development with dewatering on the hydrogeological conditions and foundation soils at the RWDF site, additional investigations and modeling are recommended. When modeling, the potential long-term reduction in heads resulting from complex causes should be taken into account, in particular, a combination of intensive water intakes operation and long-term climate changes that could amplify the dewatering impact.

To determine the risk of landslides and collapses that could lead to the formation of ponds and damming, with a subsequent change in the hydrogeological situation, it is recommended to perform periodic surveys of the condition of steep riverbank sections.

The long-term evolution of the hydrogeological situation in the area of the facility allocation is determined by many variable factors and cannot be predicted precisely. To reduce the uncertainty of models and forecasts, regular field observations are required, supplemented, if necessary, by special investigations.

Surface subsidence of the site due to undermining during mining operations. Undermining of the site, in the event of choosing it for the RWDF construction, must be excluded.

When designing communication routes and access roads associated with the facility, it is necessary to take into account the location and development prospects of the preliminarily explored and prospect-evaluated deposits of clay raw materials, chalk, phosphorites, and other minerals (if any) located within the territory of Mstislavl District.

The potential impact of groundwater abstraction on the condition of the site surface should be evaluated based on the data of permanent hydrogeological observations, geotechnical monitoring, and modeling.

The impact of aggressive environments. According to the chemical analysis results of water extract, the soils of the vadose zone are non-aggressive to concrete of grades W4, W6, W8, and W12 made on Portland cement. Sporadically distributed water in the vadose zone, as well as the water of the Dnieper-Sozh glaciofluvial aquifer complex, are moderately aggressive to metallic structures.

Soil erosion. The area of the site allocation is characterized by the manifestations of hillwash (ablation) and creep.

Hillwash is the removal (washout) of soils down the slope by surface waters, including atmospheric precipitation, with their accumulation at the foot of slopes.

Creep is the slow movement of soil down the slope under the influence of gravitational forces, seasonal freezing-thawing, and moisture fluctuations.

Oversurface soil erosion under the influence of stormwater and meltwater was observed directly at the site in areas cleared of vegetation, on unpaved roads, as well as a result of agricultural activities and machinery movement. Natural soil erosion processes on a scale that threatens the designed structures and protective barriers are not forecast without significant changes in the existing conditions at the site.

With an artificial change in the slope geometry, earthworks during construction, or utility laying, an intensification of erosion phenomena is possible.

Karst. According to the published data and research work results, the site does not belong to territories where karst is forecast. While maintaining the existing state of the geological environment and in the course of its natural evolution, karst processes that threaten the designed structures and are capable of leading to the contamination of the geological environment are not forecast at this site. The stability category with respect to karst sinkholes of the site can be assessed as "VI: the possibility of sinkholes is excluded."

Potential changes in the geological environment associated with loess-like soils. Loess-like deposits are distributed almost ubiquitously in the region under consideration, forming a continuous cover with a thickness of up to 10 m. In Novoye Selo Village (about 7.3 km northeast of the site), loess-like loams and loamy sands are developed by open-pit mining as additives for cement; the depth of the quarry is about 9 m.

Within the site boundaries, loess-like soils lie directly beneath the soil cover, reaching a thickness of 5.1 m (in the northern part of the site). Collapsibility has not been established.

It is assumed that loess-like soils will not be used as a natural foundation for high-load RWDF buildings and structures; however, they can serve as a foundation for roads, utilities, and shallow foundation structures with small loads on soils. In this regard, it is necessary to take into account the distribution of loess-like soils both at the site itself and in the adjacent territory.

Furthermore, the susceptibility of loess-like soils to water erosion can cause the failure of construction pits' walls, transformed slopes, and areas of soil cover stripping or vegetation removal.

Suffosion. The site itself and the territory to the south and west of it are classified as an area of "potential suffosion development." According to the reconnaissance survey results, the area of intensive depression development directly adjoins the northern boundary of the site, where it partially affects its contour.

The depressions represent rounded and oblong hollows with a diameter of mostly 20–70 m (sometimes 100 m or more) and a depth of predominantly no more than 3 m. The depressions can be dry, seasonally wet, or less frequently, waterlogged. They are often covered with tree and shrub vegetation.

In addition to the depressions, a specific cellular (low-hilly) relief, clearly distinguishable on satellite imagery, is also observed ubiquitously. It is formed by small (as a rule, several tens of meters in diameter) gentle hill-like elements and the depressions separating them**.**

The relief with cellular elements and depressions is hereinafter referred to as cellular-depression relief. Among the potential reasons for its formation are:

– consequences of previously occurring collapsible processes in loess-like soils;

– consequences of past or ongoing suffosion processes in the loess-like stratum;

– consequences of karst processes in Cretaceous deposits and associated suffosion in the overlying soils;

– a combination of several factors.

Suffosion and/or collapsible phenomena that led to the formation of the cellular-depression relief could be caused by changes in soil moisture content after deforestation and intensive agricultural development of the territory. The possibility that the listed processes are incomplete cannot be ruled out. It follows from this that the construction of roads and utilities to the RWDF through forest massifs outside the site boundaries can create prerequisites for suffosion and/or collapsible phenomena.

Soil liquefaction. Soil liquefaction, primarily of water-saturated sands, can be potentially caused by seismic events. Intensive technological dynamic loads capable of disrupting the existing state of foundation soils should be avoided at the site.

Technological changes in natural protective barriers. To avoid additional technological disruption of the aquitards' integrity (natural protective barriers), compliance with the established rules for the abandonment of workings is required during the abandonment of wells and other workings of any purpose.

When grading the territory, constructing embankments, engineering clay shields, and carrying out other measures that can lead to the obstruction of evaporation, the possibility of the formation of vaporous moisture accumulations and its condensation, potentially affecting the moisture content of clay foundation soils and changing their strength and deformation characteristics, should be taken into account. If necessary, drainage and ventilation of soils must be provided for the removal and evaporation of excess moisture.

Given the confined nature of groundwater, it is necessary to take into account the possibility of groundwater blowout into construction pits.

In addition to breaching the integrity of natural clay horizons, water blowout into the pit can cause the development of technologically induced suffosion.

Seismicity. Within the area of the site allocation, the intensity of seismic shocks in points of the MSK-64 scale is 5 points.

It is necessary to take into account the widespread ubiquitous occurrence at various depths of water-saturated sands, which belong to the category of "III" soils by seismic properties.

Movements of the Earth's crust. In the area of the site, a trend toward slight subsidence with an average annual velocity of about -1 to -2 mm/year is observed at the latest stage.

Preliminary forecast of water migration of contamination. A preliminary calculation of the penetration time of pollutants from the surface in the central part of the site into the first from the surface aquifer, under a varying water column, shows that if the contamination source is allocated in the central part of the site, the pollutants, taking into account vertical seepage and subsequent horizontal migration, will enter the Chernaya Natopa River in about 5.8–6.0 years.

Geological barriers in connection with potential contamination of the geological environment. The long-term safety of the radioactive waste disposal system must be ensured based on the multi-barrier principle. The main geological barriers are listed below. Among the factors determining the protective properties of geological barriers are their lithological composition, thickness, and soil filtration coefficients.

Assuming that the loess-like deposits in the areas of the main RWDF structures allocation will be removed, in the event that pollutants overcome engineering barriers, the first natural barrier on the way of their ingress into the water table groundwater is the horizon of clay soils of the Sozh end-moraine deposits located within the vadose zone. According to preliminary estimates, the penetration of pollutants through this barrier will take about 1.1 years. A part of the radionuclide contamination will be retained by clay soils.

The protective properties of sandy soils within the vadose zone can be neglected, assuming that, according to preliminary estimates, the penetration of pollutants through them due to high filtration properties may take up to 10–15 days. At the same time, given the clay content of sandy soils, the presence of clay layers and lenses in sandy soils, and the sorption properties of sands, a part of the radionuclide contamination will be retained by sandy soils.

Upon the penetration of pollutants through the vadose zone into the groundwater horizon, their movement will be directed toward the nearest watercourse draining these deposits—the Chernaya Natopa River. The soil stratum along which the groundwater flow moves can be considered as the second natural barrier. Taking into account the filtration properties of soils, the gradient of the groundwater flow, and the distance to the watercourse, the estimated travel time will be about 5.8–6.0 years according to preliminary data. A part of the radionuclide contamination will be retained by the water-bearing soils.

Taking into account the downward movement of groundwater, the third natural barrier consists of the clay soils of the Dnieper moraine.

A part of the contamination will be bound by the soils of the Dnieper-Berezina and Cretaceous terrigenous aquifers, as well as by the carbonate soils of the Cretaceous system. The latter do not form a continuous horizon extending across the entire site.

The fourth natural barrier on the way of the downward groundwater flow consists of the clayey, silty, and sandy soils of the Jurassic system, which represent a thick stratum of regional extent. The filtration properties of the natural barriers were studied by laboratory and geophysical methods.

Natural protection of water intakes. The natural protection of aquifers exploited by many individual water wells and dug wells in adjacent populated areas is associated with the first to third barriers.

Water supply in the nearby territory (in particular, Khodosy, Belynets, and Uspolye villages) and in the town of Mstislavl is predominantly carried out from the aquifer of Devonian carbonate deposits.

The "Sadovyy" water intake, located southwest of the town of Mstislavl, at a distance of about 16 km northeast of the site, exploits the waters of the Upper Devonian carbonate aquifer complex. These waters are protected by all four abovementioned natural barriers.

Water intakes in the town of Krichev and its district, which also exploit the groundwater of Devonian deposits, are located at a distance of about 20 km or more from the site.

Site 1-5

The variants of potential mutual influence between the RWDF structures and the geological environment at Site 1-5 are considered similar to Site 2-1.

The site belongs to an area with a high degree of extreme geomorphological processes manifestation, an above-average geomorphological risk, and relief stability to technological loads of 98–99%. During the surveys of 2025–2026, no active (hazardous) geological processes were observed directly at the site.

Deformations of foundation soils. Changes in the characteristics of foundation soils. When grading the territory, constructing embankments, engineering clay shields, and carrying out other measures that can lead to the obstruction of evaporation, surface, and groundwater runoff, and cause the accumulation of atmospheric precipitation water and flooding, the moisture content of clay foundation soils and their strength and deformation characteristics may change. This applies primarily to clay soils with a degree of moisture of $Sr < 0.8$. During the construction and operation of structures, it is necessary to avoid the overmoistening of foundation soils. The collection and diversion of atmospheric precipitation water (meltwater, stormwater), as well as technological water from the RWDF site, must be organized; in necessary cases, drainage and ventilation of soils should be provided.

Waterlogging and flooding. Currently, the surface runoff and evaporation conditions at the site are satisfactory. Temporary flooding of local relief depressions on unpaved roads was observed after heavy precipitation. The rise in groundwater levels is expected to be no more than 1 m relative to the data specified in the engineering-geological survey report.

The formation of perched water is possible on the top of clay layers within the vadose zone. In the central part of the site, there is a small artificial pond, presumably filled with water retained on the top of the clay soil. Artificial excavations in the northeastern part of the site (area of well 33), with a depth of about 2 m, showed no signs of flooding during the observation period (July 2025).

The possibility of their flooding by meltwater, as well as a result of prolonged rains, is not excluded.

Potential areas of potential waterlogging development, including under long-term climate change toward humidification and reduced evaporation, should be specified after the final determination of the RWDF structures allocation.

It is necessary to provide for the potential possibility of technologically induced flooding, including:

– by means of groundwater flow damming by the underground parts of structures (barrage effect);

– upon the disruption of natural drains or backfilling during territory grading of natural depressions that served as pathways for surface water runoff.

In construction practice, examples of flooding and waterlogging are known at sites where surface runoff conditions were favorable before the start of grading works and soil-vegetation layer stripping. Due to changes in runoff conditions after the aforementioned works, the accumulation of atmospheric precipitation and meltwater occurred in depressions on the top of the clay soil, with the upper part of the clay soil section transforming into a liquid state, and a degradation of strength and deformation characteristics. Furthermore, a technological aquifer was formed, and the existing water table groundwater levels rose.To prevent flooding and waterlogging, the creation of closed depressions underlain by low-permeability soils, artificial barriers, and other obstacles to runoff and evaporation should be avoided. Drainage must be provided where necessary.

The configuration of the permanent hydrogeological observation network to control potential flooding must be determined after defining (specifying) the monitored parameters (critical flooding groundwater levels, the moisture content of the foundation soils of the RWDF buildings and structures, areas of potential perched water formation, technological groundwater aquifers, and other prerequisites for flooding, depending on the specific allocation of structures, the embedment depth, types of foundations, etc.).

Changes in hydrogeological parameters, including groundwater levels and heads.

Given the deep occurrence of groundwater, a significant impact of changes in their levels and heads on the state and efficiency of the RWDF protective barriers is not expected. At the same time, long-term changes in groundwater levels can affect the state of the geological environment.

Among the potential reasons for a decrease in groundwater levels and a reduction in their heads in the area of the site are:

– a significant intensification of water intake facilities operation in the adjacent territory;

– other technological reasons (dewatering during mining operations, etc.);

– long-term shallowing of the Pripyat River.

The reaction of the geological environment can consist in the compaction of sandy soils currently being in a water-saturated state, with the development of land surface deformations.

Among the potential reasons for a rise in groundwater levels and an increase in heads are:

– long-term climate change contributing to additional infiltration into soils;

– a long-term rise in the water level in the Pripyat River due to climatic reasons, as well as a result of the construction of hydraulic structures;

– other natural and technological reasons.

A steady rise in groundwater levels can lead to the water saturation of sandy soils currently being in a dry, low-moisture, and moist state, which will reduce their stability against potential seismic impacts.

Furthermore, the moisture content of clay soils can change at the contact with sandy deposits or sandy lenses within the clay soil thickness that have transitioned into a water-saturated state and possess a hydraulic connection with the water-saturated sandy stratum. This will lead to the formation of new engineering-geological units with lower strength and deformation properties.

Continuous hydrogeological monitoring must be provided for at the designed facility and within the area of its allocation. When designing hydraulic structures on the Pripyat River and the Vit River, their potential impact on the rise of groundwater levels at the RWDF site should be taken into account.

The long-term evolution of the hydrogeological situation in the area of the facility allocation is determined by many variable factors. To reduce the uncertainty of hydrogeological models and forecasts, field observations are required, supplemented, if necessary, by special investigations.

Surface subsidence of the site due to undermining during mining operations. In the event of choosing Site 1-5 for the RWDF construction, undermining of this territory must be excluded.

In accordance with the data of the State Enterprise "Belgosgeocenter", the nearest developed mineral deposits are the Khrapkov 1 sand and gravel quarry (about 5 km to the northeast) and the Strelichevo quarry (about 10 km to the northeast). Peat extraction operations previously took place to the south, west, and east of the site. These types of activities will not affect the RWDF site.

The territory of Site 1-5 belongs to the mineragenic halogen zone of potash and rock salts. There is no data on salt deposits explored in the area of the site.

The site is adjacent to the Narovlya zone of expected oil and gas accumulation. Currently, liquid mineral resources extraction (including hydrocarbons) is being carried out north of the town of Khoyniki, according to the data of the State Enterprise "Belgosgeocenter". According to published data, hydrocarbon extraction can lead to land surface deformation, which is also observed in the fields of the Pripyat Trough. Potential extraction of liquid mineral resources (hydrocarbons, industrial brines, fresh and mineral groundwater) in the area of the site must be preceded by surface deformation modeling; observations within the framework of monitoring are required to control the impact of this activity.

The impact of aggressive properties of soils and groundwater. Data on the aggressiveness of the environments at the site are provided in the description of hydrogeological conditions. Long-term exposure to aggressive environments can have a destructive effect on structures and reduce the efficiency of protective barriers.

The existing aggressiveness must be taken into account when making design decisions. Technological impacts that could lead to its increase should be limited. The dynamics of aggressiveness must be controlled during monitoring.

Soil erosion. The site is located in an area of intensive dust storms and is characterized by modern manifestations of deflation (wind blowout, transport, and deposition of soil particles). To the east, southeast, and west of the site, aeolian (deflation-accumulation) landforms are noted. With an increase in climate aridity, these processes may intensify and assume larger scales.

The widespread distribution of fine and silty sands in the near-surface part of the section may favor wind erosion of soils during site preparation for construction works, excavation of construction pits, and during the movement of construction machinery. Under conditions of the existing radioactive contamination of the near-surface part of the section, this can lead to secondary environmental contamination by dust aerosols containing radioactive particles. Measures must be taken to minimize dust formation during the works and during subsequent handling of the excavated soil from the upper part of the section.

Since some areas of the surface contaminated with radionuclides in 1986 may be located under bulk soil deeper than 1 m, radiometric control is recommended during earthworks. During the further operation of the RWDF, the condition of the site soils should be monitored for wind erosion.

Other forms of soil erosion. There are no watercourses at the site, which excludes the eroding activity of flowing waters; however, on slopes cleared of vegetation, as a result of deforestation, grubbing, and machinery movement, manifestations of soil erosion under the influence of stormwater and meltwater are possible.

Due to the absence of areas with significant gradients, other natural forms of soil erosion processes that could pose a threat to the designed structures, destroy natural geological barriers, and lead to the contamination of the geological environment have not been detected, and their manifestation is not forecast as long as the existing state of conditions at the site is maintained.

During the preparation of the site for construction, in the course of the excavation of construction pits, and during the construction of buildings and structures, it is necessary to carry out measures to prevent technological erosion processes.

Karst processes that could pose a threat to the designed structures and lead to the contamination of the geological environment have not been detected, and their manifestation is not expected. The territory of Site 1-5 does not belong to areas of karst development. The reasons and conditions contributing to karst development are absent at the site and near it. Surface signs of active karst processes (sinkholes, subsidence troughs, etc.) are not observed. The stability category with respect to karst sinkholes of the site alArea of Location must be assessed as "VI": the possibility of sinkholes is excluded.

Collapsibility. Soils exhibiting collapsible properties were not encountered. No prerequisites for the manifestation of collapsibility capable of posing a threat to the designed structures and leading to the contamination of the geological environment have been detected.

Nevertheless, loess-like deposits occur in the area of the site. Loess-like soils are capable of exhibiting collapsibility, significantly reducing bearing capacity, and increasing deformability and compressibility upon an increase in moisture, water saturation, and freezing-thawing. They exhibit thixotropic properties under dynamic impacts. On slopes devoid of vegetation, loess-like soils are easily eroded, with the formation of washouts and gullies. This should be taken into account when designing the RWDF-related buildings and structures, roads, and utilities outside the site boundaries.

Soil liquefaction. The ability of medium-strength water-saturated sands encountered at the site to exhibit dynamic instability cannot be ruled out.

Seismic phenomena can be classified among the causes potentially capable of leading to soil liquefaction. During designing, the recommendations of specialized organizations based on the assessment of the seismic factor must be taken into account.

Intensive technological dynamic loads capable of disrupting the existing state of foundation soils should be avoided at the site.

Technological changes in natural protective barriers. At the time of compiling this report, a significant part of the site is covered by forest. Depending on the state of the climate and its long-term evolution, deforestation can lead to an increase in the moisture content of soils previously partially drained through transpiration, or, conversely, to drying and intensification of wind soil erosion. The removal of root systems and the destruction of their remains can increase the permeability of clay soils.

To avoid additional technological disruption of the aquitards' integrity, compliance with the established requirements and rules is required during the abandonment of workings of any purpose.

When grading the territory, constructing embankments, engineering clay shields, and carrying out other measures that can lead to the obstruction of evaporation, the possibility of vaporous moisture accumulations and its condensation should be taken into account. The same can lead to the obstruction of surface runoff, accumulation of atmospheric precipitation, and flooding. These factors will affect the moisture content of clay foundation soils and can lead to a degradation of their strength and deformation properties.

During monitoring, it is recommended to carry out observations of the moisture dynamics of foundation soils; if necessary, drainage and ventilation of soils should be provided.

Endogenous geological processes

Neotectonic activity. The area of the site allocation coincides with the area of the development of local neotectonic uplifts, presumably caused by the latest and modern salt-dome processes. This factor should be taken into account when organizing observations of modern movements of the Earth's crust in the area of Site 1-5.

Seismicity. In accordance with the general seismic zoning scheme, the predominant part of the Pripyat Trough, including the site area, belongs to the 6-point zone. The Pripyat Trough is a potential zone of potential earthquake foci.

The seismic factor must be taken into account when designing the RWDF. Additionally, in the event of potential extraction of hydrocarbons, industrial brines, etc., it is recommended to provide for the induced seismicity factor.

Modern movements of the Earth's crust. According to the zoning of the territory of Belarus based on the modern vertical movements of the Earth's crust, Site 1-5 belongs to the territory experiencing subsidence with an average velocity of up to 2 mm per year. The general trend can be complicated by local movements associated with salt-dome processes.

Preliminary forecast of water migration of contamination with water table groundwater. The primary boundaries of the potential contamination spread will be determined, among other things, by the geometry of the adjacent hydrographic network. It is assumed that the contamination spreading in the soils of the vadose zone by means of water seeping from the surface, which has not completely infiltrated into deeper sediments, can reach the canals skirting the site from the south, southwest, and southeast, through which it can penetrate into the Vit and Pripyat rivers.

The calculation of the estimated water migration time in the soil mass was performed without taking sorption into account, based on the assumption of a long-term or continuous inflow of contaminated water that has overcome engineering barriers. Thus, the expected estimated time for wastewater to reach the first horizon at the site selected for the engineering-geological survey will amount to 768 days (about 2 years).

A preliminary calculation of the contamination arrival time via the groundwater flow (T) into the nearest drainage canals drained by the Vit and Pripyat rivers is provided below. The distance to the near canals is assumed to be 2.3 km. At an actual groundwater flow velocity (V_{act}) of 0.5 m/day, the estimated contamination arrival time via the groundwater flow into the nearest drainage canals (T) will amount to 4,600 days (12.6 years).

It is assumed that upon reaching the drainage canals, a part of the pollutants will move in the predominant southeastern direction along the alluvial horizon of the Pripyat-Dnieper terrace, which is mostly located within the boundaries of the Polesie State Radiation and Ecological Reserve. Along its pathway, a part of the contamination will be retained by soils, primarily by their clay varieties.

The obtained assessment is preliminary and will be specified based on the data of the engineering-geological survey and hydrogeological investigations.

Geological barriers at Site 1-5 in connection with potential contamination of the geological environment. The long-term safety of the radioactive waste disposal system must be ensured based on the multi-barrier principle. Among the factors determining the protective properties of geological barriers are their lithological composition, thickness, and soil filtration coefficients.

In the event that pollutants overcome engineering barriers, the first (main) natural barrier on the way of their ingress into the water table groundwater is a thick horizon of predominantly clay soils of the Dnieper end-moraine and moraine deposits located within the vadose zone. Furthermore, a part of the radionuclide contamination will be retained by the underlying sands of the undivided Berezina-Dnieper horizon, a part of which also lies within the vadose zone. The retention capacity of sandy soils is determined by their filtration properties, clay content, and the sorption properties of sands themselves. In this regard, sandy soils are considered as the second barrier.

The third natural barrier consists of the underlying Paleogene clay soils. Their bedding conditions and properties (including clay content and hydraulic conductivity) will be studied during the engineering-geological survey.

Based on archival data from the state geological survey, the Paleogene clay deposits form a regionally persistent horizon.

Natural protection of water intakes. The first barrier protects the first from the surface aquifer, which is exploited by wells in the adjacent localities. In addition, the first barrier provides protection for surface watercourses (canals and rivers). The first to third barriers provide protection for the water intakes of the town of Khoyniki, which exploit the aquifer of Paleogene deposits (data from the State Enterprise "Belgosgeocenter").

The presence of soil zones with high permeability within the natural clay barriers cannot be excluded ("windows" of various origins in clay horizons, including areas of high sand content). To identify them, it is necessary to obtain engineering survey and hydrogeological investigation data at subsequent stages of work.

7.4 Assessment of Impact on Land Resources

The RWDF construction phase will result in the most significant mechanical alterations to the landscape structure.

According to the architectural and planning data, the area of topsoil stripping at Site 2-1 (stripping depth: 0.20 m) amounts to 39.82 ha (V = 79,640 m^3). At Site 3-3, the area of stripped topsoil (stripping depth: 0.25 m) amounts to 39.82 ha (V = 99,550 m^3). At Site 1-5, the area of stripped topsoil (stripping depth: 0.23 m) amounts to 39.82 ha (V = 91,586 m^3). The total site grading area amounts to 39.82 ha.

The predictive assessment of changes in the condition of land resources located within the boundaries of the sites under consideration has shown that the most probable consequences of the RWDF construction include mechanical removal of the fertile topsoil layer and chemical impacts (pollution caused by the operation of machinery and equipment, petroleum product leaks, generation of operational waste, etc.). In addition, erosion processes may occur in areas of unsecured soils.

During the operation of the RWDF, the following impacts on land resources may occur:

- Mechanical impacts (compaction, desiccation, formation of surface crusts, and soil littering), leading to deterioration of physical (water, thermal, and air) properties, as well as chemical properties;
- Chemical impacts resulting from emissions of pollutants into the atmospheric air;
- Leakage from wastewater drainage systems;
- Contamination associated with the handling of industrial and consumer waste.

The analysis carried out shows that this impact is minimal both in terms of area affected and level of intensity. At the same time, in order to reduce potential adverse impacts on the soil cover during the operation of the RWDF, the implementation of special mitigation measures will be provided for.

7.5 Assessment of Impact on Flora

The main impact on flora cover will occur during the construction phase. The impacts of the planned activity on flora cover include:

- clearing of tree and shrub flora within the designated area: the estimated area of tree clearing for the construction of the RWDF is 27.29 ha at Site 2-1, 2.2 ha at Site 3-3, and 39.82 ha at Site 1-5;
- destruction of herbaceous flora associated with site surface grading, removal of the upper topsoil layer, and construction of embankments for access roads.

The impact on flora will be significant but limited to the area of the RWDF site. No impacts on rare and endangered species, including species listed in the Red Book of the Republic of Belarus, are expected. Overall, the predicted impact on flora cover should be considered acceptable.

When considering the scenario of complete removal of all flora within the boundaries of the surveyed Site 2-1, and taking into account the shape of the original forest contour, it can be concluded that the impact of the planned activity in terms of fragmentation and disruption of the spatial integrity of habitats and ecological corridors will be of minimal significance. This is due to the fact that the forest area within the boundaries of the alternative site forms part of a peripheral fragment of a large forest massif, separated by an existing republican-level highway, and it does not perform a transit function connecting separate ecological cores or corridors. The original contour has a complex geometric shape and falls almost entirely within the boundaries of the alternative site, with the exception of its eastern part, along which, under the considered impact, a new boundary between the forest environment and open spaces will be formed. At the same time, it should be noted that the initial configuration of the impact contour is such that the remaining portion after the impact is already adapted to edge effects. In the long term, all impacts during the construction phase will be reduced to the adaptation of forest communities to the new configuration of the division between forested and non-forested areas. During the construction of the designed facility, the predicted impact on meadow flora should be considered acceptable, provided that measures for flora cover restoration and other special environmental protection and compensatory measures are implemented. The impact on synanthropic flora within the site boundaries is assessed as local, irreversible, and acceptable.

The planned activity at Site 3-3 will have no impact on forest flora communities due to their initial absence. Given the absence of natural meadow habitats within the surveyed area, no predictive assessment was carried out. The impact on synanthropic flora within the site boundaries is assessed as local, irreversible, and acceptable.

Based on the specific shape and size parameters of the forest massif within which the alternative Site 1-5 is located, and taking into account the nature of the considered scenario of complete flora removal within the site boundaries (edge impact on the forest contour), it can be concluded that it will retain all its key ecological functions. This is due to the substantial initial area of the forest massif and the ratio of this area to the impacted area, as well as the peripheral location of the affected site. The impact will lead to an increase in the length of the forest edge and, consequently, the area of the forest edge zone. The existing relatively high spatial and temporal fragmentation of forest stands within the considered massif, caused by economic activity, also reduces the effect of the anticipated impact due to the higher adaptive capacity of younger plantations. Meadow and synanthropic flora are not present within the boundaries of the considered Site 1-5.

It should also be noted that the specific activity of the collected pine and birch branches in the area of Site 1-5 was approximately 600 Bq/kg, while for Sr-90 it was about 200 Bq/kg. This indicates that the contribution of the tree stand to the equivalent dose rate accounts for no less than 50% of the total dose. Thus, it has been established that during the construction of the RWDF at Site 1-5, it is necessary to take a more detailed account of the distribution of radionuclides in the site's forest flora. If necessary, measures should be provided for the management of removed flora in accordance with the legislation of the Republic of Belarus.

During the operation phase of the RWDF, plant communities within the site itself will be mainly represented by areas revegetated with grass mixtures following the completion of construction. Thus, no significant impact on plant communities is expected during the operation of the RWDF.

During the operational phase of the RWDF under normal operating conditions and provided that environmental requirements are complied with, the impact on flora cover will be minimal and will not lead to irreversible consequences.

7.6. Assessment of Impact on Fauna

During the construction phase of the RWDF, the construction area will undergo significant transformation. The construction of the RWDF gives rise to a number of factors adversely affecting the condition of fauna, which are generally divided into two groups: factors of direct and indirect (secondary) impact.

Direct impacts include the mechanical destruction of fauna by motor vehicles and construction equipment. Such facilities as excavations, roads, and power transmission lines may pose a potential hazard resulting in animal mortality.

Indirect impacts include:

- changes in abiotic and biotic habitat components, ultimately affecting the distribution, abundance, and reproductive conditions of organisms;
- removal and transformation of animal habitats (stripping of the fertile topsoil layer, clearing of tree and shrub flora);
- noise and light impacts, as well as vibration;
- changes in the hydrological regime resulting from construction activities.

As tree and shrub flora is cleared and the fertile topsoil layer is removed within the construction zone, the area of animal habitats and feeding grounds will be reduced.

During the construction phase, direct adverse impacts on fauna will occur due to the significant transformation and destruction of their habitats, which will have a substantial negative effect on the populations of certain species at a narrowly local scale—specifically within the construction site area. During the construction and operation phases of the RWDF, animals are expected to move from the development area to adjacent territories due to the loss of habitats and the operation of machinery and equipment. Subsequently, mammal habitats within the RWDF site itself will mainly be represented by areas revegetated following the completion of construction, and only certain insect species and small mammals will be able to persist there, while the presence of other animal species will be temporary or incidental in nature.

Previous studies of the entomofauna in the Ostrovets District have identified populations of the violet ground beetle (*Carabus violaceus* L.) in other biotopes that are in good condition. Thus, the loss of a small part of the local population of the violet ground beetle during the construction of the RWDF at the alternative Site 2-1 will not cause significant harm to this protected species in the region. With regard to the impact of construction on a bird species listed in the Red Book of the Republic of Belarus, it has been established that the corncrake prefers to nest in open habitats, in this case within agricultural landscapes. The abundance of this species in the vicinity of the site is extremely low and insignificant at the regional level. Nesting territories of this type are not permanent and depend on crop rotation; the species readily shifts them from year to year. The construction of the RWDF will not have a significant impact on this species inhabiting agricultural landscapes. If construction activities are carried out during the autumn–winter period, by the following spring breeding individuals will shift eastwards, and the abundance of this species in the vicinity of the described area will remain unchanged.

No animal or bird species listed in the Red Book of the Republic of Belarus have been identified at the surveyed alternative sites 1-5 and 3-3.

During the operation phase of the RWDF, provided that radiation safety requirements are complied with, no significant impact on fauna directly within the RWDF site is expected.

In the post-operational period, under normal conditions of RWDF evolution, the recovery of the species composition and abundance of animals that were displaced or disappeared from the RWDF site during the construction and operational phases is expected.

Overall, the alternative sites are suitable for the construction of the RWDF in terms of fauna conditions. The construction and operation of the RWDF will not lead to a reduction in species richness or a decline in animal population abundance in the Republic of Belarus.

Ichthyofauna
Site 2-1

Negative factors adversely affecting biodiversity and fish populations in watercourses include flow regulation of water bodies, contamination by municipal, industrial, and agricultural effluents, as well as poaching. The negative impact of these factors is significantly amplified under conditions of reduced water volume in watercourses. For the Viliya River within the boundaries of alternative Site 2-1, all of the above-mentioned adverse factors have been identified. During the construction of the RWDF, no water abstraction from the river will be carried out; instead, the discharge of already properly treated effluents will be implemented, which to some extent will have a positive effect on downstream water volumes. Thus, during the construction of the facility “Construction of a Disposal and Long-Term Storage Facility for Radioactive Waste” within the water protection zone of the Viliya River, the installation of a sewage collector and the construction of an outfall structure for the discharge of effluents from treatment facilities for domestic and storm wastewater are planned. Surface runoff from the RWDF does not contain specific pollutants, undergoes dedicated treatment at wastewater treatment facilities, and the technology does not provide for the release of radioactive substances into surface runoff, even under accident conditions. Therefore, one of the main threat factors for fish during the construction and operation of the RWDF is an increase in water turbidity associated with effluent discharge, which will be expressed on a narrowly localized scale.

An increase in water turbidity due to elevated concentrations of suspended particles of fine-grained clayey substances in the watercourse leads to:

- mortality of fish eggs due to the adhesion of silt particles to the adhesive outer membrane of the eggs, resulting in cessation of embryonic respiration;
- impaired respiration of juvenile fish in a low-mobility state during the post-incubation period, caused by the ingress of silt particles between the gill lamellae;
- impaired respiration of adult fish in a low-mobility state in wintering pits during the overwintering period.

However, it should be taken into account that the discharge of treated wastewater from Site 2-1 is planned to be routed to an existing outfall into the Viliya River, located upstream of the mouth of the Gozovka River. Thus, no additional adverse impact on ichthyofauna of the considered section of the Viliya River will occur as a result of the construction of the outfall.

The existing wintering aggregation sites of fish in the Viliya River channel near the settlements of Perevozniki and Bystritsa are located significantly downstream of the planned construction works (more than 10 km) and the location of the existing outfall. Therefore, the wintering pits will not be exposed to adverse factors either during the construction works or during the subsequent operation of the outfall.

During the operation of the treated wastewater outfall into the Viliya River, as a surface water body used for spawning, feeding, overwintering, and migration of fish species of the order Salmoniformes, the requirements set out in Annex 1 to the Resolution of the Ministry of Natural Resources and Environmental Protection of the Republic of Belarus No. 15-T dated December 15, 2023 shall be taken into account. Clause 1.3 of this document stipulates that, when discharging wastewater, the water temperature at the control cross-section shall not exceed the natural temperature of the surface water body by more than 1.5°C, with a total temperature increase not exceeding 20°C in the warm period of the year (April, May, June, July, August, September, October) and 5°C in the cold period of the year (November, December, January, February, March).

Site 3-3

During construction works within the water protection zone of the Chernaya Natopa River, as well as within the water protection zone and coastal strip of an unnamed stream near the settlement of Volovniki, Mstislav District, Mogilev Region, the installation of a sewage collector and the construction of the outfall structure for the discharge of treated effluents from domestic and stormwater wastewater treatment facilities into the Chernaya Natopa River (or the unnamed stream) are planned. Surface wastewater from the RWDF does not contain specific pollutants, undergoes dedicated treatment at wastewater treatment facilities, and the technology does not provide for the release of radioactive substances into surface runoff, even under accident conditions. Therefore, one of the main threat factors for fish during the construction and operation of the RWDF is an increase in water turbidity associated with water discharge from the outfall, which will occur on a narrowly localized scale.

Fish overwintering takes place in deep pool sections with slow flow. At present, there are no wintering pits in the Chernaya Natopa River in the area of the works (Sychyovka settlement) or in the unnamed stream near Volovniki settlement. Accordingly, the outfall will not have a negative impact on fish during the overwintering period.

Water turbidity reduces visibility for fish, disorienting individuals, which may cause stress and promote the development of diseases. However, fish are able to orient themselves through olfaction and the lateral line system, and can also avoid entering such flows. An increase in water turbidity due to elevated concentrations of suspended particles of fine-grained clayey substances in the watercourse may lead to adverse effects during the spawning period, for example, the mortality of fish eggs may occur due to deterioration of the oxygen regime and the adhesion of silt particles to the egg membrane, resulting in the cessation of embryonic respiration; increased water turbidity in the watercourse may cause the deposition of fine silt and clay particles from suspended matter on the gills of juvenile fish, leading to impaired or complete cessation of respiratory function. However, this may occur only during the spawning period (spring) and only during the initial discharge; thereafter, the fish will move to other more suitable areas. An analysis of data on fish species composition and their spawning habitat requirements shows that lithophilic, psammophilic, and some litho-phytophilic fish species (e.g., *Barbatula barbatula* (stone loach), *Alburnoides bipunctatus* (spirlined bleak), common gudgeon, dace, and European bullhead (*Gymnocephalus cernua*)) spawn on gravel and sandy shoals confined exclusively to channel sections of the river. Phytophilic species (e.g., pike, bleak, white bream, common and Prussian carp, sunbleak, roach, tench, spined loach, weatherfish, and perch) spawn in narrow flooded shoreline areas, inundated mouth sections of tributary streams, or shallow nearshore zones overgrown with soft aquatic flora. This indicates the absence of such habitats in the area of the proposed outfall. Overall, for the section of the Chernaya Natopa River in the area of Sychyovka settlement, a reduced ichthyofaunal diversity has been identified—the number of fish species inhabiting the watercourse is 20% lower compared to the full species composition of this watercourse. Thus, the outfall will not affect fish species diversity in this section.

Site 1-5

During construction works for the facility “Construction of a Disposal and Temporary Storage Facility for Radioactive Waste,” the installation of a sewage collector and the construction of the outfall structure for the discharge of effluents from the domestic and stormwater wastewater treatment facilities into the Vit River are planned. Stormwater runoff from the RWDF does not contain specific pollutants, undergoes dedicated treatment at wastewater treatment facilities, and the technology does not provide for the release of radioactive substances into surface runoff, even under accident conditions. Therefore, one of the main threat factors for fish during the construction and operation of the RWDF is an increase in water turbidity associated with water discharge from the outfall, which will be manifested on a narrowly localized scale.

Fish overwintering takes place in deep pool sections with slow flow. No wintering pits were previously present in the Vit River in the area of the works (Borisovshchina settlement); however, after the deepening of a section of the watercourse channel carried out in 2006, this area has been used as an overwintering site by many fish species inhabiting this part of the river. Given that most of the deepened river channel section of the Vit River is located upstream of the planned construction site of the treated wastewater outfall structure, no adverse impact on fish overwintering is expected either during construction or during subsequent operation of the outfall.

It is important to note that an increase in water volume in the watercourse due to the outfall may have a beneficial effect on the condition of fish and amphibians inhabiting the downstream reaches of the river during low-flow periods, helping to prevent the drying out of their habitats.

Overall, for the section of the Vit River, a reduced ichthyofaunal diversity has been identified—the number of fish species inhabiting the watercourse accounts for 84% of the full ichthyofaunal composition of this watercourse. Thus, the outfall will not affect fish species diversity in this watercourse.

In the future, during the operation of the outfall, it is recommended to avoid batch (surge) discharges of large volumes of treated wastewater that significantly exceed the average annual flow volumes of the natural watercourse at the outfall section, as such discharges have a particularly strong impact:

- on small watercourses with a length of less than 5 km;
- on any watercourses during the spring spawning period of key fish species, affecting eggs and juveniles.

7.7. Assessment of Impact on Natural Complexes and Natural Features

Based on the assessment carried out of the condition of natural complexes and natural features, the potential impacts of the construction and operation of the RWDF and off-site infrastructure facilities on them have been identified.

The only natural feature subject to a special protection regime in the area of Site 2-1, within which the construction of an off-site infrastructure facility is planned, is the Vileika International Ecological Corridor (CE2) of the National Ecological Network of the Republic of Belarus. The planned pipeline for the discharge of treated wastewater will extend for 3.0 km within the boundaries of an element of the National Ecological Network. In the event that the pipeline is constructed within the territory of the Vileika International Ecological Corridor, a significant adverse impact on flora cover will occur. Nevertheless, the construction of this infrastructure facility, located within the boundaries of an element of the National Ecological Network outside specially protected natural areas, is permitted.

Within and in the vicinity of alternative Site 3-3, no adverse impacts or changes in the condition of the local protected areas “Shirina and Podrechye” and “Zakruzhye” are expected. For alternative Site 1-5, the only natural feature subject to a special protection regime, within which the construction of an off-site infrastructure facility is planned, is a state nature reserve of republican significance located within the Strelsk ecological core of the National Ecological Network of the Republic of Belarus. The length of the planned 110 kV overhead transmission line from the Mozyr CHP Plant to the “Strelichevo” substation will be 2.7 km, with a potential area of destroyed tree and shrub flora of approximately 16.2 ha, assuming a 60 m-wide corridor for the installation of the 110 kV line. No impacts on other protected areas, including the Emerald Network of Ukraine, are anticipated.

The construction and operation of the RWDF and off-site infrastructure will not have any adverse impact on other natural features subject to a special protection regime.

The economic valuation of ecosystem services was carried out in accordance with the legislation of the Republic of Belarus [14] and included a monetary assessment of the ecosystem service of biodiversity. To ensure a correct comparison of losses for alternative sites with different areas, the total value of ecosystem services was recalculated per unit area (100 ha). The analysis of the obtained values indicates a significant predominance of the environmental value of Site 1-5 over Site 3-3, and a lower value compared to Site 2-1. The total value of the assessed biological resources at Site 1-5 in specific terms (per 100 ha) amounts to 871,105.93 rubles, which is more than seven times higher than the corresponding indicator for Site 3-3 (112,112.71 rubles) and four times lower than that for Site 2-1 (3,646,425.76 rubles).

Such a significant difference is due to the presence at Site 1-5 of natural forest ecosystems with a high timber stock, a considerable diversity of medicinal plants, the presence of a protected plant species, and a higher density of amphibian and bird populations.

From the perspective of ecosystem service losses associated with the potential siting of the facility, Site 3-3 is more preferable, as the damage to natural complexes would be minimal.

7.8 Assessment of Physical Impacts, Including Radiation, Thermal and Electromagnetic Impacts, Noise and Vibration Levels

7.8.1 Physical Impact

There are no existing sources of noise at the considered site.

Acoustic impact was assessed in accordance with:

– SN 2.04.01-2020 “Noise Protection”;

– Hygienic Regulation “Safety and harmlessness indicators of noise exposure on humans”, approved by Resolution of the Council of Ministers of the Republic of Belarus No. 37 dated January 25, 2021.

During the construction period, the main noise sources (NS) are construction machinery and equipment.

According to the performed calculations, the expected noise levels from construction machinery during the construction phase at the calculation points within residential areas will not exceed the permissible sound pressure levels established by legislation.

During the operation of the facility, the main noise sources (NS) are:

- ventilation equipment;
- technological equipment;
- vehicle traffic.

The noise characteristics of the designed noise sources were adopted based on reference data for similar equipment.

During operation of the facility, 56 noise sources are expected to be in operation.

To determine the expected sound pressure levels from all noise sources at the facility, acoustic calculations of noise levels were performed at the boundary of the industrial site and in the nearest residential area.

According to the results of the performed calculations, the expected noise levels from the facility’s noise sources will not exceed the permissible sound pressure levels established by legislation.

7.8.2 Vibration. Electromagnetic radiation. Thermal impact

The assessment of electromagnetic radiation impact on human health includes the evaluation of electric and magnetic fields generated by high-voltage alternating current transmission lines (power lines) of industrial frequency, as well as high-voltage direct current installations (electrostatic field), and electromagnetic fields in the radiofrequency range, including metric and ecametric wavelength bands of television broadcasting stations. No such sources were identified within the surveyed site.

No permanent sources of vibration were identified either.

Vibration safety is ensured by:

- compliance with the operating rules and conditions of machinery and the implementation of technological processes, and the use of machinery strictly in accordance with its intended purpose;
- maintaining the technical condition of machinery, the parameters of technological processes, and elements of the production environment at the levels specified by regulatory documents, and timely execution of scheduled and preventive maintenance and repair of machinery;
- improvement of machine operation, elimination of worker contact with vibrating surfaces outside the workplace or work zone through the use of protective barriers, warning signs, warning inscriptions, color coding, signalling systems, interlocks, etc.;
- improvement of working conditions (including reduction or elimination of accompanying adverse factors);
- use of personal protective equipment against vibration.

There are no sources of thermal impact.

7.8.3 Assessment of Radiation Exposure to the Public

The criteria and requirements for radiation safety, insofar as they relate to ensuring the safety of workers and the public, are established by the Hygienic Regulation (HR-2022) [1] and the Sanitary and Hygienic Norms and Rules of the Republic of Belarus [2]. These requirements shall be complied with during the construction of radiation facilities and nuclear energy utilization facilities. During the construction and normal operation of the RWDF (radioactive waste disposal facilities), the following criteria shall be observed (Table 7.5).

Table 7.5 – Criteria for Assessing Radiation Exposure under Normal Operation and Accident Conditions

Criterion Name	Safety criteria
Dose limit (effective dose) for occupational exposure of workers	20 mSv per year averaged over any consecutive 5-year period, but not exceeding 50 mSv in any single year*
Dose limit (effective dose) for the public	1 mSv per year averaged over any consecutive 5-year period, but not exceeding 5 mSv in any single year*
Equivalent dose rate for calculations of external exposure radiation protection	at permanent occupancy workers locations – 6 μSv/h for an exposure duration of 1,700 h/year at temporary occupancy workers locations – 12 μSv/h for an exposure duration of 850 h/year
Permissible levels of surface contamination of skin, towels, protective underwear,	contamination levels: – 200 particles (β)/(cm²·min); – 2 particles (α)/(cm²·min)*

Criterion Name	Safety criteria
inner surface contamination of personal protective equipment (PPE), etc.	
Permissible levels of surface contamination of protective clothing, inner surfaces contamination of additional personal protective equipment (PPE), and outer surfaces of protective footwear:	contamination levels: - 2,000 particles (β)/(cm^2·min); - 5 particles (α)/(cm^2·min)*
Permissible surface contamination levels of rooms with permanent occupancy workers and equipment located therein	contamination levels: - 2,000 particles (β)/(cm^2·min); - 5 particles (α)/(cm^2·min)*
Permissible surface contamination levels of rooms with intermittent occupancy workers and of equipment located therein	contamination levels: - 10,000 particles (β)/(cm^2×min); - 50 particles (α)/(cm^2×minн)*
Permissible dose rate from a radioactive waste package (RWP)	Permissible dose rate at a distance of 1 m from the surface of the radioactive waste package – 0.1 mSv/h***
	Permissible dose rate at the surface of the radioactive waste package – 2 mSv/h***
Permissible contamination of the outer surface of a transport container	Removable contamination: – 100 particles (β)/(cm^2·min); – 1 particle (α)/(cm^2·min) Non-removable contamination: – 2,000 particles (β)/(cm^2·min)*
On the outer surface of a radioactive waste package upon its entry into the radioactive waste disposal facility (RWDF)	Removable contamination: - 100 particles (β)/(cm^2·min); Non-removable contamination: – 2,000 particles (β)/(cm^2·min)*
Permissible volumetric activity of radionuclides in the air of occupied rooms	Calculated based on the dose limit and the annual inhaled air volume by worker, as well as the expected effective doses per unit of inhalation intake for worker*
Effective dose of the public from radioactive waste at all stages of waste management	During radioactive waste management in the RWDF operational period– shall not exceed 10 μSv/year** For the assessment of long-term safety after the RWDF closure – not more than 300 μSv/year In the case of inadvertent human intrusion into the RWDF after its closure – 20 mSv
Reference levels of radionuclide in drinking water (the same for WHO regulation)*	Radionuclide — Reference level, Bq/L 137 Cs — 10 90 Sr — 10 60Co — 100 And other radionuclides*
General criteria for emergency	not more than 100 mSv over 7 days or over one year;

Criterion Name	Safety criteria
response (the same for IAEA requirement, GSR Part 7)*	from consumption of food products – not more than 10 mSv per year
* Hygienic Regulation "Criteria for Assessment of Radiation Exposure," approved by Resolution of the Council of Ministers of the Republic of Belarus No. 37 dated January 25, 2021 (as amended in 2022) ** Sanitary norms and rules "Requirements for Ensuring Radiation Safety of Workers and the Public in Radioactive Waste Management." Approved by Resolution of the Ministry of Health of the Republic of Belarus No. 142 dated December 31, 2015 [3]	

The radiation safety criteria presented in Table 7.5 shall be confirmed in the analysis of normal operation and after closure of the RWDF. In addition, an assessment of the consequences of radiological emergency at the RWDF shall be performed in accordance with the emergency response criteria.

7.8.3.1 Assessment of Radiation Exposure to the Public in the Event of Radiological Emergencies at RWDF Sites

At the stage of selecting a priority site, an assessment of the consequences of radiological emergencies at the RWDF for locations 1–5, 2–1, and 3–3 was performed by evaluating the effective doses to the public for compliance with the general emergency response criterion of 100 mSv established by the Hygienic Regulation (HR-2022) [1]. If this value is exceeded, protective actions and other response measures shall be implemented to reduce the risk of stochastic effects (sheltering, evacuation, prohibition of consumption of locally produced foodstuffs and drinking water from open sources, and other protective measures).

A forecast of the consequences of design-basis accidents (hereinafter — DBA) and beyond-design-basis accidents (hereinafter — BDBA) with initiating events regulated by the nuclear and radiation safety rules and regulations "Radioactive Waste Disposal. Principles, Criteria and Basic Safety Requirements" [3] has been performed. An indicative list of accidents is provided in the regulatory document of the Republic of Belarus [3]; a qualitative analysis of initiating events and possible scenarios of design-basis and beyond-design-basis accidents is presented in the analytical report [4].

Analysis of the results obtained has shown that any initiating event inevitably leads to one of two critical consequences: either the occurrence of a fire or the drop of a radioactive waste package.

The dropping of radioactive waste containers may occur as a result of the following events:

- catastrophic external impacts of natural and anthropogenic origin, including earthquakes (maximum design-basis earthquake of 7 points);
- dropping of individual radioactive waste packages during transport and handling operations and during placement in RWDF facilities;
- failure of equipment used in radioactive waste package handling systems;
- falling of technological equipment and building structures onto radioactive waste packages.

Fire of radioactive waste containers may occur as a result of the following events:

- complete loss of power supply;
- external impacts of man-made origin (external fire, air shock wave caused by an explosion that may occur during transport operations);
- aircraft crash;
- shock wave with an overpressure of 30 kPa;
- fire with a temperature exceeding 800°C for 1 hour at the surface of RWDF structures.

The analysis of initiating events and the modelling of various DBA and BDBA scenarios at the RWDF were performed using the AFRY and SAFRAN software codes. These software codes are recommended by the IAEA for modelling radionuclide transport under various operational scenarios, including radioactive waste storage facilities both after closure of the repository (disposal facility) and in the event of various accidents, including earthquakes, flooding, aircraft crashes, and other events. The AFRY software code was developed on the basis of the NORMALYSA model, has undergone international validation within the framework of the IAEA MODARIA project — Modelling and Data for Radiological Impact Assessments — and may be used for modelling radionuclide transport in the environment [5,6].

AFRY Intelligent Scenario Modelling (until July 2024 – ECOLEGO, https://www.intelligentscenariomodelling.com/) – software code for the creation of dynamic models and performance of deterministic or probabilistic modeling of radionuclide migration in the environment, including radionuclide migration in soil and groundwater, during the operation of radioactive waste storage and disposal facilities

SAFRAN (Safety Assessment Framework, http://safran.facilia.se/safran/show/HomePage) – program code that enables to characterize waste, visualize waste management schemes, conduct systematic and structured safety assessments in accordance with safety standards, and demonstrate compliance with regulatory criteria.

A radiation-environmental model of a reference radioactive waste disposal facility (RWDF) was developed, accident consequences were simulated, and data on activity release were obtained using the SAFRAN software code. Subsequently, the SAFRAN-generated model was integrated into AFRY to further simulate radionuclide transport in the environment, update RWDF site data, and assess radiation doses to the public.

The assessment of the consequences of design-basis and beyond-design-basis accidents for the RWDF was performed for atmospheric stability category E, which is one of the prevailing and most adverse atmospheric stability categories and is characterised by the worst meteorological conditions.

The assessment of the consequences of radiological emergency was performed taking into account the destruction and fire of waste containers NZK-150-1.5P containing radioactive waste with the highest total activity (class II (short-/medium-lived), class III radiation hazard), intended for disposal in the RWDF.

According to the requirements [7], the design of the NZK is capable of withstanding the loads arising under normal handling conditions:

- a static compressive load applied for 24 hours, equal to five times the mass of the filled container, simulating stacking loads;
- a dynamic load resulting from the drop of a waste container onto a rigid surface from a height of 0.5 m, impacting the base and the edge between the base and the wall;
- an impact load caused by the drop of a carbon steel rod with a hemispherical end (radius 16 mm), 32 mm in diameter and weighing 6 kg, from a height of 1 m, directed at the centre of the weakest part of the NZK.

The operating conditions of the NZK do not exceed the values of these loads and ensure its integrity during technological operations involving radioactive waste packages at the RWDF site.

The assessment of the consequences of DBA and BDBA was performed based on data on annual effective doses (hereinafter — AED) to the public, since beyond the RWDF site boundary the effective dose to the public does not exceed the general response criterion even on an annual basis — 100 mSv. The assessment of DBA and BDBA consequences was carried out for areas outside the RWDF site boundary at distances of 100 m, 1 km, and 3 km, and up to the nearest populated settlement. An additional assessment was performed for an accident involving the crash of a heavy aircraft (400 t) at distances of 100 m, 1 km, 3 km, at the nearest populated settlement, and up to the borders of neighbouring states [8].

The nearest settlement to site 2-1 is the bowery of Mislyany, located 1 km from the site centre; for site 1-5 — the village of Novoselki, located 2.5 km from the site centre; and for site 3-3 — the village of Volovniki, located 2 km from the site centre.

As a result of the assessment of the consequences of six DBA scenarios and four BDBA scenarios, it was determined that the most severe scenarios are as follows:

- DBA scenario — dropping of radioactive waste packages during transport and handling operations and during placement in RWDF facilities;
- BDBA scenario — fire of radioactive waste packages due to the crash of an aircraft.

Within this section, the results of the assessment of radiological emergency at the RWDF with the most severe consequences for the public among all analyzed scenarios are presented:

- DBA scenario — dropping of a radioactive waste package with destruction of the NZK containing radioactive waste (release — 1.7×10^8 Bq);
- BDBA scenario — crash of a 5-ton aircraft with fire of radioactive waste packages (release — 3.63×10^7 Bq);
- additionally, a scenario involving the crash of a heavy aircraft with a mass of 400 t and 70 t of fuel, with fire of radioactive waste containers (release — 7.26×10^9 Bq).

DBA scenario — dropping of a radioactive waste package with destruction of the NZK containing radioactive waste

The following conditions were used in the modelling:
release height — 14 m [4, 9];
destruction of containers with a total release of activity into the environment of $1.7{\times}10^8$ Bq.
In this scenario, a conservative assumption is made that no upper protective structures are present, and the shielding factor is equal to 1.

The results of the assessment are presented in Table 7.6.

Table 7.6 – Total AED to the public in the event of a DBA – dropping of a radioactive waste package with destruction of the NZK containing radioactive waste

Distance from the source, km	AED excluding food consumption, mSv/year	AED for all exposure pathways, mSv/year
0.1	9.3×10^{-3}	3.4×10^{-2}
1.0	1.6×10^{-3}	5.4×10^{-3}
3.0	6.7×10^{-4}	2.1×10^{-3}
Nearest settlement: site 1-5 – 2.5 km site 2-1 – 1.0 km site 3-3 – 2.0 km	8.0×10^{-4} 1.6×10^{-3} 9.2×10^{-4}	2.5×10^{-3} 5.4×10^{-3} 3.0×10^{-3}

In the event of a DBA involving the drop and destruction of radioactive waste packages, the maximum AED to the public at the RWDF site boundary (100 m from the release point) will be approximately $\mathbf{3.4 \times 10^{-2}}$ mSv/year, which is significantly below 1 mSv and does not exceed the emergency response criterion of 100 mSv. Therefore, no protective actions will be required outside the site boundary.

BDBA scenario – crash of a 5-ton aircraft with fire of radioactive waste packages.

Justification of the event probability.

This scenario is justified based on IAEA recommendations [10] using two criteria:

- selection distance value (SDV);
- selection probability level (SPL).

When applying the SDV criterion, potential risks from aircraft crashes are considered if the number of annual flight operations exceeds 1000 d^2, where d is the distance from the site to the airport. In this case, the minimum distance from the sites to the airport is 50 km, and the number of flights is 2.5×10^6, which is unrealistic.

The SPL criterion takes into account the distance of the site from the route centreline. According to a letter from the Department of Aviation [11], route centrelines are located up to 4.5 km from the sites. The above-mentioned area navigation routes have RNAV 5 specification, which allows an aircraft deviation from the route centreline of up to 5 nautical miles (9,260 m); therefore, the consequences of an aircraft crash at the RWDF site should be considered.

In study [12], it is substantiated that 4.5% of aviation accidents occur during the en-route phase of flight. As a rule, accidents are caused by in-flight collision, onboard explosion, or fire; in such cases, the aircraft is destroyed in the air, resulting in the formation of debris.

The number of fragments and their mass depend on the dry mass of the aircraft. Aircraft engines are the most compact and heavy components of an aircraft (weighing more than 1 ton) and typically reach the ground intact; aviation fuel, as a rule, does not reach the ground and evaporates during the ballistic phase following in-flight breakup of the airframe. Four fragments are the maximum number of aircraft fragments weighing more than 1,000 kg that can be following in-flight breakup of the airframe.

The probability of an aircraft crash at the site is estimated in [12] at 5.6×10^{-7}.

Results of the assessment of public exposure in the event of a BDBA — crash of a 5-ton aircraft with fire of radioactive waste packages.

Based on the above, modelling of the BDBA was performed under the following conditions:
crash of an aircraft with a mass of up to 5 t with 0.2 t of fuel and Fire of NZK containers;
release height — 26 m [4, 9];
total release of activity into the environment — 3.63×10^7 Bq.

The results of the assessment are presented in Table 7.7.

Table 7.7 – Total AED to the public in the event of a BDBA – crash of a 5-ton aircraft with fire of radioactive waste packages

Distance from the source, km	AED excluding food consumption, mSv/year	AED for all exposure pathways, mSv/year
0.1	6.9×10^{-4}	5.5×10^{-3}
1.0	1.3×10^{-4}	1.2×10^{-3}
3.0	5.5×10^{-5}	4.5×10^{-4}
Nearest settlement: site 1-5 – 2.5 km	6.2×10^{-5}	5.2×10^{-4}

site 2-1 – 1.0 km site 3-3 – 2.0 km	1.3×10^{-4} 7.4×10^{-5}	1.2×10^{-3} 6.3×10^{-4}

In the event of a BDBA involving the crash of a 5-ton aircraft with Fire of radioactive waste packages, the maximum AED to the public at a distance of 100 m from the release point will be approximately 5.5×10^{-3} mSv/year, and at a distance of 3 km — 4.5×10^{-4} mSv/year, which is below 1 mSv and does not exceed the emergency response criterion of 100 mSv. Therefore, no protective actions will be required outside the site boundary.

7.9 Assessment of Waste Generation Volumes and Waste Management Methods

7.9.1 Management of Waste Generated During the Construction Phase of the Facility

The main sources of waste generation during the construction phase of the proposed facility are:

- preparatory and construction/installation works (welding, insulation, and other activities);
- maintenance and emergency repair of construction machinery, equipment, and auxiliary systems;
- activities of the construction workforce.

Information on the types of waste generated during the construction phase is presented in Table 7.8.

Table 7.8 – Types of Waste Generated During Construction of the Facility

Name of technological process	Waste name and code; hazard class; physical state; physicochemical composition	Recommended waste management option
Construction and installation works	3511008 Mixed unsorted steel scrap, non-hazardous, solid, inert (ferrous metal, 100% by mass).	Transfer for reuse to third-party organizations (to reuse facilities) within the State Association “Belvtormet”.
	1730200 Branches, twigs, and tops, non-hazardous, solid (wood, 100% by mass).	Transfer for reuse to third-party organizations (to reuse facilities) registered in the Register (https://www.ecoinfo.by/административные-процедуры/реестры)
	1730300 Waste from stump uprooting, solid (85–95% wood and bark)	Transfer for reuse to third-party organizations (to reuse facilities) registered in the Register (https://www.ecoinfo.by/административные-процедуры/реестры)
	3142707 Broken concrete products, non-hazardous, solid, inert (concrete, 100% by mass)	Transfer for reuse to third-party organizations (to reuse facilities) registered in the Register (https://www.ecoinfo.by/административные-процедуры/реестры)
	1871707 Paper bags from raw material (cement), Class 4; solid; composition: kraft paper (90%), polymer liner (up to 2%), residual contents (cement, lime-based mixture, sand) (up to 8%).	Transfer for disposal (to disposal facilities) (MSW landfill)
	3991300 Mixed construction waste, Class 4; solid; mixture of materials in the form of broken ceramic products, drywall, and	Transfer for reuse to third-party organizations (to reuse facilities) (https://www.ecoinfo.by/administrativ

Name of technological process	Waste name and code; hazard class; physical state; physicochemical composition	Recommended waste management option
	finishing materials. Composition is variable.	e-procedures/registers)
Construction workers' activities	9120400, production waste similar to municipal waste; non-hazardous; solid; mixture of non-recoverable paper, polymers, organic waste, glass, laminated materials (up to 90% by mass), fines (up to 5% by mass), inorganic impurities (5%); generation up to 100 kg/person/year. With an average workforce of 100 people, 10 t of waste will be generated	Transfer for disposal (to disposal facilities) ((MSW landfill)

To prevent contamination of the territory by waste during construction, the requirements for the organization of construction sites established by Article 22 of the Law of the Republic of Belarus "On Waste Management" must be complied with.

7.9.2 Waste Management During the Operational Phase of the Facility

During the operation of the RWDF, industrial waste will be generated. An assessment of the processes carried out at the facility indicates that the types of waste listed in Table 7.9 are expected to be generated.

Table 7.9 – Qualitative composition of industrial waste generated during the operation of the facility

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency
1	1870601	Waste paper and cardboard from office and clerical activities	low-hazard (Class 4); solid; Paper, cellulose up to 100% by mass	Office premises	213 kg; reuse; TU 500 kg, at least once per year (taking into account item 1–5 of the table)
2	1870606	Uncontaminated corrugated packaging cardboard waste	low-hazard (Class 4); solid; Paper, cellulose up to 100% by mass	Unpacking of materials and components	100 kg; reuse; TU 500 kg, at least once per year (taking into account item 1–5 of the table)
3	1870608	Other uncontaminated paper waste	low-hazard (Class 4); solid; Paper, cellulose up to 100% by mass	Unpacking of materials and components	50 kg; reuse; TU 500 kg, at least once per year (taking into account item 1–5 of the table)
4	1870609	Other uncontaminated cardboard	low-hazard (Class 4); solid; Paper, cellulose up to	Unpacking of materials and components	50 kg; reuse; TU 500 kg; at least once per year (taking into

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency
		waste	100% by mass		account item 1–5 of the table)
5	1871000	Paper and cardboard filters contaminated with hazardous pollutants (mainly organic)*	moderately hazardous (Class 3); solid; oil up to 20% by mass, paper up to 30% by mass, metal up to 50% by mass	Vehicle operation	2 kg; reuse; TU 20 kg, at least once per year (taking into account item 14 of the table)
6	5351901	Waste of finished medicinal products (tablets)	moderately hazardous (Class 3); solid; pharmaceutical products up to 70% by mass, polymer blister packaging up to 20% by mass, paper up to 10% by mass	Staff activities; replacement of expired medicines in first aid kits	up to 1 kg; neutralization; TU 5 kg, as the container is filled
7	5711400	PET bottles (polyethylene terephthalate bottles)	moderately hazardous (Class 3); solid; PET (polyethylene terephthalate) up to 100% by mass	Staff activities	75 kg; reuse; TU 1.2 t (Gazelle-type vehicle with a 4 m³ cargo compartment), at least once per year
8	3991300	Mixed construction waste	low-hazard (Class 4); solid; mineral components (brick, lime mortar, concrete debris, etc.) up to 90%, wallpaper residues (paper), wood up to 8%, polymers from finishing materials up to 2%	Repair of buildings and structures	3.5 t; reuse; TU 4.5 t (container capacity 8 m³, “boat-type” container), as accumulated
9	5410202	Waste engine oils	moderately hazardous (Class 3); liquid; mineral, semi-synthetic, or synthetic oil, or a mixture thereof	Vehicle operation	Up to 15 kg (20 L); reuse; TU up to 150 kg (200 L metal drum), as accumulated (combined with items 9–10)
10	5410203	Waste diesel oils	moderately hazardous (Class 3); liquid; mineral, semi-synthetic, or synthetic oil, or a mixture thereof	Operation of diesel generators and other backup power sources	Up to 15 kg (20 L); reuse; TU up to 150 kg (200 L metal drum), as accumulated (combined with items 9–10)

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency
11	5412000	Waste brake fluid	moderately hazardous (Class 3); liquid; mixture of hydrocarbons	Motor vehicle operation	4.8 kg (5 L); reuse; TU 10 kg (10 L metal canister), as accumulated
12	5492800	Used oil filters	Moderately hazardous (Class 3); solid; oil up to 25% by mass, paper up to 30% by mass, metal up to 45% by mass	Vehicle operation	2.0 kg; reuse; TU 20 kg, at least once per year (taking into account item 5 of the table)
13	5711800	Plastic packaging waste	Moderately hazardous (Class 3); solid; polymeric materials up to 100% by mass	Unpacking of raw materials, materials, and components	10 kg; reuse; TU 100 kg (taking into account items 14, 17 of the table), once per year
14	5711900	Plastic containers from perfumery and cosmetic products	low-hazard (Class 4);solid;polymeric material (polyethylene, polypropylene) up to 100% by mass	Provision of employees with hygiene products	10 kg, reuse; TU 100 kg (taking into account items 13, 17 of the table), once per year
15	5712400	Spent ion-exchange resins	moderately hazardous (Class 3); solid; synthetic organic ion exchangers (copolymers of styrene with sulfonic or amino groups)	Operation of water treatment systems	2000 kg; reuse; TU 2.0 t, as generated
16	5712700	Plastic packaging and containers with residues of hazardous contents	moderately hazardous (Class 3); solid; polymers (up to 90% by mass) contaminated with paints and varnishes (coating materials) and hydrocarbons (up to 10% by mass)	Construction works; supply of reagents, oils, etc.	100 kg; reuse; TU 100 kg, as accumulated, but at least once per year
17	5712710	Plastic waste in the form of containers from detergents, cleaning agents, and other similar products	moderately hazardous (Class 3); solid; polymer material (polyethylene, polypropylene) up to 100% by mass	Cleaning of premises and sanitary facilities	20 kg; reuse; TU 100 kg; (taking into account items 13, 17 of the table), once per year

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency
18	5712110	Waste polyethylene film products	moderately hazardous (Class 3); solid;	Unpacking of materials and components	10 kg; reuse; TU 100 kg; as accumulated
19	5750201	Worn-out tires with metal cord	moderately hazardous (Class 3); solid; rubber up to 90% by mass, metal cord up to 10% by mass	Vehicle operation	100 kg; reuse; TU 100 kg; as accumulated (taking into account item 20 of the table)
20	5750202	Worn-out tires with textile cord	moderately hazardous (Class 3); solid; rubber up to 90% by mass, textile cord up to 10% by mass	Vehicle operation	100 kg, reuse; TU 100 kg as accumulated (taking into account item 19 of the table)
21	5820601	Wiping materials contaminated with oils	moderately hazardous (Class 3); solid; textile up to 90% by mass, hydrocarbons up to 10% by mass	Equipment repair	20 kg, reuse; TU 20 kg as accumulated (container capacity), but at least once per year
22	5820903	Worn-out cotton and other workwear	low-hazard (Class 4); solid; textile up to 90%, synthetic materials up to 10% by mass	Provision of workers	500 kg, reuse; TU 500 kg, as accumulated
23	5960300	Spent zeolites	low-hazard (Class 4); solid; synthetic aluminosilicates (100% by mass)	Water treatment systems	2000 kg; disposal; TU 2000 kg, as accumulated
24	8420300	Sediment from backwashing of iron-removal filters (iron and manganese hydroxides)	moderately hazardous (Class 3); solid; iron and manganese hydroxides up to 80% by mass, water	Water treatment systems	2000 kg, disposal; TU 2000 kg, as accumulated
25	8430100	Screenings (waste from bar screens)	moderately hazardous (Class 3); solid; organic materials up to 90% by mass, polymers up to 10% by mass	Water purification systems	1000 kg, disposal; TU 1000 kg, as accumulated but at least onceper year
26	8430200	Sludge from biological treatment facilities for domestic	moderately hazardous (Class 3); solid; organic substances 70%, mineral fraction 30%	Local domestic wastewater treatment systems	1 t/year; disposal; TU 5000 kg, as accumulated, but at least once per year

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency
		wastewater			
27	8430300	Activated sludge from treatment plants	low-hazard (Class 4); solid; organic matter 100% (activated sludge)	Water purification systems	20 t; reuse; TU 5000 kg, as accumulated, but at least once per year
28	8430500	Sand from grit chambers (mineral sediment)	low-hazard (Class 4); solid; sand up to 90%, organic matter up to 10%	Local stormwater treatment systems	9,5 t/year, disposal; TU 5000 kg, as accumulated, but at least once per year
29	8440100	Suspended solids sediment from stormwater treatment	low-hazard (Class 4); solid; sand up to 50%, organic matter up to 30%, sludge 20%	Local stormwater treatment systems	10 t/year; disposal; TU 5000 kg, as accumulated, but at least once per year
30	9120300	Waste from kitchens and catering establishments	Non-hazardous	Canteen	8,2 t/year; reuse; TU 5000 kg, as accumulated, but at least once per year
31	9120400	Production waste similar to municipal (household) waste	non-hazardous; solid; mixture of non-recoverable paper, polymers, organic waste, glass, laminated materials (up to 90% by mass), fines (up to 5% by mass), inorganic impurities (5%)	Workers activities	22 t; disposal; TU 250 kg (1 container with a capacity of 1.1 m³), once every 3 days, municipal utility special transport (housing and communal services)
32	9120800	Waste (sweepings) from cleaning the territories of industrial enterprises and organizations	low-hazard (Class 4); solid; sand up to 50% by mass, organic material up to 50% by mass	Site cleaning	18 t; reuse; TU 6 t (container capacity 8 m³), at least twice per year
33	9121100	Plant waste from cleaning the territories of gardens, parks, squares, burial sites, and other landscaped green areas	Non-hazardous; solid	Site cleaning and maintenance of green spaces	16 t; reuse; TU 6 t (container capacity 8 m³), at least twice per year (spring, summer, autumn)

No	Waste code	Waste name	Hazard level of waste (waste hazard class); aggregate state; physicochemical properties*	Probable sources of generation	Estimated annual generation volume**; waste management procedure after collection; recommended transport unit (TU) and removal frequency

* – the physicochemical properties of waste are determined based on the principles set out in Table 1 of the Resolution of the Ministry of Natural Resources and Environmental Protection "On Approval of the Instruction on the Procedure for Inventorying Industrial Waste" No. 17 dated February 29, 2008. After commissioning of the facility, the specified physicochemical properties of the waste must be confirmed within the framework of a scheduled inventory of industrial waste.

** – the estimated annual generation volume corresponds to the required capacity for waste reuse, disposal, and neutralization. Waste storage at the facility is carried out in temporary storage areas equipped in accordance with the project design and the requirements of the Environmental Safety Requirements in the Field of Atmospheric Air Protection (EcoNIP). The establishment of dedicated waste storage or disposal facilities as part of the construction project is not required.

The conditions for the generation, collection, temporary storage, and management of waste during the operation of the RWDF will not lead to deterioration of the environmental situation at the RWDF or in adjacent territories.

During the operation of the RWDF, secondary radioactive waste (SRW) is generated in the form of:

- filter elements of ventilation and water treatment systems;
- rags generated from the decontamination of equipment, containers, and transport vehicles;
- liquid waste (spent decontamination solutions, floor drainage water) generated during wet cleaning of premises and equipment (vehicles);
- workwear and personal protective equipment (PPE) of workers.

Secondary solid radioactive waste (SRW) is collected in plastic or paper bags and, together with accompanying documentation, is sent to the radioactive waste processing complex for treatment and conditioning.

Secondary liquid radioactive waste is collected in barrels and transferred to the radioactive waste processing complex for processing and conditioning.

The conditions for the generation and collection of secondary radioactive waste during the operation of the RWDF will not lead to deterioration of the environmental situation within the industrial site or in adjacent areas.

7.10 Assessment of Changes in Socio-Economic and Other Conditions

During the disposal of radioactive waste, its reliable isolation is ensured, providing radiation safety for humans and the environment throughout the entire period during which the radioactive waste remains potentially hazardous.

The RWDF complies with safety requirements under normal operation and anticipated operational occurrences, including accidents. Its radiological impact on workers (workers), the public, and the environment does not result in exceedance of the dose limits for workers (workers) and the public, or of the established limits for radioactive discharges and releases into the environment, as prescribed by regulatory documents.

Environmental protection measures have been incorporated into the design of the RWDF.

Operational monitoring is envisaged, including the use of automated monitoring systems.

The construction of the RWDF will contribute to the further socio-economic development of the region and to the reduction of risks associated with the storage of radioactive waste under conditions unsuitable for disposal.

Orders for the manufacture of equipment, products, and materials will benefit various industrial sectors both in the region and across the Republic of Belarus as a whole.

The radioactive waste disposal and interim storage facility is a high-tech and automated facility requiring a limited staff of highly specialized workers. The total number of operational workers at the RWDF is estimated at approximately 200 people.

The implementation of the RWDF construction project will enable:

- ensuring safety in radioactive waste management in accordance with modern requirements;
- reducing risks associated with radioactive waste storage in Belarus;
- ensuring safe disposal of radioactive waste and reducing the burden of radiation exposure on future generations;
- eliminating radiation exposure to workers and the environment from the operation and maintenance of existing radioactive waste interim storage facilities in Belarus.

In order to foster a positive public attitude toward the RWDF construction project and demonstrate tangible benefits for the local population, the following measures are envisaged:

- public information through mass media;
- ensuring strict compliance of the RWDF design and construction with applicable legislation and modern safety requirements;
- conducting public consultations and state environmental expertise in accordance with the current legislation of the Republic of Belarus;
- implementation of a monitoring programme for the construction and commissioning phase of the RWDF, taking into account agreed environmental requirements and conditions, as well as an environmental monitoring programme for the post-operational period.

Despite not having the status of a town-forming facility, the construction of the RWDF will bring a number of benefits to the region:

- Employment: new job opportunities will be created for the local population.
- Infrastructure: The construction of the facility requires the development of new roads, utility networks, and communication systems.
- Taxes and investments: Local budgets will receive additional tax revenues and earmarked contributions for social programmes.
- Scientific potential: The facility attracts specialized experts, contributing to the development of the scientific and technical sector in the region.

The construction of the high-tech RWDF complex will enhance the scientific potential of the region and promote the development of modern educational standards.

Ongoing monitoring of the facilities will facilitate the collection of statistical data for further analysis and scientific development in this field, as well as the practical implementation of scientific findings.

7.11 Technogenic and Natural Fire Hazard

Site 2-1

Residential areas. Within the settlements and their vicinity, medium-intensity agricultural activities are carried out; therefore, when using specialized machinery, the risk of technogenic hazardous events in the future can be assessed as moderate. However, taking into account the establishment of a sanitary protection zone, the future risk of occurrence of sources of negative impact on the operation of the RWDF, and subsequently on natural ecosystems, is extremely low.

Water surfaces. Due to the absence of oil slicks on water surfaces, this site presents no risk of technogenic hazardous events in the future.

Roads. Despite the fact that the R-45 republican highway is located near the boundaries of alternative Site 2-1 and carries relatively heavy traffic, traffic management is considered good; therefore, the risk of technogenic hazardous events in the future is extremely low.

Industrial enterprises. Considering the specific nature and high level of organization of production at the industrial facility located near the alternative site (the Belarusian Nuclear Power Plant), the probability of technogenic hazardous events in the future is assessed as extremely low.

For Site 2-1 in the Ostrovets District, in the event of a beyond-design-basis severe accident and a reference beyond-design-basis accident at the Belarusian Nuclear Power Plant, protective measures will be required in accordance with the External Emergency Plan of the Belarusian Nuclear Power Plant.[18]

Other potentially technogenic hazardous facilities. There are no storage facilities for flammable substances (solid, liquid, or gaseous), peatlands, main gas, oil and product pipelines, railways, river and sea transport routes, airfields, air routes and flight corridors, or coal and peat extraction facilities within the entire radius of the area.

Radioactive contamination. Regarding the soil contamination density with caesium-137 radionuclides, no changes in values are projected by 2056, with most of the area of alternative Site 2-1 expected to have contamination density values below 3.7 kBq/m². Thus, by the middle of the 21st century, the territory of alternative Site 2-1 will not be classified as a radioactive contamination area under the applicable regulatory standards.

Natural fire hazard. In general, the flora of the site is characterized by a moderate level of fire resistance in the event of fire occurrence. The considered option involving complete removal of tree stands within the boundaries of alternative Site 2-1 is the preferred one; therefore, it can be concluded that natural fire hazard will be absent.

Overall, it can be concluded that technogenic hazardous events have an extremely low probability of occurrence in the future within a 2 km radius of alternative Site 2-1.

Site 3-3

Residential areas. The ongoing economic activities within the settlements of Sychevka, Yushkovichi, Volovniki, and Molyatichi and in their vicinity do not pose a risk of technogenic hazardous events in the future.

*Peatlands***.** Considering that the Chyornaya Natopa peatland located within a 2 km radius is not being exploited and is not planned for development, the risk of technogenic hazardous events is excluded. It should also be noted that it is located in the floodplain of the Chyornaya Natopa River, where the groundwater level is consistently high, which prevents Fire of peat deposits.

Water surfaces. Due to the absence of oil slicks on water surfaces, there is no risk of technogenic hazardous events.

Roads. The Khodosy–Molyatichi road section has low traffic intensity; therefore, the risk of technogenic hazardous events is extremely low.

Railways. The operational railway line in the Krichiv–Orsha direction is characterized by low traffic intensity; therefore, it can be concluded that the risk of incidents is extremely low.

*Industrial enterprises***.** As a result of the analysis of a beyond-design-basis accident at the Smolensk Nuclear Power Plant, precautionary and urgent protective measures will be implemented in the area of Site 3-3 for workers and all persons present at the RWDF site, in accordance with applicable legislation [18].

Other potentially technogenic hazardous facilities. There are no storage facilities for flammable substances (solid, liquid, or gaseous), main gas, oil and product pipelines, river and sea transport routes, airfields, air routes and flight corridors, industrial enterprises, or coal and peat extraction facilities within the entire radius of the area.

Overall, it can be concluded that technogenic hazardous events have an extremely low probability of occurrence in the future within a 2 km radius of alternative Site 3-3.

*Radioactive contamination***.** Regarding the soil contamination density with caesium-137 radionuclides, a decrease in values is projected by 2056, with the territory of alternative Site 3-3 expected to have contamination density values below 3.7 kBq/m². Thus, by the middle of the 21st century, the territory of alternative Site 3-3 will not be classified as a radioactive contamination area under the applicable regulatory standards.

Natural fire hazard. In terms of the weighted average fire resistance index, the flora of alternative Site 3-3 is characterized by low fire resistance in the event of fire occurrence due to the complete predominance of recent clear-cut areas. Based on this, the alternative site is characterized by a high risk of fire development in the event of Fire. However, given the small area of recent clear-cut sites and their sporadic distribution, the predicted probability of fire occurrence within the boundaries of alternative Site 3-3 is assessed as extremely low. The considered option involving complete removal of tree stands within the boundaries of alternative Site 3-3 is the preferred one; therefore, it can be concluded that natural fire hazard will be absent.

Site 1-5

Residential areas. Within the settlement of Novoselki, no active economic activity is carried out; therefore, the level of technogenic hazard can be assessed as extremely low in the future.

*Water surfaces***.** Due to the absence of oil slicks on water surfaces, this site presents no risk of technogenic hazardous events in the future.

Roads. Due to the poorly developed road network and low traffic intensity, the risk of technogenic incidents in the future is extremely low.

Other potentially technogenic hazardous facilities. There are no storage facilities for flammable substances (solid, liquid, or gaseous), main gas, oil and product pipelines, railways, river and sea transport routes, airfields, air routes and flight corridors, industrial enterprises, coal and peat extraction facilities, or peatlands within the entire radius of the area.

Overall, it can be concluded that technogenic hazardous events have an extremely low probability of occurrence in the future within a 2 km radius of alternative Site 1-5.

In the event of fires in the Polesie State Radiation-Ecological Reserve (PSRER), effective doses at Site 1-5 over a 1-day period will not exceed the response criteria, and no protective measures will be required, as the maximum effective doses of internal inhalation exposure for an adult during a 1-day fire duration will not exceed the effective dose for the population [18]. In the event of a fire, radiation monitoring may be required and, if necessary, decontamination at the site may be carried out.

Radioactive contamination. Regarding the soil contamination density with caesium-137 radionuclides, a decrease in values is projected by 2056, with most of the area of alternative Site 1-5 expected to have contamination density values ranging from 37 to 185 kBq/m². The extreme southern part of the alternative site will have contamination density values ranging from 185 to 555 kBq/m². Thus, by the middle of the 21st century, the territory of alternative Site 1-5 will be classified as a radioactive contamination area under the applicable regulatory standards.

Natural fire hazard. In general, the flora of the site is characterized by a moderate level of fire resistance in the event of fire occurrence.The considered option involving complete removal of tree stands within the boundaries of alternative Site 1-5 is the preferred one; therefore, it can be concluded that natural fire hazard will be absent.

7.12 Assessment of Environmental Impact during RWDF Closure

Closure of the RWDF is an activity carried out after the completion of radioactive waste emplacement in the RWDF modules and aimed at bringing the RWDF into a state that will remain safe throughout the period during which the waste placed therein remains potentially hazardous [12].

The operating organization ensures the implementation of activities for the preparation of the RWDF for closure, including:

- conducting a comprehensive engineering and radiological survey of the RWDF;
- decontamination of equipment, pipelines, systems, and components to the extent necessary for preparation for closure;
- management of radioactive waste accumulated at the RWDF during its operation, including ensuring its disposal.

According to the technological solutions, closure of the RWDF does not take place immediately after the disposal compartments are filled, but after a period of temporary storage of radioactive waste packages under storage conditions, in order to study the process of natural changes in the protective properties of the barriers and to confirm the design safety criteria. During this period, active monitoring of the condition of engineered and natural barriers, as well as the host rock formations, is carried out.

Closure of the RWDF is carried out in accordance with the RWDF closure design. The closure design provides and justifies the final closure option for the RWDF. The design solutions for closure of the RWDF shall be aimed at bringing it to a condition that will remain safe throughout the period during which the radioactive waste placed therein remains potentially hazardous.

During the closure of surface facilities, the following activities are envisaged:

- decontamination works;
- collection and dispatch of liquid radioactive waste generated during decontamination according to the adopted scheme;
- collection and preparation of radioactive waste generated for disposal in the disposal facility;
- dismantling and removal of technological equipment;
- dismantling and removal of engineering support systems equipment;
- repeated decontamination of premises and removal of radioactive waste for disposal;
- removal of clean equipment for disposal or reuse;
- dismantling of internal building structures;

- dismantling of all external building structures;
- preparation of contaminated structures for disposal, followed by final disposal
- removal of clean structures to an industrial landfill or for reuse;
- remediation of the territory surrounding the RWDF;
- containerization of contaminated soil and disposal of containers;
- land reclamation measures;
- site landscaping in accordance with adopted decisions.

The execution of works on the closure of surface facilities of the RWDF will be accompanied by the generation of non-radioactive waste, which will be transferred to a specialized organization on a contractual basis.

The main

Overall, the impact on environmental components during the RWDF closure period is assessed as acceptable. As a result of the implementation of environmental protection measures after closure of the RWDF, flora cover will be restored on the site.

7.13 Assessment of Environmental Impact during the Post-Operational Stage

Closure of the RWDF module is justified in a specially developed design. After completion of the closure process, during the post-operational period of the RWDF, the following activities are carried out:

- physical protection of the RWDF;
- monitoring of the radioactive waste disposal system, including control of the condition of engineered and natural barriers;
- monitoring of environmental conditions;
- storage of documentation on the closed RWDF, including the main characteristics of the RWDF and the disposed radioactive waste, as well as the main results of monitoring of the radioactive waste disposal system.

During the post-operational period, the following potential adverse impacts of the RWDF may occur as a result of the loss of integrity of the engineered barriers of the RWDF storage facilities, caused by their natural degradation or by unintentional human intrusion during exploratory drilling or construction activities.

As a result of this adverse impact, there may be radiological exposure to future generations and contamination of environmental components due to the release of radionuclides into the atmosphere and/or groundwater.

Impact of the RWDF on groundwater

During predictive preliminary assessments of the RWDF impact on groundwater, it was assumed that, as a result of various accident scenarios associated with the loss of integrity of engineered barriers of the RWDF, groundwater rise, etc., radionuclides would be leached from the radioactive waste due to the possible ingress of water into their emplacement areas. Subsequently, contaminated water containing radionuclides, through processes of diffusion and convection over a period of 130–300 years and predominantly convection over a period of more than 300 years after the start of radioactive waste emplacement in the RWDF, would enter the unsaturated zone and further, through filtration, reach the groundwater aquifer.

The migration of radionuclides in the aquifer occurs due to convective transport with moving water, taking into account the retardation of radionuclides by the surrounding clay and sandy formations, as well as longitudinal dispersion caused by the heterogeneity of the pore space in the fractured host medium.

The radioactive waste disposed of in the RWDF is in a stable form, meaning that the rate of radionuclide leaching from it is limited. The predicted levels of groundwater contamination beyond the RWDF site will not exceed the established reference levels for radionuclide content in drinking water in cases of the combined presence of multiple radionuclides in water.

Supporting calculations were carried out by TVEL JSC (Russian Federation) with the involvement of leading Russian specialists.

During the preliminary assessment of long-term safety:

– an analysis and systematization of data on the current state of the geological environment and groundwater, the chemical composition of water in nearby water bodies and watercourses, and the existing hydrogeological regime of groundwater was carried out, which, in combination with the results of engineering surveys, made it possible to determine RWDF evolution scenarios;
– an algorithm for hydrodynamic and geochemical transport calculations was described, a contamination source model was developed, and quantitative estimates of the dynamics of contaminant release into the environment were obtained';
– based on the developed hydrogeological model, the results of hydrodynamic calculations are presented for the natural groundwater regime, the disturbed regime during construction, the disturbed regime during operation, and the re-established (natural) regime after closure of the RWDF, including for the considered RWDF evolution scenarios;
– a geochemical transport model for the spread of contamination from the RWDF has been developed, and on its basis a forecast of contamination spread from the RWDF has been provided, taking into account various values of geochemical transport parameters, and groundwater contamination levels in the near-field zone of the RWDF have been determined;
– a forecast of contamination spread from the RWDF has been provided based on the results of hydrogeological calculations and values of geochemical transport parameters.

Conclusion: According to the performed assessments, the design features of the RWDF, as well as the envisaged environmental protection measures, are considered sufficient to prevent any potential adverse impact on groundwater, including under potentially possible accident scenarios, during the post-closure period of the RWDF. The expected dose levels for the population caused by the disposed radioactive waste will not exceed the dose limit of 0.3 mSv/year at the boundary of the RWDF site during the period in which the waste remains potentially hazardous.

Impact on the population

The quantitative justification of the long-term safety of the RWDF was performed under a contract with JSC “TVEL,” including calculated dose burdens to the population as a function of distance and time. During the preliminary assessment of long-term safety, specialists of TVEL JSC used a certified specialized computational software and hardware complex for three-dimensional geofiltration and geomigration modeling, “GeRa.” The use of this software was approved by Gosatomnadzor.

Conclusion: According to the report “Preliminary Assessment of Long-Term Safety,” under the normal evolution scenario of the RWDF, the conducted long-term safety assessments demonstrated that the expected dose levels will not exceed the regulatory limits at the site boundary over the period during which the waste retains potential hazard. The predicted average annual levels of radionuclide exposure to the population decrease with increasing distance from the disposal modules.

List of References

1. Criteria for Assessment of Radiation Exposure: Hygienic Regulation: approved by Resolution of the Council of Ministers of the Republic of Belarus No. 37 dated January 25, 2021 “On Approval of Hygienic Regulations” (as amended by Resolution of the Council of Ministers of the Republic of Belarus No. 829 dated November 29, 2022).
2. Sanitary norms and rules “Requirements for Ensuring Radiation Safety of Workers and the Public in Radioactive Waste Management.” Approved by Resolution of the Ministry of Health of the Republic of Belarus No. 142 dated December 31, 2015.
3. Radioactive Waste Disposal. Principles, Criteria and Basic Safety Requirements: rules and regulations on nuclear and radiation safety: approved by Resolution of the Ministry of Emergency Situations of the Republic of Belarus No. 7 dated January 20, 2012.
4. Activity 3 – Improvement of radioactive waste and spent nuclear fuel management technology; Stage 3.1.4 Determine a list of possible accidents at the radioactive waste disposal facility (RWDF) and emergency response measures. Perform an assessment of the radiation safety of the proposed RWDF design. Justify the safe operational limits of the RWDF in terms of discharges and releases and their operational limits. Develop proposals for the organisation of a radiation monitoring and surveillance system for the radioactive waste disposal system during operation of the RWDF and after its decommissioning. Prepare a set of measures for the decommissioning of the RWDF. Determine the technical and economic indicators of the RWDF project as a whole and its first stage: R&D report: No. 20162228 / State Scientific Institution “Sosny Joint Institute for Power and Nuclear Research” – Minsk, 2018.
5. https://www.intelligentscenariomodelling.com/;
6. Safety Assessment Framework, http://safran.facilia.se/safran/show/HomePage.
7. Data Sheet. Non-returnable reinforced concrete protective container for solid and solidified radioactive waste NZK-150-1.5P. L.65.555.00.000 DS. – Moscow: VNIPIET State Institute (All-Russian Scientific Research and Design Institute of Energy Technology), 2000. – 17 p.
8. Environmental Impact Assessment Materials. Section 11. Assessment of radiological impact on the population of the Republic of Belarus in the event of accidents at the RWDF for alternative site locations. Book 3. Justification of the selection of design-basis and beyond-design-basis accident scenarios during RWDF operation based on the results of the assessment of radiological impact on the population in the event of accidents at site 2-1. Modelling and assessment of consequences for the population in the event of accidents at the RWDF located at site 1-5. Assessment of the demographic situation and morbidity of the population in 2025 in the administrative districts of RWDF siting at sites 1-5, 2-1, and 3-3. 2184-ППЗ-ОВОЗ 11.3. Volume 7.11.3. Republican Center for Hygiene, Epidemiology and Public Health (RCHEPH), Minsk, 2026.
9. RB-134-17 “Recommended Methods for Assessment and Forecasting of Radiological Consequences of Accidents at Nuclear and Fuel Cycle Facilities.”
10. External Human Induced Events in Site Evaluation for Nuclear Power Plants: Safety Guide. IAEA Safety Standards Series No. NS-G-3.1. International Atomic Energy Agency (IAEA), Vienna, 2004.
11. Ministry of Transport and Communications of the Republic of Belarus. Department of Aviation. Letter No. 3-50 dated February 18, 2026.
12. PSAR of Belarusian NPP-2. Preliminary Safety Analysis Report. Belarusian Nuclear Power Plant. Unit 1. Chapter 2. Characteristics of the Area and NPP Site. NIAEP JSC. Revision 2 dated April 22, 2016.

13. Belnipienergoprom RUE. Construction of a radioactive waste disposal and interim storage facility. Pre-design documentation. Environmental Impact Assessment materials. Section 16. Forecasting and assessment of changes in atmospheric air conditions based on calculations of pollutant dispersion in ambient air (including summation groups), taking into account background concentrations of pollutants in ambient air. Book 1. Forecasting and assessment of changes in atmospheric air conditions based on calculations of pollutant dispersion in ambient air (including summation groups), taking into account background concentrations of pollutants in ambient air. 2184-ППЗ-ОВОС16.1. Volume 7.16.1. Minsk, 2026;
14. National Academy of Sciences of Belarus. Center for Geophysical Monitoring of the National Academy of Sciences of Belarus State Institution. Construction of a disposal facility for radioactive waste of classes 3 and 4 and long-term storage of radioactive waste of class 2. Pre-design documentation. Surveys and investigations. Section 7. Conducting exploratory geophysical works for seismological monitoring. Report. Book 1. Conducting exploratory geophysical works for seismological monitoring. 2184-PP3-IZ7.1. Volume 8.7.1. Minsk, 2025.
15. National Academy of Sciences of Belarus. V.F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus State Scientific Institution. Construction of a radioactive waste disposal and interim storage facility. Pre-design documentation. Environmental Impact Assessment materials. Section 8. Assessment of the environmental impact (in terms of land resources, natural complexes, and natural objects) of the planned radioactive waste disposal activity. Book 8. Development of the EIA in terms of land resources, natural complexes, and natural objects. Preparation of a programme and proposals for organizing local environmental monitoring of soil conditions. Final report. 2184-ППЗ-ОВОС 8.8. Volume 7.8.8. Minsk, 2026.
16. Belnipienergoprom RUE. Construction of a radioactive waste disposal and interim storage facility. Pre-design documentation. Environmental Impact Assessment materials. Section 17. Preliminary environmental impact assessment in terms of forecasting and evaluating changes in environmental conditions and socio-economic conditions as a result of the planned activity. Book 1. Preliminary environmental impact assessment in terms of forecasting and evaluating changes in environmental conditions and socio-economic conditions as a result of the planned activity. 2184-ППЗ-ОВОС17.1. Volume 7.17.1. Minsk, 2026.
17. National Academy of Sciences of Belarus. V.F. Kuprevich Institute of Experimental Botany of the National Academy of Sciences of Belarus State Scientific Institution. Construction of a radioactive waste disposal and interim storage facility. Pre-design documentation. Environmental Impact Assessment materials. Section 8. Assessment of the environmental impact (in terms of land resources, natural complexes, and natural objects) of the planned radioactive waste disposal activity. Book 9. Development of the EIA in terms of land resources, natural complexes, and natural objects. Final report. 2184-ППЗ-ОВОС8.9. Volume 7.8.9. Minsk, 2026ю
18. NPCG State Enterprise. Report on completed works. Assessment of the consequences of possible nuclear and/or radiological accidents beyond the site boundary during the operation of a disposal facility for radioactive waste of classes 3 and 4 and long-term storage of radioactive waste of class 2 (final report). Minsk, 2024.
19. 2184-ППЗ-ПОДБ Preliminary assessment of long-term safety, TVEL JSC, Moscow 2026

8. MEASURES TO PREVENT, MINIMIZE AND/OR COMPENSATE ADVERSE ENVIRONMENTAL IMPACTS RESULTING FROM THE IMPLEMENTATION OF THE PLANNED ACTIVITY

8.1 Environmental protection measures at the construction stage of the RWDF

8.1.1 Measures for the protection of atmospheric air

In order to protect atmospheric air from pollution during construction and installation works, the following organizational measures will be implemented:

- strict compliance with sanitary rules and hygiene standards during the operation of construction machinery, equipment, and transport vehicles;
- verification of compliance of the parameters of the machinery and equipment used, in terms of exhaust gas composition, noise, and vibration, with legal requirements;
- refuelling of equipment only at stationary fuelling stations; refuelling of low-mobility machinery (excavators, bulldozers) using fuel tankers; use of hoses equipped with shut-off valves at the outlet; prohibition of the use of buckets and other open containers for refuelling; organization of collection of used oils with subsequent transfer to specialized collection points; prohibition of oil discharge onto soil; use of diesel fuel and other fuels and lubricants complying with GOST standards;
- prevention of fuel and oil leakage into soil and discharge of fuels and lubricants onto the ground surface during maintenance of machinery and equipment;
- starting and warming up of vehicle engines in accordance with an approved schedule;
- prevention of engine idling during downtime of equipment;
- prohibition of repair works on machinery within the construction site area;
- prohibition of burning construction waste on the construction site;
- storage of dusty and volatile materials (cement, paints, solvents) in sealed containers.

8.1.2 Measures for the protection of surface and groundwater

In order to prevent contamination of surface waters in the RWDF siting area and to ensure the rational use of water resources during the construction phase, the following measures are envisaged:

- execution of construction works in compliance with requirements ensuring the sanitary protection of water resources;
- temporary accumulation of waste in specially designated areas equipped in accordance with sanitary regulations, with timely removal for recovery;
- refuelling of equipment at a specially designated hard-surfaced area;
- washing of vehicle wheels when leaving the construction site is provided at a specially designated area with collection of wastewater in special tanks, followed by transport to wastewater treatment facilities;
- prohibition of wastewater discharge onto the terrain.

To eliminate the impact of RWDF construction on groundwater, measures are planned to ensure the integrity of natural geological barriers, the installation of engineered barriers (including an artificial geological barrier), and, if necessary, the installation of dewatering and drainage systems, among others. The list of measures will be defined at the design stage of the works after the required scope of engineering and geological surveys has been carried out.

To monitor the impact of the RWDF on groundwater within the RWDF site and the adjacent territory, it is planned to carry out observations of the dynamics of the hydrogeological conditions. During the operation of the RWDF, systematic monitoring of groundwater quality is envisaged through measurements and sampling from observation wells.

8.1.3 Measures for the Protection of the Soil Cover

During the construction phase, the following measures are envisaged to reduce impacts on the soil cover:

- removal of the fertile soil layer prior to the commencement of construction works and its management in accordance with the procedures established by legislation;
- construction of a minimal number of temporary access roads to the construction site;
- delivery of construction materials as needed and timely removal of construction waste;
- use of mobile or container-type temporary worker facilities on the construction site, which do not require excavation;
- selection of locations for long-term parking of construction machinery with hard impermeable surfacing and bunding;
- refuelling of road construction equipment only at stationary fuelling stations;
- refuelling of low-mobility equipment using fuel tankers and hoses equipped with shut-off valves at the outlet, with the use of drip trays to prevent contamination from entering the soil;
- use of properly maintained machinery and equipment with correctly adjusted fuel systems, preventing losses of fuels and lubricants;
- movement of vehicles and construction machinery strictly within the construction corridor;
- washing of vehicle wheels when leaving the construction site is provided at a specially designated area with collection of wastewater in special tanks, followed by transport to wastewater treatment facilities;
- strict compliance with work technologies and schedules.

8.1.4. Measures for the Protection of Flora

During the construction phase, the following measures will be implemented to reduce mechanical impacts on flora cover:

- handling of flora strictly in accordance with the requirements of the legislation of the Republic of Belarus;
- carrying out all construction works and vehicle movement strictly within the land acquisition (right-of-way) corridor;
- selection of the optimal routing of linear utilities and their installation within a single utility corridor.

To reduce impacts on flora associated with the potential chemical contamination of soils and damage to flora, the following measures are envisaged:

- prevention of spills and leaks during the transportation of petroleum products, liquid transport operations, and the discharge of fuels and lubricants onto the ground surface;
- separate collection and storage of waste in designated containers or receptacles, followed by its removal to authorized disposal facilities or for recovery;
- maintenance of transport and construction equipment in specially designated areas;
- organization of construction material storage areas on land free of woody flora, prevention of littering within the construction zone, and prevention of contamination by fuels and lubricants.

8.1.5 Measures for the Protection of Fauna

As measures to minimize the adverse impact of the construction of the RWDF on fauna, the following measures are envisaged:

- minimal land acquisition in order to preserve habitat conditions for animals and birds;

- strict compliance with the boundaries of the land allocation area, prevention of excessive land take, and movement of construction machinery only along specially designated roads;
- installation of fencing around construction sites;
- verification of compliance of the parameters of the machinery and equipment used, in terms of exhaust gas composition, noise, and vibration, with the manufacturer's technical specifications, which will help prevent both chemical and mechanical impacts;
- thorough removal of logging residues to prevent the creation of favorable conditions for forest pest reproduction;
- prevention of the risk of Fire of forest areas within the work site and adjacent territories, and ensuring strict compliance by construction and survey workers with environmental protection legislation and fire safety regulations;
- prohibition of bringing into the construction site and storing any hunting equipment (firearms and traps) and engaging in recreational hunting, and prevention of any poaching activitiesю

8.1.6 Measures for Reducing Acoustic Impact

Protection of the surrounding area from external and internal noise sources will be ensured through the following measures:
- acoustically rational planning of the site layout;
- execution of the noisiest works strictly during daytime hours;
- selection of equipment and machinery with noise characteristics ensuring compliance with noise standards at workplaces and on adjacent territories.

Vibration safety will be ensured by:
- compliance with the rules and operating conditions of machinery and the implementation of technological processes, and the use of machinery strictly in accordance with its intended purpose;
- maintaining the technical condition of machinery, process parameters, and elements of the working environment at the level stipulated by regulatory documents, and ensuring timely scheduled and unscheduled maintenance and repair of machinery;
- improvement of machine operation, prevention of workers' contact with vibrating surfaces outside the workplace or working zone through the installation of guards, warning signs, and the use of warning notices, color coding, warning signalling systems, interlocks, etc.;
- use of personal protective equipment against vibration.

8.1.7 Measures to Reduce the Impact of Non-Radioactive Waste

Measures aimed at preventing and reducing the level of adverse environmental impacts from production and consumption waste include:
- compliance with the requirements, rules, and standards established by the legislation of the Republic of Belarus in the field of waste management;
- proper waste accounting and record-keeping;
- organization of waste storage areas in accordance with the requirements of regulatory, technical, and sanitary documentation;
- timely removal of waste to designated facilities;
- safe conditions for waste transportation;
- compliance with environmental and sanitary requirements for waste storage.

Temporary waste storage areas shall be arranged in such a way as to prevent contamination of soil, surface and groundwater, and atmospheric air.

Waste collection shall be carried out separately according to types, hazard classes, and other characteristics, in order to ensure their reuse, treatment, and disposal.

Waste transportation shall be carried out in ways that exclude the possibility of waste loss during transport, the creation of emergency situations, or harm to the environment, human health, and economic or other facilities.

8.2 Environmental protection measures during the operation stage of the RWDF

8.2.1 Measures for the protection of atmospheric air

To reduce emissions of harmful chemical and radioactive substances into the atmosphere, the following technical solutions are provided:

- for exhaust gas removal in the vehicle garage area, exhaust ventilation systems with local exhaust capture from vehicles are provided, equipped with fans, gas nozzles, and hoses;
- equipping RWDF buildings with supply-and-exhaust ventilation systems with multistage air purification using high-efficiency HEPA filters that retain radioactive aerosols;
- use of certified containers ensuring diffusion tightness and preventing the release of radionuclides throughout the entire storage period;
- conditioning of radioactive waste into stable forms to prevent the formation of radioactive dust and gases;
- regular monitoring of atmospheric air quality at the boundary of the sanitary protection zone.

To reduce emissions from vehicle equipment, the following measures are envisaged:

- mandatory inspection of vehicle engines for compliance with permissible emission levels of harmful chemical substances into the atmosphere;
- starting and warming up of vehicle engines in accordance with an approved schedule;
- prohibition of leaving equipment with engines running, except where required for operational needs;
- timely maintenance of vehicles, including adjustment of fuel systems, ensuring that pollutant emissions in exhaust gases remain within established limits.

8.2.2 Measures for the Protection of Surface and Groundwater

In order to prevent contamination of surface and groundwater in the RWDF siting area and to ensure the rational use of water resources during the RWDF operation phase, the following measures are envisaged:

- establishment of a system of engineered barriers (a combination of engineered barriers and natural geological barriers) to prevent radionuclide migration into the environment;
- use of bentonite mats, polymer membranes, and special sorbent materials capable of retaining radionuclides even in the event of concrete integrity failure;
- collection and treatment of stormwater and domestic wastewater at the facility's treatment plants;
- temporary accumulation of waste in specially designated areas equipped in accordance with sanitary regulations, with timely removal for recovery;
- refuelling of equipment at a specially designated hard-surfaced area;
- establishment of a monitoring system for groundwater and surface water.

To prevent the potential release of radionuclides from the special drainage system into surface and groundwater during the operation of the RWDF, a set of specific organizational and technical measures is envisaged:

- the special drainage system is constructed using seamless cold- and hot-formed steel pipes made of corrosion-resistant steel;
- monitoring of the volumes of water conveyed through the special drainage system is carried out;
- periodic integrity inspections of the special drainage network are provided;

Such measures make it possible to reduce the additional adverse impact on surface and groundwater from wastewater discharge.

The potential volume of contaminated atmospheric precipitation that may become contaminated with radionuclides is extremely small due to the implementation of special measures aimed at reducing the likelihood of radionuclide release into the environment. Such measures primarily include:
- disposal of waste in certified sealed single-use containers that prevent the release of radionuclides into the environment;
- the transport and technological scheme for radioactive waste disposal at the RWDF excludes prolonged storage of radioactive waste packages in the open air, without protection from atmospheric precipitation;
- upon receipt of radioactive waste packages for disposal, their parameters are checked for compliance with the waste acceptance criteria for disposal;
- radioactive waste is disposed of in reinforced concrete compartments that prevent interaction between radioactive waste and atmospheric precipitation;
- engineered barriers of the RWDF structures prevent radionuclides from entering groundwater with leachate and condensate;
- availability on site of spill response kits for leak mitigation (absorbents, drip trays) during handling of liquid radioactive waste;
- void spaces around waste packages placed for disposal are backfilled with clay powder so that all gaps between packages and walls, as well as floor slabs of the facility, are filled;
- a stormwater drainage system is provided for the removal of surface runoff from the site;
- to protect against soil erosion and wind/water removal, restoration of flora cover is provided through sowing of grass seed mixtures.

In order to monitor groundwater conditions, observation wells located both upstream and downstream of the groundwater flow are provided. Systematic monitoring of groundwater quality is envisaged through measurements and sampling from monitoring wells.

8.2.3 Measures for the Protection of the Soil Cover

In order to reduce potential adverse impacts on the soil cover during the operation phase of the RWDF, the following measures are envisaged:
- establishment of grass cover on open areas to prevent wind and water soil erosion;
- ensuring the proper functioning of drainage and runoff collection systems within the RWDF site;
- use of properly maintained equipment and application of special trays, containers, drip trays, and similar devices when handling process materials;
- compliance with waste management requirements: municipal solid waste shall be stored in standard metal containers installed on a hard-surfaced site, fenced on three sides with a solid barrier, equipped with curbs and convenient access roads. Overfilling of containers shall not be allowed. Timely removal shall be ensured in accordance with an agreement concluded with a specialized waste collection organization;
- regular sampling of soil within the RWDF site and within the sanitary protection zone for radionuclide content analysis;
- compliance with the rules for safe management of radioactive waste.

8.2.4 Measures for the Protection of Flora

During the operation phase, minimization of impacts on flora cover is ensured through:

- movement of vehicles and special-purpose machinery only on roads;
- maintaining all culverts and drainage facilities in working condition to prevent flooding and waterlogging of adjacent areas;
- prohibition of unauthorized tree cutting, movement of machinery off roads, and storage of materials on the soil and flora cover;
- continuous monitoring through environmental monitoring activities.

8.2.5 Measures for the Protection of Fauna

During the operation phase, minimization of impacts on fauna is ensured through:

- measures for the protection of atmospheric air;
- movement of vehicles and special-purpose machinery only on roads;
- noise protection measures (use of low-noise equipment, improved sound insulation, etc.);
- installation of reliable physical barriers (fences, mesh barriers) along the perimeter of the industrial site to prevent the intrusion of large and medium-sized mammals;
- use of special netting or deterrent devices to prevent birds from using the structures for resting or nesting;
- use of directional lighting fixtures with protective hoods to prevent night lighting from disorienting birds and insects.

The main objective is radiological isolation of the facility: the ecosystems surrounding the RWDF shall maintain their natural structure.

8.2.6 Measures for Reducing Acoustic Impact

Noise (acoustic impact) reduction measures during the operation of the RWDF are aimed at ensuring comfortable working conditions for workers and compliance with sanitary standards at the boundary of residential areas.

The main measures include:

- installation of noise silencers in the ducts of supply-and-exhaust ventilation systems (this is an important measure, as RWDF ventilation operates continuously);
- mounting of high-capacity pumps, compressors, and fans on vibration-damping foundations or spring isolators to prevent noise transmission through building structures;
- restriction of manoeuvring operations of special-purpose equipment and movement of heavy trucks (container carriers) during nighttime hours;
- installation of low-noise, high-efficiency, and environmentally resistant equipment ensuring ease of maintenance, a long service life, and certification for use in the Republic of Belarus.

Measures for vibration control include:

- ventilation units and air handling systems will be installed on vibration-isolating bases using anti-vibration rubber pads;
- air ducts will be connected to fans via flexible connectors;
- enclosing structures of ventilation chambers will be designed to ensure the required sound insulation performance;
- fan rotational speed and air velocity in ducts will be selected taking into account permissible sound pressure levels;
- installation of pumps on vibration-isolating bases designed for the relevant pump type;
- installation of equipment on vibration isolators in accordance with the manufacturer’s installation drawings.

As the RWDF is a facility with a strict safety regime, many radiation protection measures (such as thick concrete walls and airtight airlocks) also inherently provide a high degree of acoustic insulation.

8.2.7. Measures to Reduce the Impact of Non-Radioactive Waste

Measures aimed at preventing and reducing the level of adverse environmental impacts from production and consumption waste include:

- compliance with the requirements, rules, and standards established by the legislation of the Republic of Belarus in the field of waste management;
- proper waste accounting and record-keeping;
- strict compliance with waste generation standards and disposal limits;
- organization of waste storage areas in accordance with the requirements of regulatory, technical, and sanitary documents;
- timely removal of waste to designated facilities;
- safe conditions for waste transportation;
- compliance with environmental and sanitary requirements for waste storage.

When organizing temporary waste storage (accumulation) areas, measures are taken to ensure environmental safety.

The arrangement of temporary waste storage (accumulation) areas is carried out taking into account the hazard class, physicochemical properties, and reactivity of the generated waste, as well as the requirements of applicable regulations and standards.

Waste collection is carried out separately according to types, hazard classes, and other characteristics in order to ensure their recycling, use as secondary raw materials, treatment, and disposal.

8.2.8 Measures to Minimize Radiological Impact

Minimization of radiological impact at the RWDF is achieved through the implementation of the following measures:

- increasing the distance between workers and the public and sources of ionizing radiation to the maximum feasible extent (distance protection);
- minimizing the duration of technological operations to ensure time-based protection;
- establishment of acceptance criteria for radioactive waste delivered to the RWDF at a level ensuring radiation safety for workers and the public;
- use of specially certified protective containers ensuring an acceptable radiation level on the surface;
- use of specially designed radiation-shielding engineered barriers (radiation protection) in the most radiation-hazardous areas, including the unloading area, incoming inspection area, temporary storage area, special vehicle cabin, and overhead crane cabin in the hall above the RWDF disposal cells;
- establishment of operational control levels for radiation exposure at the RWDF below the permissible limits in accordance with applicable regulatory legal acts;
- protection of workers through the use of personal protective equipment (including respiratory protection);
- organization of work using site zoning, with the use of sanitary checkpoints and sanitary airlocks when crossing zone boundaries;
- implementation of incoming inspection of radioactive waste upon delivery to the RWDF, as well as inspection of potentially contaminated vehicles upon entry to the RWDF;

- implementation of radiation monitoring (process, environmental, and individual) to assess compliance of exposure levels of workers and the public to ionizing radiation sources with the requirements of sanitary rules and Hygienic Regulations, as well as with established control levels.

The radiation monitoring system envisaged at the RWDF includes:

- monitoring of gamma radiation dose rate and alpha and beta particle flux densities at workplaces, in individual rooms, and in the adjacent territory;
- monitoring of radioactive contamination levels of radioactive waste packages received for disposal, as well as of surfaces in working areas and equipment, and of workers' skin, protective clothing, and footwear;
- monitoring of radionuclide volumetric activity in indoor air;
- monitoring of areas for accumulation and handling of secondary radioactive waste;
- monitoring of contamination levels of transport vehicles;
- individual dosimetric monitoring of workers exposure and monitoring at the boundary of the sanitary protection zone of the RWDF;
- monitoring of radioactive release;
- monitoring of environmental components.

8.3 Environmental Protection Measures during the modules of RWDF Closure and the Post-Operation Phase

Environmental protection measures during the modules of RWDF closure and the subsequent phase are aimed at ensuring long-term safety and minimizing radiological impact on the population and the biosphere.

Preparation of the RWDF for monitored maintenance

This stage consists of two sub-stages:

- establishment of a system of multifunctional protective barriers (upper protective covers) preventing the infiltration of atmospheric precipitation and the release of radionuclides;
- decontamination, dismantling, or repurposing of buildings, structural components, and systems that are no longer required for ensuring safety.

The engineered safety barrier system preventing the spread of ionizing radiation and radioactive substances into the environment includes:

- First barrier – container walls;
- Second barrier – buffer material filling the free space in the compartments (stabilizing backfill of disposal cells), performing an isolating function (anti-filtration and anti-migration) for at least 100 years. Subsequently, it continues to perform a sorption barrier function;
- Third barrier – reinforced concrete structures of the walls and slabs of the RWDF disposal cells.
- Fourth barrier – clay liner and bentonite mats along the perimeter (walls and floor) of the RWDF disposal cells. The perimeter clay liner performs isolating and sorption functions. Bentonite mats provide an isolating function for an unlimited period provided their integrity is maintained.

At the post-operational stage, an additional (fifth) safety barrier is envisaged — a covering multifunctional cap system, which provides additional protection of the safety barriers and the disposed radioactive waste during the post-closure period of the RWDF.

Monitored preservation

- regular monitoring of gamma dose rate, radon flux density, as well as activity in soil, air, surface water, and groundwater;

- inspection of the integrity of protective covers and timely remediation of ground subsidence or cracks that may lead to water accumulation;
- installation of durable warning markers and implementation of land-use restrictions (prohibition of construction and drilling of wells) to prevent intentional or accidental human intrusion;
- maintenance and archiving of detailed records on the composition, activity, and exact location of disposed waste for future generations;
- development of technology and design documentation for decommissioning activities of the RWDF.

9 FORECAST OF POTENTIAL EMERGENCY AND BEYOND-DESIGN-BASIS ACCIDENT SITUATIONS AND ASSESSMENT OF THEIR CONSEQUENCES

The consideration of this issue is divided into two parts:

- forecasting of natural and man-made events affecting the safety of the RWDF;
- assessment of the risk of emergency situations at the RWDF.

9.1 Forecast of natural and man-made events affecting RWDF safety

During the process of selecting the RWDF site, particular attention was paid to the assessment of natural and man-made conditions characterizing the proposed RWDF site and affecting the safety of this atomic energy facility. The list of these conditions is specified in the regulatory documents of the Ministry for Emergency Situations of the Republic of Belarus [1, 2]. Natural conditions are presented in Table 4.5 and were assessed in accordance with [1] for all three candidate sites with a probability of occurrence of $\leq$ 1 in 10,000 years.

For Site 2-1, the nearest hazardous industrial facility is the Belarusian Nuclear Power Plant, located at a direct distance of 3.1 km. The probability of a severe beyond-design-basis accident involving core melt at the Belarusian Nuclear Power Plant has been estimated at 10^{-7} per reactor-year [3]. This value is one order of magnitude lower than the design target value of 10^{-6} recommended by the IAEA [4].

For Site 3-3, the nearest radiologically hazardous industrial facility — the Smolensk Nuclear Power Plant — is located at a direct distance of 117 km. The probability of a severe beyond-design-basis accident involving core melt at the Smolensk Nuclear Power Plant has been estimated at 7×10^{-8} per reactor-year [5]. This value is significantly lower than the design target probability of 10^{-6} recommended by the International Atomic Energy Agency [4].

For Site 1-5, the analysis of the probability of natural and man-made emergency situations showed that a fire in the Polesie State Radiation-Ecological Reserve dominates over other possible types of local-level emergencies, with an estimated occurrence probability of 9.8×10^{-3} per year [6].

According to the assessment of the probability of occurrence of man-made emergency situations in the vicinity of the potential RWDF siting areas, the level of technogenic hazard in the considered territories is acceptable, and the sites may be used for the construction of the RWDF.

9.2 Assessment of the risk of emergency situations at the RWDF

There are no analogue facilities in the Republic of Belarus for the disposal and temporary storage of radioactive waste and, consequently, no corresponding technological processes, technological equipment, or other systems used at such facilities. Therefore, in accordance with Clause 8 of regulatory document [7], this section presents the results of the assessment of emergency situation occurrence for a reference facility — a radioactive waste disposal facility — based on the methodology applied in the Russian Federation for a similar reference facility, namely a radioactive waste disposal facility (according to the Russian classification system) [8].

For the assessment, an expert method was used, in which quantitative risk estimates are obtained through the processing of expert opinions.

At the first stage of the procedure, hazard identification was carried out in the course of production activities. This is the process of detecting, identifying, and recognizing hazardous and harmful occupational factors and determining their quantitative, temporal, spatial, and other characteristics necessary and sufficient for the development of preventive measures (preventive and corrective actions) ensuring occupational safety.

Based on the conducted procedure, a fault tree has been developed for the RWDF (see Figure 9.1).

The values assigned to the fault tree events are presented in Table 9.1.

The expert judgment method consists of experts analysing the problem with quantitative assessment of their judgments and processing of the results. A survey was conducted among a group of experts from TVEL OJSC and Belnipienergoprom RUE, in which they were asked to assess the probability of occurrence of events from the previously developed fault tree. The probability assessment was carried out using a scoring system.

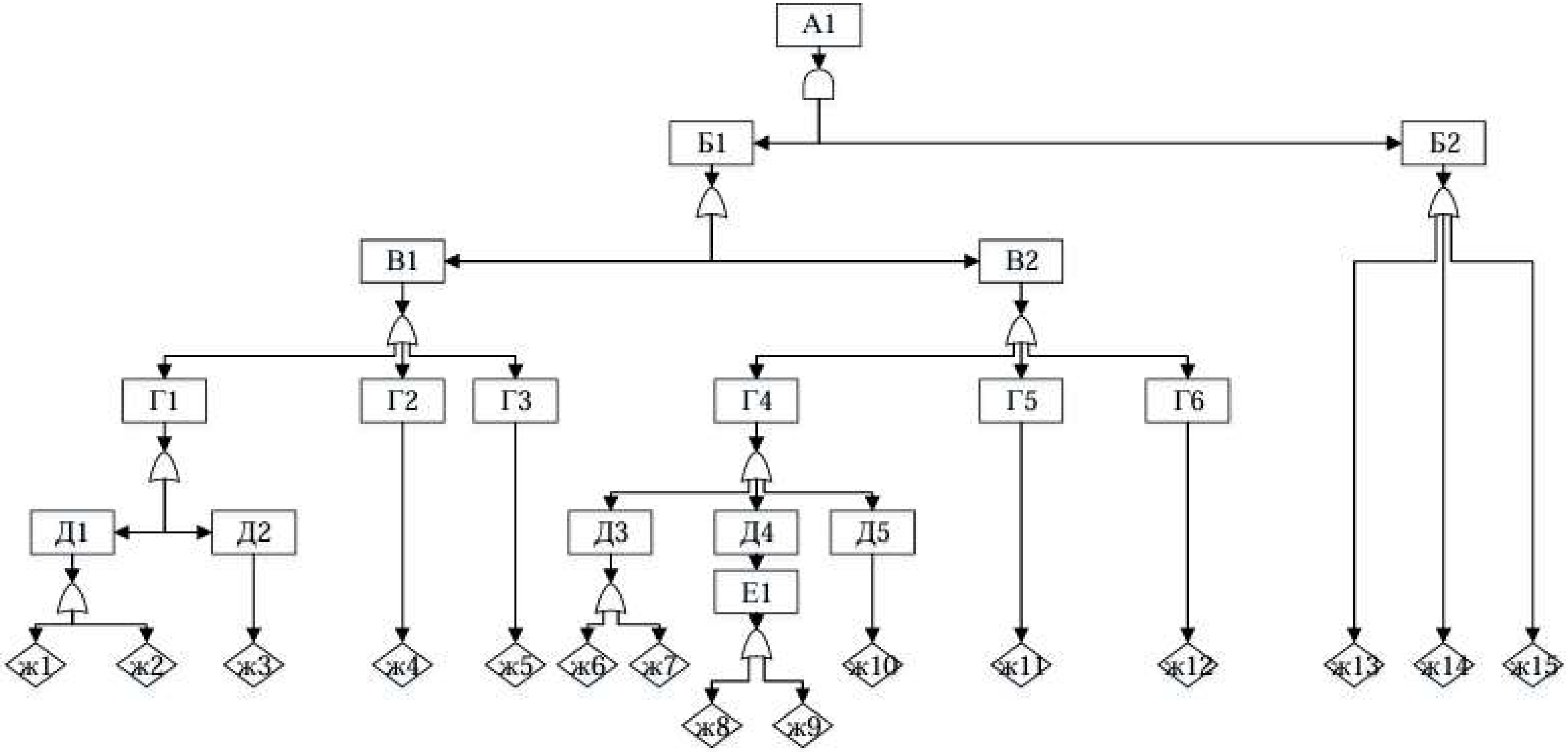


Figure 9.1 – Fault tree model option

Table 9.1 – Values of the fault tree events.

Code	Value
A1	Release of radionuclides into the environment
B1	Loss of container integrity
B2	Loss of integrity of the protective structure
C1	During storage
C2	During transportation
D1	Equipment falling onto a container
D2	Fire outbreak
E3	Container defects
E4	Container dropped from height
E5	Fire outbreak
E6	Container defects
F1	Human error
F2	Use of equipment in violation of operating requirements
F3	Human error
F4	Equipment failure
F5	Use of equipment in violation of operating requirements
G1	Power supply interruption
H1	Employee lacks skills in operating the equipment
H2	Issues related to the employee’s psycho-emotional condition
H3	Equipment is not inspected before the start of work
H4	Short circuit occurrence
H5	Manufacturing defect
H6	Employee lacks skills in operating the equipment
H7	Issues related to the employee’s psycho-emotional condition
H8	External anthropogenic or natural impact
H9	Failure of power supply equipment
H10	Equipment is not inspected before the start of work
H11	Power supply interruption
H12	Manufacturing defect
I13	Earthquake occurrence
I14	Terrorist attack
I15	Aircraft crash

Based on the scoring assessments provided by experts from TVEL OJSC and Belnipienergoprom RUE, the probabilities of occurrence of the basic events were estimated. These values represent the mean probabilities of occurrence of the events, derived from the conversion of the scoring system. The resulting probability values are presented in Table 9.2.

Table 9.2 – Probability values for the occurrence of basic events

Event	Probability Value
Human error resulting in equipment falling onto a radioactive waste container. The employee lacks sufficient skills in operating the equipment.	0.000082
Human error attributable to the employee’s psycho-emotional condition, resulting in equipment falling onto a radioactive waste container.	0.000026
Loading equipment is used in violation of requirements, as it is not inspected prior to operation, resulting in its falling onto a container.	0.000028
Fire occurrence due to a short circuit (during radioactive waste storage).	0.000026

Loss of container integrity during storage due to manufacturing defects.	0.000082
Human error attributable to the employee’s psycho-emotional condition, resulting in a container falling during transportation.	0.000026
Equipment failure due to a power supply interruption caused by external anthropogenic or natural impacts.	0.0000064
Equipment failure due to a power supply interruption caused by malfunctioning power supply equipment.	0.0000028
Container falling from a height due to a defect in loading equipment, as pre-operational inspection was not performed.	0.00001
Fire outbreak due to a short circuit (during transportation of radioactive waste).	0.000024
Loss of container integrity during transportation due to manufacturing defects.	0.000046
Breach of the integrity of the protective structure due to an earthquake.	0,000001
Breach of the integrity of the protective structure due to a terrorist act.	0.000001
Breach of the integrity of the protective structure due to an aircraft crash.	0.000001

The probability of the “top event”, namely the release of radionuclides into the environment, is calculated taking into account the logical operators of the fault tree, “AND” and “OR”. The results of the calculation are presented in Table 9.3.

Table 9.3 – Probability values of event occurrence

Code according to the fault tree	Event	Probability value of event occurrence
A1 (overall)	Release of radionuclides into the environment	1.47×10^{-9}
C2	Breach of the integrity of the protective structure	0.000003
C1	Loss of container integrity during storage	0.00021
C2	Loss of container integrity during transport	0.00028
D1	Equipment falling onto a container during storage	0.00014
E4	Container falling from a height during transport	0.00021
E1	Human error during storage of radioactive waste containers	0.00011
E3	Human error during transport of a radioactive waste container	0.00011
D4	Equipment failure due to improper operation	0.000092

Since the probability of occurrence of an emergency situation is three orders of magnitude lower than 10^{-6}, according to the scoring system, the occurrence of an emergency situation due to internal technological causes is considered practically impossible.

To prevent a potential emergency situation, the following preventive measures are proposed:

1. Workers actions – implementation of a system of periodic briefings, retraining, training seminars, etc.
2. Short circuit – enhanced insulation of live electrical components, etc.
3. Work with equipment – use of various simulators to practice operational actions in order to prevent workers errors when operating equipment.
4. Failure of power supply systems – thorough inspection of equipment, both primary and auxiliary electrical equipment.

List of references

1. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 48 of 18 August 2022, Nuclear and Radiation Safety Rules and Regulations “Siting of nuclear material storage facilities, radioactive waste storage facilities, and radioactive waste disposal facilities”;
2. Resolution of the Ministry for Emergency Situations of the Republic of Belarus No. 70 of October 22, 2024, Nuclear and Radiation Safety Rules and Regulations «Nuclear Power Plant Site. Safety Requirements»;
3. BLR1.B.130.1.150705.&&&&&.075.HE.0001 Preliminary Safety Analysis Report of NIAEP JSC”. Belarusian Nuclear Power Plant, Unit 1, Chapter 15 “Accident Analysis”, Rev. 2, November 26, 2015;
4. BLR1.B.130.1.150705.&&&&&.075.HE.0001 Preliminary Safety Analysis Report of NIAEP JSC. Belarusian Nuclear Power Plant, Unit 1, Chapter 15 “Accident Analysis”, Rev. 2, November 26, 2015;
5. External Human-Induced Events in Site Evaluation for Nuclear Power Plants, Safety Guide No. NS-G-3.1, Vienna, 2004;
6. Berbegova M. A., “Assessment of Risk Indicators for the Second Stages of the Smolensk and Kursk NPPs”, PhD thesis (Candidate of Technical Sciences degree), Moscow, ANO MCYAB, 2015;
7. Belnipienergoprom RUE. Construction of a radioactive waste disposal and tinterim storage facility. Pre-project documentation. Environmental Impact Assessment materials. Section 13: Assessment of the impact of man-made emergency situations on RWDF operation. Book 1: Assessment of the impact of man-made emergency situations on RWDF operation at alternative Site 1-5. 2184-ППЗ-ОВОС 13.1. Volume 7.13.1. Minsk, 2026;
8. Environmental Safety Requirements in the Field of Atmospheric Air Protection (EcoNIP)17.02.06-001-2021 “Environmental Protection and Natural Resource Use. Rules for Environmental Impact Assessment”;
9. Lisichkin V. V., Bachelor’s thesis. Assessment of the Risk of Emergency Situations at a Radioactive Waste Disposal Facility. National Research Tomsk Polytechnic University, Tomsk, 2019.

10 ASSESSMENT OF POTENTIAL SIGNIFICANT ADVERSE TRANSBOUNDARY ENVIRONMENTAL IMPACT RESULTING FROM THE IMPLEMENTATION OF THE PLANNED ACTIVITY

In Section 7.8.3 of the EIA, it is substantiated that, as a result of design-basis and beyond-design-basis accidents, the AED for the population at a distance of 100 m from the RWDF is below 1 mSv and does not exceed the emergency response criterion of 100 mSv; therefore, no protective measures outside the site will be required.

According to the recommendations of the Republic of Lithuania [1], the EIA Report considers a severe beyond-design-basis accident scenario (catastrophic event) — the crash of a 400-ton aircraft.

The maximum impact on the population and the environment is expected in the event of the crash of a heavy aircraft with a take-off mass of 400 t. The impact factors of an aircraft crash accident were determined based on published data analysing the main accident processes associated with aircraft impact, implemented in the FIRE programs [2].

Conservatively, it is assumed that as a result of an aircraft crash onto the RWDF site, the area of the kerosene spill will be 9,032 m².

Taking into account the RWDF design [3], an aircraft crash may result in the Fire of the upper layer of N/Л зackages in one module.

The following assumptions were used in the modelling:

- crash of a 400-t aircraft carrying 70 t of fuel, resulting in Fire of the NZK containers;
- release height: 100 m [2];
- total activity released into the environment: 7.26×10^9 Bq.

The results of the assessment are presented in Table 10.1.

Table 10.1 – Total AED to the public resulting from the crash of a heavy aircraft (400 t) with subsequent fire of radioactive waste packages.

Distance from the source, km	AED excluding food consumption, mSv/year	AED for all exposure pathways, mSv/year
0.1	9.0×10^{-2}	7.1×10^{-1}
1.0	1.2×10^{-2}	9.4×10^{-2}
3.0	4.6×10^{-3}	3.8×10^{-2}
Nearest settlement: site 1-5 – 2.5 km site 2-1 – 1.0 km site 3-3 – 2.0 km	 5.4×10^{-3} 1.2×10^{-2} 6.0×10^{-3}	 4.4×10^{-2} 9.4×10^{-2} 5.3×10^{-2}

In the event of a heavy aircraft crash (400 ton) with fire of radioactive waste packages AED will be less than 1 mSv and not exceed the emergency response criterion of 100 mSv. The maximum AED to the public at a distance of 100 m from the release point will be approximately 0.71 mSv/year, and at a distance of 3 km it will be 0.038 mSv/year.

Therefore, no radiation protective actions will be required outside the site boundary.

An assessment of the dose and the dependence of the public dose on distance in the event of a heavy aircraft crash (400 ton) with fire of radioactive waste packages at the facility (RWDF) located on three selected sites was performed with regard to transboundary impact on the population of affected States.

The results of the assessment are presented in Table 10.2 and Figure 10.1.

Table 10.2 – AED at the borders of affected States in the event of a heavy aircraft crash (400 t) with fire of packages at the selected sites.

Country	Site 1-5		Site 2-1		Site 3-3	
	Distance, km	AED, mSv	Distance, km	AED, mSv	Distance, km	AED, mSv
Latvia	474	$4,2 \times 10^{-4}$	108	$1,5 \times 10^{-3}$	328	$5,8 \times 10^{-4}$
Lithuania	376	$5,1 \times 10^{-4}$	20	$6,7 \times 10^{-3}$	340	$5,6 \times 10^{-4}$
Poland	423	$4,6 \times 10^{-4}$	191	$9,3 \times 10^{-4}$	510	$3,9 \times 10^{-4}$
Ukraine	34	$4,2 \times 10^{-3}$	316	$6,0 \times 10^{-4}$	194	$9,2 \times 10^{-4}$

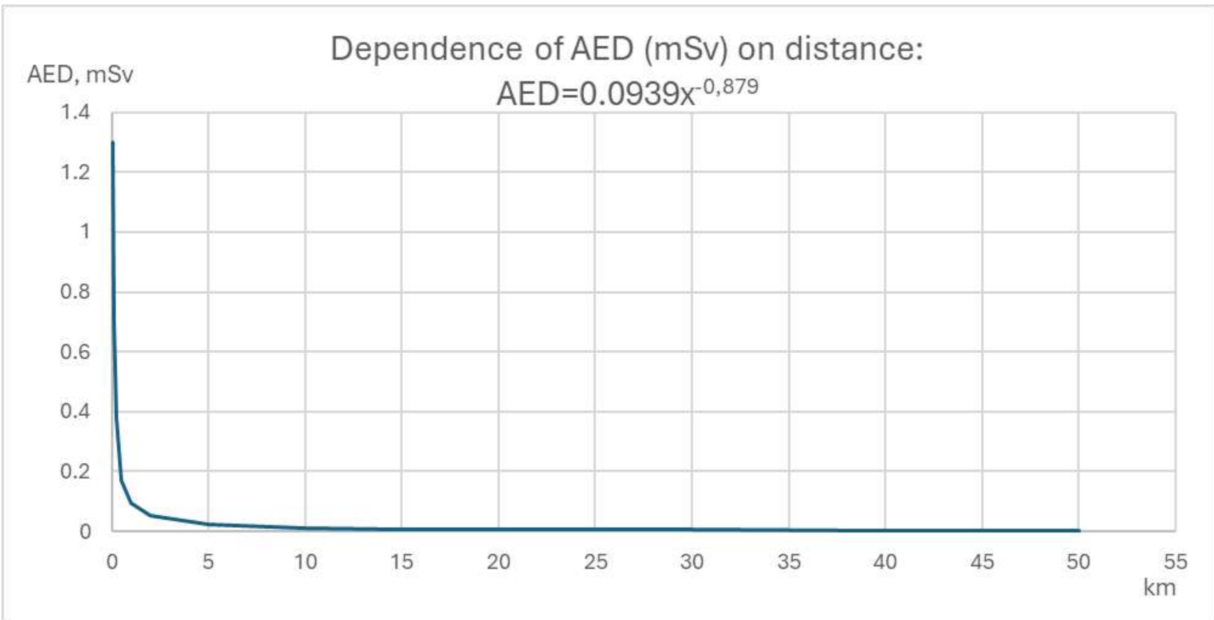


Figure 10.1– Dependence of AED on distance resulting from a heavy aircraft crash (400t)

At the borders of the affected States (Latvia, Lithuania, Poland, Ukraine), in the event of a heavy aircraft crash (400 t) with fire of radioactive waste packages at the selected RWDF sites, the AED to the public will be less than 1 mSv, which does not exceed the emergency response criterion of 100 mSv. Therefore, no radiation protection measures for the population of these countries will be required.

List of References

1. Ministry of Environment of the Republic of Lithuania No. 08(F)-117 dated January 9, 2026. On the EIA Program.
2. Damaging factors of an aircraft crash affecting territorial infrastructure. Accident prevention and safety. Science and safety. https://pamag.ru/pressa/predotvrashenie-avarii_sdanii.
3. Construction of a radioactive waste disposal and interim storage facility. Pre-project documentation. Section 1. General description 01260-000-000-OX. CPTI JSC, TVEL JSC. Moscow, 2025.

11 PROPOSALS FOR THE POST-PROJECT ANALYSIS (LOCAL MONITORING) PROGRAM

11.1 Operational Environmental Monitoring

Systematic operational environmental monitoring (hereinafter referred to as OEM) shall be carried out at the RWDF. For monitoring environmental components, it is envisaged either to establish an operational environmental monitoring laboratory or to engage third-party organizations on a contractual basis.

The purpose of monitoring is to observe the condition of the environment and to assess and forecast changes in environmental conditions under the influence of natural and anthropogenic factors.

Within the framework of the OEM Program, the following activities will be carried out:

- laboratory work, including various types of analyses and testing of samples collected from different environmental components;
- office-based work, including collection, processing, compilation, and analysis of information, as well as preparation of monitoring records and reports based on the monitoring results.

OEM for the RWDF includes monitoring of atmospheric air, surface water, groundwater, soil, radiation conditions, and waste generation and management.

The environmental and radiological monitoring program is developed taking into account the specific features of all stages of the RWDF life cycle.

Proposals for the environmental monitoring program during RWDF operation are presented in Table 11.1.

Table 11.1 – Proposed environmental monitoring program for the operational phase of the RWDF.

Object of control	Parameter	Monitoring point	Monitoring frequency
Acoustic impact	Noise level monitoring	Boundary of the sanitary protection zone (SPZ), nearest residential development	Once per year
Ambient air	Volumetric activity of alpha and beta aerosols in ambient air	Boundary of SPZ, nearest residential development	Once per year
	Radionuclide composition of radioactive substances in ambient air aerosols	Boundary of SPZ, nearest residential development	Once per year
	Pollutant chemical substances	Boundary of the SPZ, nearest residential development	Once per year
Soil cover, grass, snow	Sanitary-chemical indicators: nitrates, petroleum products, total iron	Within the SPZ of the facility	Once per year
	Specific activity (alpha, beta, gamma activity); gamma dose rate	Within the SPZ of the facility	Two times per year Once a year

Object of control	Parameter	Monitoring point	Monitoring frequency
Wastewater (combined discharge of domestic and stormwater runoff)	Chemical composition according to design solutions: biochemical oxygen demand over 5 days (BOD5), chemical oxygen demand (COD), synthetic surfactants (SPAV), ammonium ion, pH, suspended solids, petroleum products, chloride ion, sulfate ion, mineralisation, total nitrogen, total phosphorus	At discharge into the water body	once per quarter
	Radiological and environmental monitoring based on the radionuclide composition of radioactive waste delivered for processing to the RW processing facility (alpha, beta, gamma radiation)	At discharge into the water body	once per year and after elimination of an abnormal situation
Surface water body	Chemical composition according to design solutions: BOD5, COD, SPAV, ammonium ion, pH, suspended solids, petroleum products, chloride ion, sulfate ion, mineralisation, total nitrogen, total phosphorus	Background and control monitoring points	once per month
	Radiological and environmental monitoring based on the radionuclide composition of radioactive waste delivered for processing to the RW processing facility (alpha, beta, gamma radiation)	Ffter treatment, prior to discharge	Once per year, in the period after the end of the spring flood, and after the elimination of an abnormal situation
Groundwater	Chemical composition (mineralisation, pH, hardness, permanganate oxidizability, BOD, dissolved oxygen)	Observation wells	once per quarter
	Specific alpha and beta activity.		
	Measurement of		

Object of control	Parameter	Monitoring point	Monitoring frequency
	groundwater level in an observation well		
Production and consumption waste	Gamma dose rate	Non-radioactive waste collection site	Upon request
Waste delivered to the RWDF	Total volumetric alpha and beta activity	Unloading unit	Upon receipt

The OEM Program includes compliance by the enterprise’s departments with environmental legislation requirements and regulatory documents in the field of environmental protection, relating to:

- compliance with established impact standards for environmental components;
- compliance with environmental quality standards within the impact zone of the designed facility;
- implementation of environmental protection measures aimed at reducing anthropogenic pressure on the environment.

Objects of OEM include:

- sources of emissions of pollutants into ambient air;
- sources of discharges of pollutants into sewage systems and wastewater networks;
- wastewater treatment systems;
- recirculating water supply systems;
- sources of industrial waste generation;
- waste storage and disposal facilities;
- warehouses and storage facilities for raw materials, materials, reagents, etc.

OEM is carried out by the enterprise itself in order to ensure compliance, during economic and other activities, with environmental legislation requirements and established environmental protection standards, as well as for self-monitoring of the rational use of natural resources and implementation of measures aimed at limiting and reducing environmental impacts.

PEC is carried out by the enterprise itself in order to ensure compliance, in the course of economic and other activities, with environmental protection legislation requirements and established environmental standards, as well as for self-monitoring of the rational use of natural resources and implementation of measures aimed at limiting and reducing environmental impacts.

Post-operational period

During the post-operational period, groundwater monitoring is envisaged, which includes:

- checking for the presence of water in the cells via observation pipes using a portable endoscope and a moisture sensor;
- visual inspection of engineered barriers and preserved (mothballed) equipment.

11.2 Hydrogeological Monitoring

The migration of contaminants within an aquifer depends on a combination of diverse factors that cannot be fully accounted for through theoretical modelling and laboratory experiments. This increases the importance of the results of field investigations.

In accordance with the recommendations, pilot monitoring sites may be established within areas of potential contamination. These sites may include an observation network for studying the groundwater regime, tracking changes in hydrochemical conditions, and detecting the movement of the contamination plume.

To predict possible changes in hydrogeological conditions, including waterlogging, and to assess the impact of such changes on the geological environment in connection with the construction and operation of the RWDF, the results of long-term hydrogeological observations (groundwater monitoring) at the RWDF site and in the surrounding area are required. Monitoring should commence prior to the start of construction works and continue throughout the construction phase and after its completion. The monitoring area should extend beyond the RWDF construction site and be defined by natural landscape and geographical boundaries.

For Site 2-1, the boundaries of the monitoring area may be defined by the Viliya River to the north and east and the Gozovka River to the west. South of the RWDF site, it is advisable to use monitoring stations from the monitoring network of the Belarusian Nuclear Power Plant. The proximity of the potential RWDF site to the Belarusian Nuclear Power Plant site, where geological and hydrogeological conditions are similar and have been studied in detail, is considered a favourable factor. It is recommended, to the extent possible, to make full use of monitoring data on the migration of contaminants under similar hydrogeological conditions in the vicinity of the Belarusian Nuclear Power Plant site. It is also recommended to supplement the monitoring network at the Belarusian Nuclear Power Plant site with additional observation wells during the construction of the RWDF at Site 2-1. Systematic hydrogeological observations directly at Site 2-1 and in its surrounding area were initiated in 2025 by the State Enterprise "GEOSERVICE".

For Site 3-3, the boundaries may be defined by the Chernaya Natopa River to the south and west and the Belaya Natopa River to the north and east.

For Site 1-5, the boundaries may be defined by the Vit River to the west and a system of canals south of the site. East of the site, monitoring points should be placed close to its boundary on the side of the village of Novoselki. It is also advisable to include sampling of water from wells and boreholes (if available) in the villages of Novoselki and Dvorishche in the monitoring program. North of the site, monitoring points may be located along its boundary on the side of the town of Khoiniki.

In the future, it is recommended to:

- ensure continuity of these observations;
- after the design organisation defines the locations of RWDF buildings and structures, adjust and expand the network of hydrogeological observation wells;
- take measures to ensure the long-term preservation of the observation network.

During groundwater monitoring, the following should be controlled:

- groundwater levels and temperature;
- chemical composition and contamination of groundwater;
- radiological contamination of groundwater.

The following parameters should also be included among the controlled (measured) parameters during long-term observations:

- mean groundwater levels;
- maximum and minimum groundwater levels;
- amplitudes of groundwater level fluctuations;
- deviations of maximum and minimum levels from the long-term mean value;
- seasonal occurrence and duration of high groundwater levels.

Part of the monitoring wells should be located outside the RWDF site, along groundwater flow directions, in order to observe the condition of water flowing away from the RWDF footprint.

During the construction and operational phases, at least all aquifers of Quaternary deposits should be subject to monitoring. The frequency of measurements and sampling may be higher in the upper aquifers and lower in the deeper aquifers.

Since shallow aquifers (primarily groundwater) play a major role in the recharge of small rivers in the area and are easily susceptible to contamination, monitoring of surface water contamination in these watercourses is required as an additional indicator of possible leaks from RWDF structures. The surface water monitoring zone should include sampling points located on the watercourses closest to the RWDF.

In order to prevent deterioration of the properties and characteristics of foundation soils, over-saturation should be avoided. In this regard, during construction and after its completion, it is recommended to additionally organise monitoring of the development of wetting and waterlogging processes (occurrence, spatial distribution, patterns of manifestation, affected area, etc.) and of the effectiveness of the drainage system at the RWDF site and in the adjacent area.

The following should be provided for:

- monitoring of the development of perched water, technogenic groundwater horizons, and other hydrogeological conditions conducive to waterlogging (at key locations);
- assessment of the aggressiveness of perched water and technogenic groundwater horizons;
- assessment of the impact of surface water infiltrating into soils at the site on the composition and aggressiveness of groundwater;
- monitoring of the effectiveness of drainage systems (if present).

Decisions on the number and placement of observation wells should be made after the specific locations of the planned RWDF buildings and structures and their technical characteristics have been defined.

To refine estimates of the migration rate of contaminants (movement of the contamination plume), groundwater observation wells should be located near potential sources of contamination as well as outside the RWDF site.

The depth of the wells will be determined in accordance with the depth of occurrence of the monitored aquifers and groundwater bodies at each specific monitoring location.

During the construction period, the recommended frequency of observations and groundwater sampling is at least once every three months.

During the operational period, it is recommended that observations and sampling be carried out at a frequency of at least once every six months. If significant changes or deviations from the established patterns and trends of the monitored parameters are identified, the frequency of observations and sampling should be increased, depending on the suspected causes. Observations at an increased frequency should be continued until a new hydrogeological and hydrochemical regime is established, the causes of the changes are identified, or the monitored parameters return to their baseline values.

11.3 Geotechnical Monitoring

The monitoring programme and subsequent activities carried out under it shall be developed and performed by a specialised organisation or under its scientific and methodological supervision.

During excavation of pits, construction of foundations, as well as erection of buildings and structures, changes in the properties of foundation soils may occur. In turn, changes in the strength and deformation properties of soils affect the rate and magnitude of settlements of buildings and structures.

Since the most reliably standardised and accurately measurable parameter is the settlement of building and structure foundations, it is proposed to carry out mandatory geotechnical monitoring of deformations of RWDF structures using geodetic methods.

Within the geotechnical monitoring programme, the following main areas are recommended.

1. Assessment of the moisture dynamics of foundation soils of RWDF buildings and structures.

For soil moisture monitoring, stationary moisture sensors may be used, installed in the ground at pre-defined control depths (monitoring points). If necessary, the moisture sensors will allow assessment of the effectiveness of the drainage system.

2. Monitoring of the stress dynamics and deformations of foundation soils of RWDF buildings and structures.

During construction and subsequent filling of the RWDF, as the load on the foundation soils increases, continuous monitoring of actual stresses in the soils, vertical and horizontal deformations of the natural foundation and engineered barriers, as well as foundations and structures, is required. For this purpose, it is recommended to provide integrated monitoring, including the use of the following equipment:

- stationary pore pressure sensors;
- soil stress sensors;
- soil pressure sensors;
- extensometers;
- in-place inclinometer systems.

Control sections and monitoring points should be designated after determining the locations of structures, loads on the soils, as well as in areas of expected abrupt changes in loading conditions.

The equipment shall be installed:

- prior to and during construction — in the foundation soils;
- during construction — in the clay engineered barrier, foundations, and structures.

Due to potential radiological hazards, as well as the need to carry out monitoring in inaccessible locations, the equipment shall ensure remote data transmission capability and autonomous operation.

If measurements indicating excessive deformations or their potential precursors are recorded, including a sharp increase in pore pressures, etc., construction works or radioactive waste emplacement activities shall be suspended until the causes are identified and the necessary corrective measures are developed.

3. Monitoring of surface deformations at key areas and/or RWDF structures. This may be carried out using periodic cycles of terrestrial laser scanning, including the use of UAVs and other methods.

Geodetic observations of movements and deformations of foundations, base soils, as well as buildings and structures erected on them, shall be carried out according to a special programme prepared by the organisation performing the measurements on the basis of the assignment.

Settlement of foundation bases shall be measured by geometric, trigonometric, and hydrostatic levelling. The accuracy class of the measurements and the method of work shall be determined by the required accuracy of the resulting data.

Measurements of deformations of foundation soils and foundations of buildings and structures under construction shall be carried out as part of geotechnical monitoring throughout the entire construction (or reconstruction) period and during the operational phase until conditional stabilisation of deformation processes is achieved, but for not less than 1 year after completion of construction. Criteria for assessing the stabilisation of settlements and deformations shall be established by the design organisation and included in the assignment. Monitoring of deformations and displacements of buildings and structures in operation shall be carried out in the event of the appearance of cracks, opening of joints, as well as significant changes in the operating conditions of a building or structure.

4. Monitoring of recent crustal movements. This is currently being carried out in the vicinity of the Belarusian Nuclear Power Plant. It is recommended to perform periodic observations near the RWDF site using a similar methodology, with comparison of the obtained results with those from the Belarusian Nuclear Power Plant monitoring. In the case of selecting Site 2-1, the monitoring areas for the Belarusian Nuclear Power Plant and the RWDF may be considered as a single monitoring polygon.

Monitoring of recent crustal movements (hereinafter referred to as RCM) includes activities for determining the horizontal and vertical components of movements.

The use of modern satellite geodetic technologies (GPS measurements) for determining the position of points at different time periods subsequently makes it possible to determine horizontal displacement components with millimetre-level accuracy. Space geodesy methods are an order of magnitude more accurate than measurements performed using classical geodetic techniques. They allow observations at remote points without requiring intervisibility, are characterised by high metrological performance, all-weather capability, and advanced data processing software.

Coordinates of geodetic control points are determined using geodetic satellite GPS receivers.

Monitoring of RCM (vertical component of movements): observations of vertical crustal movements within the RWDF area are carried out using high-precision Class I repeated levelling.

The influence of hydrogeological, hydrological, and meteorological conditions and factors on the state and behaviour of the monitored foundation elements, as well as on the integrity of structures and protective barriers, shall be monitored at a frequency specified by the monitoring programme throughout the entire service life of the RWDF.

During decommissioning of the facility, the requirements of SN 1.02.01-2019 or an equivalent technical regulatory legal act (TNPA), as well as other applicable special TNPAs in force at that time, shall be observed. The scope and extent of the works will be determined by the technological solutions for decommissioning the facility, further management of radioactive waste, and the functional use of adjacent territories.

11.4 Seismological Monitoring

Within the seismological monitoring programme, the following main areas are recommended:

1. Seismological monitoring

The implementation of seismological monitoring consists of the following stages:

– organisation of a seismological monitoring system consisting of a local network of observation stations located within a 30 km zone from the potential RWDF site. At the RWDF lifecycle stages, the local network should optimally include at least 7 observation stations, using buried or borehole installation of seismic sensors. During the pre-design investigation phase, it is acceptable for the network to include at least 5 observation stations;

– conducting seismological observations at all stages of the design, construction, and operation of the RWDF, including observations that shall be carried out for at least 12 months prior to the start of construction; i.e., at least 5 seismic stations shall perform monitoring for no less than 12 months before construction begins;

– control of the operability and maintenance of monitoring equipment;

– processing and interpretation of original records of seismic events (seismograms). Practice has shown that one seismic station records at least 2 seismic events (records) per day; thus, the minimum volume of recorded events in the monitoring system over one month is at least 300 (5 stations × 30 days × 2 records), and optimally not less than 420 (7 stations × 30 days × 2 records);

– spatial localisation of event sources and determination of their energy parameters;

– preparation of bulletins and protocols of seismological observations;

– creation and maintenance of seismological monitoring databases;

– discrimination (classification) of natural and anthropogenic seismicity (e.g., indstrial explosions) based on established criteria for determining their origin;

– assessment of the detection threshold sensitivity for recording seismic events at different ranges of epicentral distances and energy levels, and analysis of the representativeness of these events in the catalogue;

– analysis of the spatial and energy structure of seismic event occurrence over time;
– compilation of an event catalogue.

2. Seismotectonic works

These are carried out on the basis of data obtained during seismological monitoring. The works consist of the following stages:

– refinement of the general seismic zoning of the site region (300 km) and detailed seismic zoning of the near-field area (30 km) within a 30 km radius of the site;

– preparation and refinement of a consolidated unified catalogue of historical and instrumentally recorded earthquakes in the region and near-field area of the site;

– preparation of an earthquake epicentre map;

– identification and/or refinement of active seismotectonic structures and maps of earthquake source zones (ESZ) at scales of 1:500,000 and 1:50,000 for regions with R = 300 km and R = 30 km, using the full available dataset and applying criteria for delineating ESZ.

12 JUSTIFICATION OF THE PREFERRED OPTION FOR THE LOCATION AND/OR IMPLEMENTATION OF THE PROPOSED ACTIVITY

The analysis of studies related to site selection takes into account the assessment of engineering-geological conditions, as well as social, resource-related, logistical, and a number of other safety factors.

The identified alternative sites are characterised by the absence of exclusionary factors and by a minimal number of natural factors unfavourable for the siting of the RWDF, as specified in Resolution No. 48 of the Ministry of Emergency Situations [1].

According to Order No. 49 of October 22, 2023 of the Department for Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus [2], during the site selection stage for a near-surface radioactive waste disposal facility, it is recommended that, from among the preliminarily selected sites, those territories suitable for further investigation be identified [1].

At the preliminary stages of the investigations, analysis of archival and repository data of the Republic of Belarus relating to geological, geophysical, tectonic, hydrogeological, climatic, and meteorological conditions identified, at a number of the candidate sites under consideration. On this basis, these sites were excluded from further consideration and were not subjected to detailed investigation.

As a result of the screening based on exclusion criteria [1], three suitable candidate sites were selected for detailed investigation:

- Site 1-5 in the Khoiniki District;
- Site 2-1 in the Ostrovets District;
- Site 3-3 in the Mstislavl District.

The proposed methodology [2] envisages a comparative analysis of suitable sites using a ranking method in order to support decision-making on the selection of the optimal site for the RWDF. The procedure is carried out in accordance with the description provided in the subsection “Implementation of the site ranking method for the purpose of selecting suitable sites for the RWDF” of Section 3.3 “Determination of RWDF site characteristics” of the Nuclear and Radiation Safety Guidance “Site Selection for a Near-Surface Radioactive Waste Disposal Facility” [1].

According to studies conducted by the Scientific Institution “Sosny Joint Institute for Power and Nuclear Research”, based on an expert assessment of the significance of criteria and their attributes in accordance with Order No. 49 of 22 October 2023 of the Department for Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus, as well as IAEA recommendations and regulatory legal acts (NPA) and technical regulatory legal acts (TNPA) of the Republic of Belarus and the Russian Federation, six main criteria were identified for selecting the priority site:

Criterion 1 – “Infrastructure criterion”;
Criterion 2 – “Political criterion”;
Criterion 3 – “Economic and logistical criterion”;
Criterion 4 – “Social criterion”;
Criterion 5 – “Barrier properties of the geological environment”;
Criterion 6 – “Impacts of natural and anthropogenic origin”.

These criteria will be taken into account in selecting the final site for the RWDF. The selection of the model of the planned activity implementation takes into account the ISAM methodology, an international IAEA project on Improvement of Safety Assessment Methodologies for Near Surface Disposal Facilities.

The development of evaluation criteria for selecting the preferred option in the impact assessment process is carried out through a critical analysis of the project's resource components across the facility's life cycle stages, as well as indirect safety requirements, including environmental ones. For RWDF complexes, the set of expert evaluation criteria is proposed to be based on the ALARA principle (As Low As Reasonably Achievable) and data on international experience in site selection for RWDF construction [3], namely:

Criterion 1 – distance from the site to the nearest settlements, m;

Criterion 2 – population within a 3 km radius;

Criterion 3 – distance to hydrological network features, m;

Criterion 4 – absence of specially protected natural areas and cultural heritage protection zones within a 5 km radius;

Criterion 5 – number of hazardous facilities within a 5 km radius;

Criterion 6 – availability of transport infrastructure and distance to it, km, as well as its capacity (number of lanes in one direction);

Criterion 7 – average distance to sources of radioactive waste generation (accumulation), km;

Criterion 8 – land allocation area, km^2.

The selection of criteria is based on resource-logistical principles taking into account the entire facility life cycle, including possible waste processing and subsequent decommissioning of the storage facility, as well as principles of environmental safety and the influence of neighbouring facilities (enterprises) on the RWDF complex. It also considers the high requirements for the quality of works (operations) performed at all stages of the facility life cycle, which are established by relevant professional standards, thereby placing safety requirements in the foreground, prevailing over socio-economic site selection criteria.

For the selection of the preferred RWDF siting option, a comparison of alternative sites based on natural and anthropogenic conditions has been carried out.

Table 12.1 – Comparative characteristics of alternative RWDF siting options

Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
Population within a 3 km radius	220 people	324 people	29 people
Distance from the site to the nearest settlements, km	Aveny village (8 residents), distance less than 1 km	Volovniki village (29 residents), distance 1 km	Novoselki village (29 residents), distance 1 km
Distance to hydrological network features, m	Located at the watershed divide of adjacent water bodies, approximately 8–10 km from the channel of the Viliya River and 2.0–2.5 km from the channels of the Gozovka and Polpe rivers.	Located at the watershed divide between the Chyornaya Natopa River and its left tributary, the Chernotopka River, approximately 0.8 km from the channel of the Chyornaya Natopa River and 1.0 km from the channel of the Chernotopka River see Figure 4.1). The Sorochinka and Mertvitsa rivers are situated on the opposite (right-bank) side of the Chyornaya Natopa catchment, at a distance of about 2 km.	Located in the lower reach, within the left-bank watershed portion of the Vit River basin, approximately 5 km southeast of the river channel.
Number of hazardous facilities within a 5 km radius	1 (Belarusian Nuclear Power Plant)	1 (Zabolotye-Agrostandart OJSC)	1 (PSRES)
Absence of specially protected natural areas and cultural heritage protection zones within a 5 km radius	1. The Vileika ecological corridor of international importance (CE2) is located 1.4 km northwest of the site boundary. 2. The Naroch ecological core area of international importance (CE6) is located 4.2 km northeast of the site boundary. 3. The Soročansky Lakes protected area of national importance is located 4.2 km northeast of the site boundary.	None	A botanical natural monument of local importance “Dubrava” is located 1.5 km south of the site boundary.
Availability of transport infrastructure and distance	Highway P-45 Polotsk–Glubokoye–Lithuanian Border	Highway N-10827 Krichev–Khodosy–Kurmanovo–Rubanovka (0.2 km from the	Highway N-4581 Khoiniki–Tulgovichi (1.7 km from the

Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
thereto (km), as well as its capacity (number of lanes in one direction)	(Kotlovka) (0.2 km from the RWDF boundary). Road Category IV; 2 traffic lanes; lane width 3 m; asphalt concrete pavement	RWDF boundary). Road Category IV; 2 traffic lanes; lane width 3 m; asphalt concrete pavement	RWDF boundary). Road Category IV; 2 traffic lanes; lane width 3 m; asphalt concrete pavement
Average distance to the principal source of radioactive waste generation (State Enterprise “Belarusian Nuclear Power Plant”), km	5.9 km	491.5 km	585.3 км
Specific economic valuation of biodiversity ecosystem services, BYN/100 ha	3646425.76 Rubles	112112.71 Rubles	871105.93 Rubles
Wind rose	During the cold season (autumn–winter), south-western (17–23%), southern (18–23%), and western (15–18%) winds predominate. During the warm season, the frequency of south-western winds increases to 17–19% and that of western winds to 19–22%.	In winter, winds from the south-western sector predominate, with a frequency of 50–53%. The summer season is characterised by the predominance of north-western and western winds, with a combined frequency of 31–36%.	In winter, southern, south-western, and western winds prevail (S, SW, W together account for 48%). In summer, western and north-western winds are most developed (W and NW: 19% each; N: 12%; NE: 10%).
Tectonic conditions			
Crustal type	A	AB	BC
Depth to crystalline basement rocks, m	480 – 500	1400	1200
Distance to the nearest deep regional tectonic fault, km	45 – 50	85	10
Presence of neotectonically active zones identified by other investigation methods	Not identified	Not identified	Not identified
Identification of geotectonic faults based on investigations	Not identified	Not identified	Not identified

Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
carried out in 2024–2026			
Identification of exclusionary geotectonic factors for RWDF siting	Not identified	Not identified	Not identified
Seismic conditions			
Maximum design earthquake with a recurrence period of 10,000 years, intensity (MSK scale)	7	5	6
Maximum calculated intensity from a potential seismic event in the nearest possible earthquake source zone, intensity (MSK scale)	5	4	6
Maximum calculated intensity from a potential seismic event in the Vrancea zone, intensity (MSK scale)	5	5	6
Distance to the nearest earthquake source zone (ESZ), km (according to IAEA recommendations, not less than 5 km)	30	12	0 – the site is located within the North Pripyat ESZ zone
Soil category according to seismic properties	II	II	II
Design earthquake (DE), intensity (MSK scale)	6	4	5
Geomorphological conditions	It is located within the Vileika Lowland of the West Belarus subregion of the Central Belarusian uplands and ridges	It is located within the Horki Plain. The surface of the plain is flat and undulating. The site relief is gentle and slightly hilly. Slopes are moderately gentle and gently	It is located within the geomorphological region of the Khoiniki Lowland of the Polesia Lowland. The main part of the

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Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
	area. The main relief features of the region include the Viliya River valley, the flat-undulating Vileika plain, and moraine uplands — the Svir and Oshmyany elevations.	inclined, with gradients of 1–3°. The overall surface gradient is directed to the south and south-west: absolute elevations decrease towards the valley of the Chyornaya Natopa River from 197 to 177 m.	site area is occupied by a gently undulating moraine plain, characterised by a flat terrain, locally slightly undulating or finely hilly, formed by the Pripyat (Dnieper) glacial sheet. Absolute ground elevations range from 138 to 150 m; the surface is gently inclined from south to north.
Age and composition of pre-Quaternary deposits (to a depth of 100 m)	Neogene deposits – sands, sandy loams, loams, clays with organic matter admixture. Underlain by Silurian semi-rock and rock dolomites and marls.	Cretaceous system deposits – clayey chalk, marl, sands. Underlain by Jurassic deposits – silty (silt) and clay formations (clays, loams).	Cretaceous system (K) – lower substage deposits are represented by terrigenous rocks (clays, silts, siltstones, sands, sandstones), upper substage by carbonate rocks (marl, chalk). Occur at depths of 70–150 m, thickness 50–290 m. Paleogene system (Pg) is represented mainly by clays, siltstones, silts, sands, sandstones.
Depth to the top of pre-Quaternary deposits	Neogene deposits are encountered at a depth of 90.7 m. Underlain by Silurian deposits.	Cretaceous deposits are encountered at a depth of approximately 40–43 m.	Encountered at a depth of 47 m.
Occurrence pattern of the top of pre-Quaternary deposits	Sub-horizontal, with elevation amplitude up to 6.0 m (according to archival engineering survey data for the Belarusian NPP construction)	In the southern part of the site, the pre-Quaternary (Cretaceous) deposits lie closer to the ground surface than in the northern part (Jurassic deposits).The amplitude of absolute elevations of the top of Cretaceous deposits is about 1.8 m. The top of Jurassic deposits is sub-horizontal.	The top of the pre-Quaternary deposits is sub-horizontal.

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Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
Composition of Quaternary deposits	Morainic and fluvioglacial deposits: sands of varying grain size with lenses and interlayers of clayey soils; sandy loams and loams with gravel–pebble material and lenses and interlayers of sands; clays. Rarely – gravel soils (below 30 m depth).	Loess-like loams, morainic and fluvioglacial deposits: sands of varying grain size with lenses and interlayers of clayey soils; sandy loams and loams with gravel–pebble material, with lenses and interlayers.	Berezina–Dnieper undivided horizon-glaciofluvial intermorainal (f, lgIbr–IId) deposits: silty sands; Dnieper horizon. Glaciofluvial supramorainal deposits (f, lgIIdS)–predominantly fine, fine to medium, and clayey sands. Glacial till deposits (gt II d)–fine sands, less commonly silty sands, and medium sands.
Thickness of Quaternary deposits, m	79.2-92.6	41.5 (in the area of Cretaceous deposits occurrence) – 84.0 (in the area without Cretaceous deposits	Sown to depth of 47m (absolute elevation 94.18 m)
Specific soils	Not identified	Loams and loess-like sandy loams, occurring over most of the site beneath the soil–flora layer, with a thickness of 0.6–3.7 m	Not identified
Modern geological processes	Not observed	Suffosion processes in local areas	Not observed
Foundation conditions for main structures	Posibility of constructing main structures on a natural foundation	Presence of soils with a deformation modulus E < 20 MPa; replacement of soils with low strength characteristics may be required	Presence of soils with a deformation modulus E < 20 MPa; replacement of soils with low-strength characteristics may be required
Hydrogeological conditions			
General data	The Sogozh moraine aquifer (gt IIsž) (groundwater) occurs throughout the Site 2-1. The aquifer is mainly unconfined, with confined conditions occurring locally. The hydraulic head reaches 12.0 m. It occurs at a depth of 9.8 m. Static (piezometric) levels are recorded at	Dnieper–Sogozh aquifer water–glacial complex (f, lg IId–sž). It occurs throughout the area. The aquifer is of mixed confined–unconfined type. Static (piezometric) levels are observed at depths of 3.2–15.6 m (absolute	Berezin–Dnieper aquifer water–glacial complex, confined–unconfined. Encountered at a depth of 12.4–25.2 m (absolute elevations 115.98–120.91 m). In borehole 38, the piezometric level is established at a depth of

Orig. Inv. No.	Signature and Date	Repl. Inv. No.

Criterion	Site 2-1 (Ostrovets District)	Site 3-3 (Mstislavl District)	Site 1-5 (Khoiniki District)
	depths of 9.8–13.4 m. Absolute elevations of static (piezometric) levels range from 162.88 m to 164.77 m. Groundwater flow is directed northwest towards the Viliya and Gozovka rivers. The hydraulic gradient is 0.0016. The site 2-1 is located on a watershed divide. Recharge occurs through infiltration of atmospheric precipitation, while discharge occurs via leakage to underlying aquifers and lateral drainage into surface watercourses (Viliya and Gozovka rivers).	elevations 166.34–176.37 m). The hydraulic head reaches 7.7 m. The depth to the top of the aquifer varies from 5.9 to 22.1 m across the site. Groundwater flow is directed southwards towards the Chyornaya Natopa River.	20.2 m (absolute elevation 120.98 m). Hydraulic head is 5.0 m. Water-bearing soils are silty, fine, and medium sands. The upper aquitard consists of glacial till and morainic sandy loams and loams. In borehole 38, the lower aquitard (Paleogene clayey soils) was encountered at a depth of 47.0 m; the thickness of the unit is 21.8 m. The assumed direction and gradient of flow, according to archival data, are oriented towards the south-west.
Lower aquitard	Morainic sandy loams and loams of the Sogozh horizon, 17.5–38.9 m thick	Morainic sandy loams and loams of the Dnieper horizon, 3–21 m thick	The lower aquitard (Paleogene clayey soils) was encountered at a depth of 47.0 m
Water aggressiveness	Waters are non-aggressive to concrete of any water-resistance grade and moderately aggressive to metal structures	Waters are non-aggressive to concrete of any water-resistance grade and moderately aggressive to metal structures.	Waters are non-aggressive to concrete of any water-resistance grade and moderately aggressive to metal structures
First confined aquifer from the ground surface	Dnieper–Sogozh water-glacial aquifer complex. Occurs at depths of 41.3–54.5 m. Piezometric levels are observed at depths of 21.27–32.87 m. Hydraulic head is 9.0–10.0 m	Dnieper–Sogozh water-glacial aquifer complex	Berezin–Dnieper water-glacial aquifer complex, confined–unconfined
Assumed hydraulic relationship between aquifers	Groundwater flow is downward. The aquifers and aquifer complexes are hydraulically interconnected	Groundwater flow is downward. The aquifers and aquifer complexes are hydraulically interconnected	The Berezin–Dnieper aquifer complex is hydraulically connected to the supramorainic water-glacial deposits.

Rev. | Qty | Sheet | Doc n | Signature | Date

2184-ПП3-ОВОС-ТЧ

12.1 Justification of the Preferred Radioactive Waste Disposal Method

Section 4.1 provides a detailed consideration of the technological alternatives for the implementation of the proposed activity.

The following are subject to interim storage:

- solid radioactive waste, including solidified liquid radioactive waste of Class I radiation hazard, after preliminary decay storage in order to reduce heat generation to values established by the radioactive waste acceptance criteria for disposal;
- solid radioactive waste, including solidified liquid radioactive waste of Class II radiation hazard, containing radionuclides with a half-life of more than 31 years, without prior decay storage for the purpose of reducing heat generation;
- disused sealed radioactive sources of the first and second categories by radiation hazard.

The following are subject to disposal in near-surface radioactive waste disposal facilities located at depths of up to 100 metres, without prior decay storage for the purpose of reducing heat generation:

- solid radioactive waste, including solidified liquid radioactive waste of Class II radiation hazard, with a half-life of not more than 31 years;
- solid radioactive waste, including solidified liquid radioactive waste of Class III radiation hazard, containing radionuclides with a half-life of more than 31 years;
- disused sealed sources of ionizing radiation of the third category by radiation hazard.

The following are subject to disposal in near-surface radioactive waste disposal facilities located at ground level, without prior decay storage for the purpose of reducing heat generation:

- solid radioactive waste, including solidified liquid radioactive waste of Class III radiation hazard, with a half-life of not more than 31 years;
- solid radioactive waste, including solidified liquid radioactive waste of Class IV radiation hazard;
- disused sealed sources of ionizing radiation of the fourth and fifth categories by radiation hazard.

As noted above, regulatory documents define near-surface disposal for short-lived intermediate-level waste (ILW-SL), low-level waste (LLW), and very low-level radioactive waste (VLLW).

In addition, non-fragmentable radioactive waste will be disposed of. Long-lived Class II radioactive waste is planned to be stored at the site above ground level.

12.2 Conclusions

1. Based on a comparative analysis of natural and additional conditions characterising the alternative sites for RWDF siting, compliance of each of the specified sites with the requirements has been determined.
2. The proposed preliminary RWDF design complies with the requirements of the regulatory documents of the Republic of Belarus regarding the placement of radioactive waste relative to ground level.
3. In accordance with the legislation of the Republic of Belarus, it is planned to take a decision by the Council of Ministers of the Republic of Belarus regarding the RWDF siting and design after the completion of the EIA procedure and the receipt of a positive conclusion from the state environmental expertize group. The powers of the Council of Ministers of the Republic of Belarus are defined by Law of the Republic of Belarus No. 208-Z dated October 10, 2022, "On Safety Regulation when Using Atomic Energy."

List of References

1. Resolution of the Ministry of the Republic of Belarus No. 48 dated August 18, 2022 “On approval of the norms and rules for ensuring nuclear and radiation safety”;

2. Order of the Department for Nuclear and Radiation Safety of the Ministry for Emergency Situations of the Republic of Belarus No. 49 dated October 22, 2023;

3. Pankratov N.S., Belov V.V. Site selection for the construction of radioactive waste disposal facilities // Bulletin of the Peoples’ Friendship University of Russia. Series: Engineering Research. 2020. Vol. 21, No. 1. pp. 36–47. http://dx.doi.org/10.22363/2312-8143-2020-21-1-36-47.

13 ASSESSMENT OF THE RELIABILITY OF PREDICTED IMPACTS OF THE PROPOSED ACTIVITY AND UNCERTAINTIES IDENTIFIED DURING THE EIA PROCESS

The identification of potential impacts of the proposed economic and other activities on the environment is a complex process that includes comprehensive research, analysis, and documentation of the information required for decision-making; therefore, certain uncertainties may arise during the impact assessment process.

The uncertainty of environmental impact assessment for the proposed activity is a multifactor quantity resulting from a combination of individual probabilistic variables and errors arising from the use of diverse and time-varying data within the assessment system.

Since such facilities are designed for long-term operation, standard forecasting methods are supplemented by specific tools.

To assess the impacts of the planned activity on the population and the environment, verified methodological software tools were used in this study. The input data were based on long-term environmental monitoring results within the National Environmental Monitoring System.

For characterization of the natural conditions at the alternative RWDF sites, a set of field and research studies was carried out in compliance with the requirements of the regulatory documents of the Republic of Belarus.

In the present case, the most important factors (groups of factors) determining the level of EIA uncertainty are:

1. the reliability of monitoring data and industrial environmental control data;
2. uncertainty in assessing changes in the probability of occurrence of a given accident;
3. uncertainty in the assessment of long-term risks to the environment and human health associated with exposure factors.

The first of the above-mentioned factors (or groups of factors) contributing to uncertainty can be assessed with a certain degree of approximation, as the measurement error associated with the main types of measurements used to determine the level of contamination of environmental components, carried out in accredited laboratories using certified methods. In most cases, such error does not exceed 20%.

The environmental impact assessment included in the present documentation was carried out for all environmental components using a conservative approach, i.e., based on the most pessimistic assumptions.

Uncertainty in the assessment of risks to the environment and human health associated with exposure factors can be mitigated and taken into account through the analysis of subsurface condition monitoring data during the RWDF operation stage, as well as through continuous updating of input data for recalculation and modelling of long-term safety. It is also stated in

IAEA Publication 1449 2.11 that: “During normal operation of a radioactive waste disposal facility, no releases of radionuclides are expected or only very minor releases (such as small amounts of gaseous radionuclides) may occur, and therefore there will be no significant radiation doses to members of the public.” Even in the event of an accident involving damage to the integrity of waste packages at a disposal facility site, it is considered unlikely that any releases would have radiological consequences beyond the facility boundary (p. 14).

Within the system of existing uncertainties, the environmental impact assessment of the proposed activity should be considered satisfactory.

14 CONDITIONS FOR FACILITY DESIGN TO ENSURE ENVIRONMENTAL SAFETY OF THE PROPOSED ACTIVITY

The design of an RWDF requires strict compliance with environmental safety requirements established by legislation in the field of the use of nuclear energy and environmental protection. The main objective is to protect the population and the environment from radiological and anthropogenic impacts at all stages of the facility life cycle.

Key design conditions:

- safety justification**:** The design documentation shall include predictive calculations for assessing the safety of the disposal system over the entire period of potential hazard of the waste;
- multiple barrier protection: safety is ensured through a system of physical barriers (engineered and natural geological formations) that prevent the migration of radionuclides;
- site selection: mandatory investigation of tectonic, seismic, hydrogeological, and climatic conditions of the area. The site shall be stable against external natural and anthropogenic impacts;
- EIA and environmental protection development: the project is subject to mandatory environmental impact assessment (EIA), and at subsequent stages the design documentation shall include an “Environmental Protection” section;
- acceptance criteria: the project establishes requirements for the characteristics of radioactive waste packages (radionuclide composition, physical state) acceptable for disposal in this type of RWDF.

Environmental protection measures included in the project:

Radiation monitoring

Establishment of the scope, methods, and automated monitoring systems for air, soil, and groundwater conditions.

Accident prevention

Technical solutions eliminate the possibility of radionuclide release above the established limits even in beyond-design-basis accidents.

Facility closure

The concept for closure of RWDF modules and decommissioning of the facility shall be defined already at the design stage.

Sanitary protection zone (SPZ)

Justification of the boundaries of the zone around the facility within which population residence and certain types of economic activities are restricted.

Design organizations that are license holders or applicants for a licence, in addition to complying with the requirements for the design of radiation facilities established by regulatory legal acts, shall comply with the requirements of licensing legislation set out in the Licensing Regulations and in the Resolution of the Ministry for Emergency Situations of the Republic of Belarus No.

64 dated September,21, 2021 “On requirements for the composition and content of documents substantiating nuclear and radiation safety assurance.” In order to prevent violations of these licensing requirements, only workers engaged in the design of radiation facilities who hold valid (unexpired) training certificates and/or knowledge examination protocols in the field of radiation safety shall be permitted to perform such work.

Design is carried out on the basis of:
- nuclear and radiation safety norms and rules;
- sanitary norms and regulations (SPORO);
- environmental protection legislation;
- IAEA recommendations on the protection of people and the environment.

The implementation of the project is possible only upon completion of the full environmental impact assessment procedure and the receipt of a positive conclusion of the State Environmental Expertise.

15 MAIN CONCLUSIONS OF THE ENVIRONMENTAL IMPACT ASSESSMENT

1. One of the main challenges in the development of the nuclear industry today is the accumulation and continuous generation of radioactive waste (RW). To address this issue, the construction of a radioactive waste disposal and interim storage facility (RWDF) is proposed.

2. An RWDF is a high-tech and automated facility requiring a limited staff of highly specialized workers.

3. The establishment of an RWDF is necessary to address the issues of accumulated and newly generated radioactive waste, as it will make it possible to:
- ensure safe management of radioactive waste in accordance with current requirements;
- eliminate the use of existing interim storage facilities, which will improve environmental safety through the application of new technologies ensuring safer radioactive waste storage, and reduce the risk of potential contamination of the regional territory by radionuclides;
- eliminate radiation exposure to workers and the environment associated with the operation and maintenance of existing radioactive waste interim storage facilities in Belarus.

4. The new facility will be of significant importance for the socio-economic development of the region through:
- additional tax revenues and earmarked contributions to social programmes;
- the creation of additional jobs;
- the attraction of qualified experts, contributing to the development of the scientific and technical sector in the region;
- the attraction of investment to the region.

5. Three sites within the territory of the Republic of Belarus were considered as alternative locations for the RWDF:
- site 1-5 (Khoiniki District, Gomel Region);
- site 2-1 (Ostrovets District, Grodno Region);
- site 3-3 (Mstislavl District, Mogilev Region).

6. A high level of safety of the RWDF will be ensured through protection based on a system of multiple barriers preventing the spread of ionizing radiation and radioactive substances into the environment. The following engineered safety barriers are used at the RWDF:

radioactive waste package;
engineered structures of monolithic reinforced concrete;
buffer material;
underlying barrier;

cover layer.

7. Impacts on atmospheric air will occur both during the construction and operation phases of the RWDF. Atmospheric air pollution during the construction period will be local and short-term. During the operation phase of the RWDF, the concentration of pollutants in atmospheric air will not exceed the air quality standards.

8. Acoustic impacts during the construction and operation of the RWDF will not exceed the established hygienic noise standards of the Republic of Belarus.

9. During the construction phase of the RWDF, portable toilets with subsequent pumping-out by a specialized organization are provided for the disposal of domestic wastewater. No adverse impact on surface and groundwater from water use is anticipated during the construction period of the RWDF. For the operation of the RWDF, separate sewer systems will be established: domestic wastewater and stormwater drainage systems. A dedicated (special) sewer system is planned; in the event that wastewater is contaminated with radionuclides, it will be treated. The discharge of contaminated wastewater into water bodies is excluded.

The impact on the hydrological regime of the area is limited to local redistribution of near-surface groundwater flows, the regime of which is mainly controlled by atmospheric precipitation. The hydrological regime of rivers and lakes in the area will not undergo any changes.

10. The most significant impact on the environment will be the impact on soil (mechanical and chemical) and flora cover during the construction phase. The site grading area is 39.82 ha; the earthworks (cut depth at each site of approximately 1.0 m, excluding displaced soil) amount to 398,200 m³. The removal of the soil and flora layer is inevitable and irreversible during construction works and site clearance; it can only be minimized through the implementation of environmental protection measures to be incorporated into the project.

11. The RWDF site does not fall within the boundaries of protected areas (PAs) of the Republic of Belarus, their buffer zones, or territories reserved for the establishment of new nationally designated protected areas. No impact on rare and endangered species, including species listed in the Red Data Book of the Republic of Belarus, is expected.

12. The conditions for the generation, collection, and interim storage of production and consumption waste during the construction and operation of the RWDF will not lead to a deterioration of the environmental situation at the RWDF site or in adjacent areas. Waste shall be collected, temporarily stored in specially designated areas, and transferred to a specialized organization on a contractual basis.

13. Negative impacts on the environment at all stages of the RWDF life cycle will be minimized through the implementation of specific environmental protection measures.

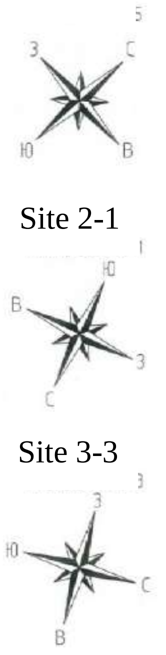
14. The qualitative and quantitative forecast characteristics of environmental conditions and population’s living conditions, as well as the measures provided for in the pre-design documentation, make it possible to assess the RWDF as an environmentally safe facility.

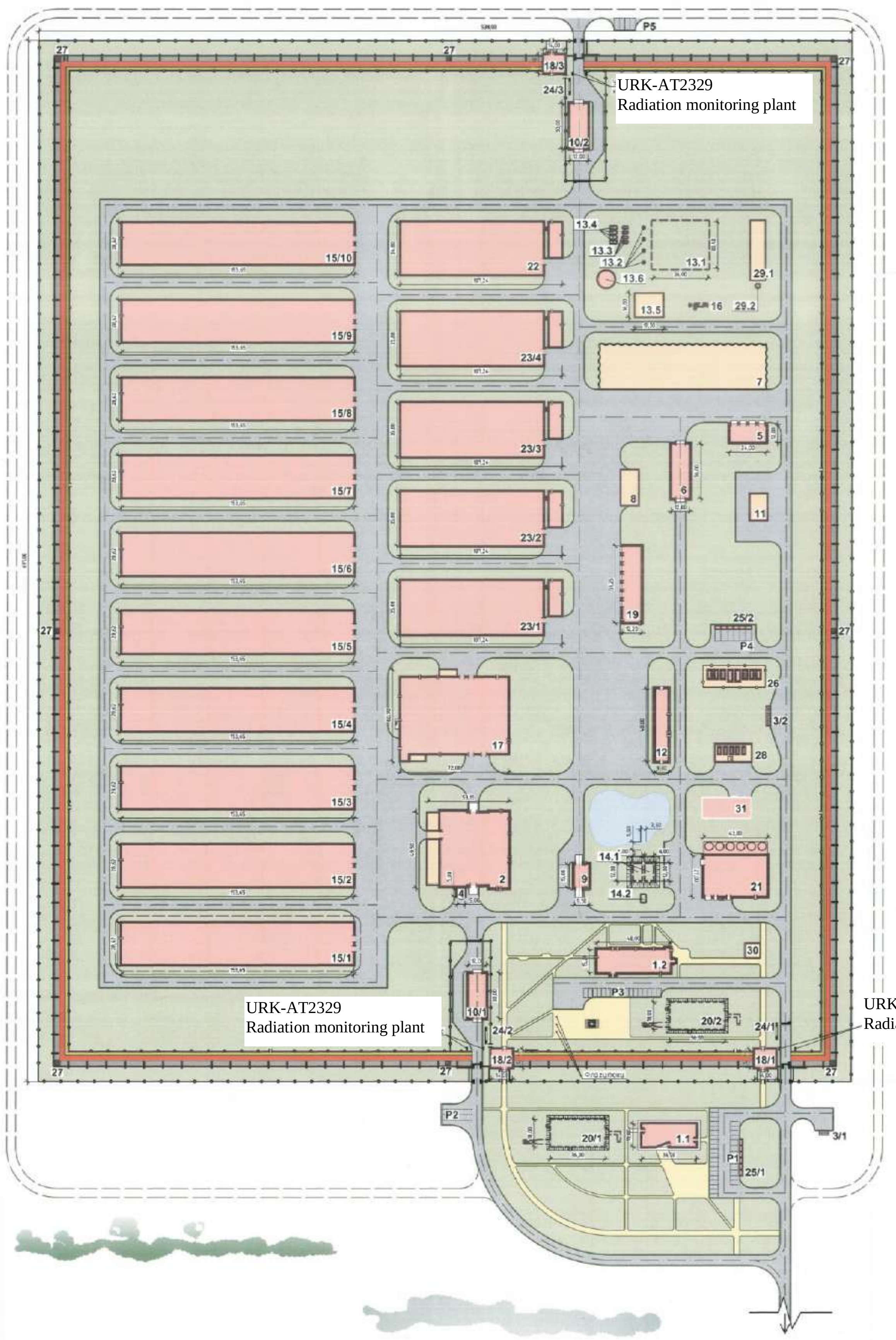
Preliminary General Layout Scheme

Site 1-5

Site 2-1

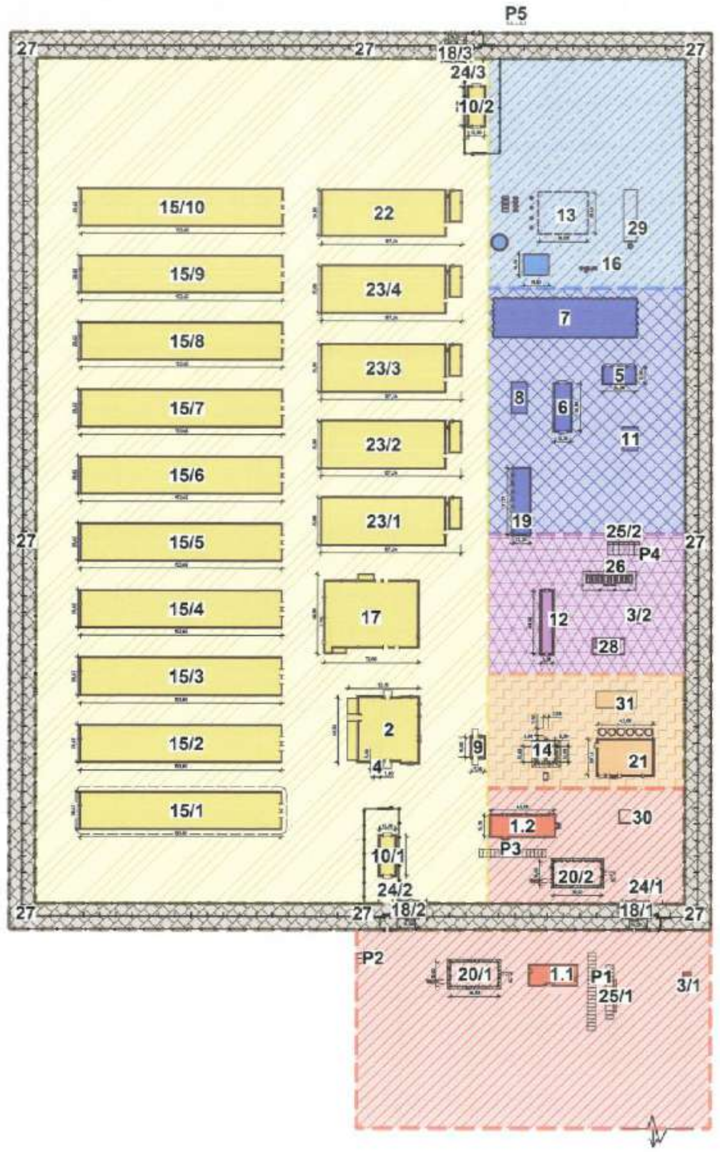
Site 3-3





Agreed:
Director of the Belarusian Organisation for the Radioactive Waste Management Republican Unitary Enterprise
(Signed) M.A.Kisel
April 22, 2026
Seal: “Republic of Belarus. Ministry of Energy. Belarusian Organisation for the Radioactive Waste Management Unitary Enterprise”

Pragmatic Use of the Territory



Explanation of Buildings and Structures

Table 1

Pos. No.	Description	Coordinates of grid element	Remarks
	Land plot for siting the facilities of other purpose		
1.1	Administrative and amenity building (AAB)		Being designed
1.2	Integrated amenity building (IAB)		Being designed
2	Technological building		Being designed
3	Site for collecting the household wastes, 2 off		Being designed
4	Shelter for Dewar flasks with liquid nitrogen		Being designed
5	Parking bay for lift trucks		Being designed
6	Shelter for storage of materials		Being designed
7	Material storage area		Being designed
8	Area for heavy machinery		Being designed
9	Decontamination point for road transport and equipment		Being designed
10	Area for inspection of special transport and construction machinery, 2 off		Being designed
11	Area for mobile fuel filling station		Being designed
12	Transformer substation		Being designed
13	Local complex for treatment of surface water run-offs		Being designed
13.1	Accumulating sump tank		Being designed
13.2	Sewerage pump station, 4 off		Being designed
13.3	Petroleum and oil separators, 4 off		Being designed
13.4	Polishing units, 4 off		Being designed
13.5	Precipitate drying area		Being designed
13.6	Sewerage pump station for supplying treated effluent		Being designed
14	Pumping station for production and fire-fighting water supply with tanks		Being designed
14.1	Water-storage tanks, 2 off		Being designed
14.2	Pumping station		Being designed
15	RW repository modules, 10 off		Being designed
16	Household refuse processing plant		Being designed
17	RW processing complex		Being designed
18	Secured perimeter with three motor transport checkpoints		Being designed
19	Garage for special vehicles		Being designed
20	Protection structure, 2 off		Being designed
21	Area for siting the drink water conditioning and purification		Being designed
22	Area for placement of radioactive wastes from treatment of spent nuclear fuel		Being designed
23	Repository of solid radioactive wastes, 4 off		Being designed
24	Inspection area, 3 off		Being designed
25	Battery-charging stations of the SKAT type, 2 off		Being designed
26	Battery energy storage system (BESS) (10 MW for 3 hours)		Being designed
27	Technological masts, 8 off		Being designed
28	Area for siting the diesel generator sets		Being designed
	(5 x 500 kW)		
29	Sludge dump of wash water of the water treatment plant		Being designed
29.1	Section of the sludge dump of wash water of the water treatment plant		Being designed
29.2	Sewerage Pumping Station of clarified wash water of the water treatment plant		Being designed
30	Special-purpose area		Being designed
31	Electric boiler house		Being designed

Legend

Table 2

Designation	Remarks
	Buildings and structures being designed
	Process area being designed
	Driveway being designed
	Pedestrian ways being designed
	Landscaping being designed
	Footwalk for the team, 1 m wide
	Exclusion zone, 3 m wide
	Reinforced-concrete fence 2.5 m with antidigging system with concertina razor wire
	Wire mesh fencing of the Euromesh type 2.5 m high with gates with concertina razor wire
	Fence made of profiled sheets

P1	Visitor parking with battery-charging stations
P2	Standing area for special vehicles
P3	Parking area for cars
P4	Parking area with battery-charging stations for special vehicles
P5	Standing area for construction machinery
	Anti-ram barrier
	Rolling gate
	Area for temporary storage and disposal of radioactive wastes
	Logistics support area
	Electro-technical purpose area
	Auxiliary purpose area (water conditioning and purification)
	Administration and accommodation area
	Water and wastewater treatment facility area
	Guarding buffer zone

Indicators according to the General Layout

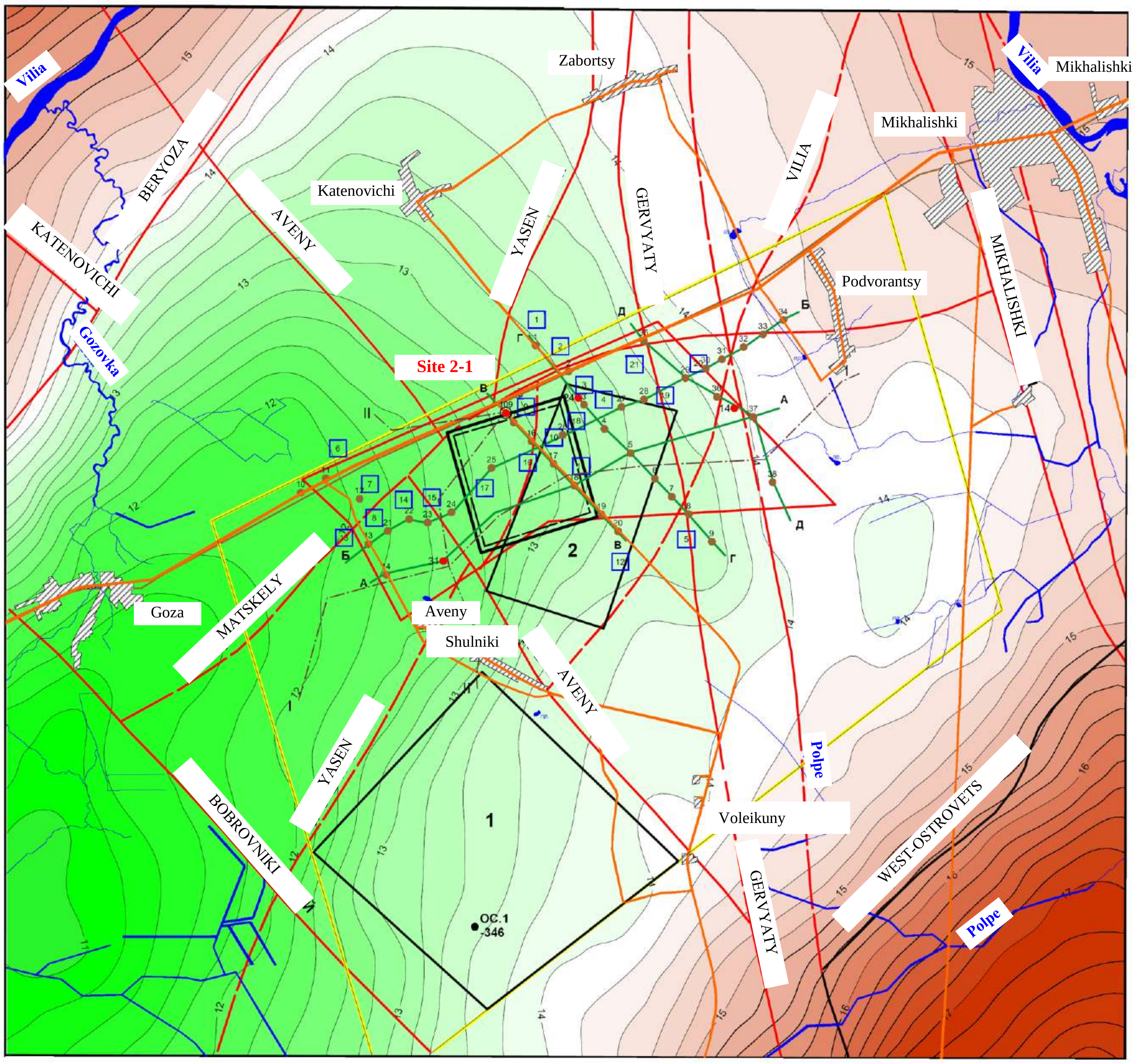
Table 3

Description of the indicator	Value, ha
Area within the fence	37.18
Area of building	8.45
Area of solid pavements (motor roads, pedestrian ways)	11.62
Other territories (landscaping, planting)	19.75

Appendix A

Rev.	Areas	Sheet	Doc. No.	Signature	Date	2184-ППЗ-ОИ4.16-ГП-ГЧ-004 Construction of the facility for temporary storage and disposal of radioactive wastes			
Developed by		Shapovalova		(Signed)		General Plan.	Stage	Sheet	Number of sheets
Checked		Shapovalova		(Signed)					
Approved		Mikhalchenko		(Signed)					1
Head of the department		Griroruk		(Signed)		Preliminary General Layout Scheme	BELNIPIENERGOPROM RUE, Minsk, Belarus		
QC		Novash		(Signed)					
Chief Engineer of the Project		Yezubchik		(Signed)					

Appendix B – Gravitational Field Map



LEGEND

GL(-500), mGal

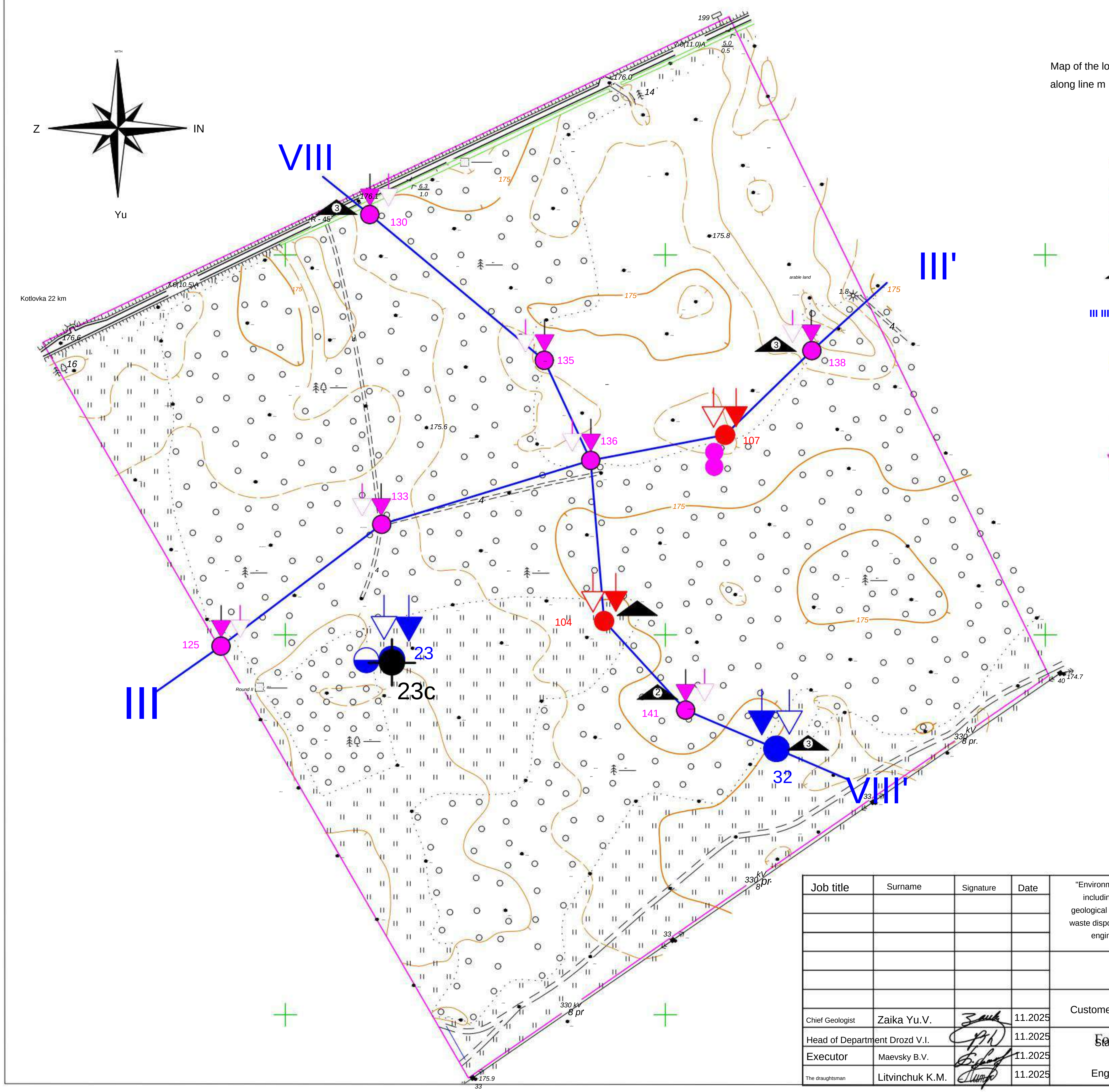
39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10

- Ostrovets point for the NPP, 2008
- Prospective site 2-1 for siting the Radioactive Wastes Landfill
- Faults penetrating into a sedimentary apron
- Faults of the internal structure of the crystalline basement
- 1 — Boundaries and numbers of prospective sites for the NPP, 2008
- OC.1 -346 — Parametric well drilled by the Belgeologia RUE in 2009
- 7 — TEM sounding points, 2024
- 14 — Vertical electric sounding points 2024
- A — A Lines of the vertical electric sounding section
- I — I Lines of the geologic-geophysical profiles
- 14 Wells of the Geoservice UE, 2024
- 109 the same to the depth of 100 m
- Recommended position of the Radioactive Wastes Landfill 1x1 km (2024)

Scientific and Practical Centre for Geology RUE Belarusian Integrated Geological Exploration Expedition Branch Geophysical crew	**Construction of the landfill for radioactive wastes of the 3rd and 4th classes and site for permanent storage of radioactive waste of the 2nd class. Determining the engineering geophysical conditions of siting District No.2: Ostrovets** Contract No.58-GP/24 dated May 3, 2024 and Additional Agreement No.1 dated August 30, 2024 with the Belnipienergoprom RUE		
	Responsible officer: Chief Geophysicist of the Belarusian Integrated Geological Exploration Expedition Branch A.V.Belyashov		2024
Appendix C, Sheet No.	**Map of the gravitational field (G-500) scaled to the depth of 500 metres (Site 2-1)**		
Scale 1: 25,000	Topographic base of the scale 1:25 000		
Developed Checked	Chief Geophysicist Head of the Geophysical crew	(Signed) (Signed)	A.V.Belyashov Ye.V.Osadchiy

Appendix C

Map of the location of engineering-geological sections
along line m III-III' and VIII-VIII'



Conventional designations

135 Drill hole, its number

Static sounding point, its number

Dynamic sounding point, its number

Soil testing with a pressuremeter

3 Soil stamp testing, their quantity

III III' its number Engineering-geological section line,

A hydrogeological well from which test or express water pumping was carried out (located next to the engineering-geological well)

Central hydrogeological well in the bush

Survey site outline

Materials from previously conducted research [34]

Object No. 143-24-02 Inv. No. 58241

102 Drill hole, its number

110 Dynamic sounding point, its number 120 Static sounding point, its number

Object No. 333/08-02, inventory No. 52840

Borehole, its number

2533 Static sounding point, its number

23 Dynamic sounding point, its number

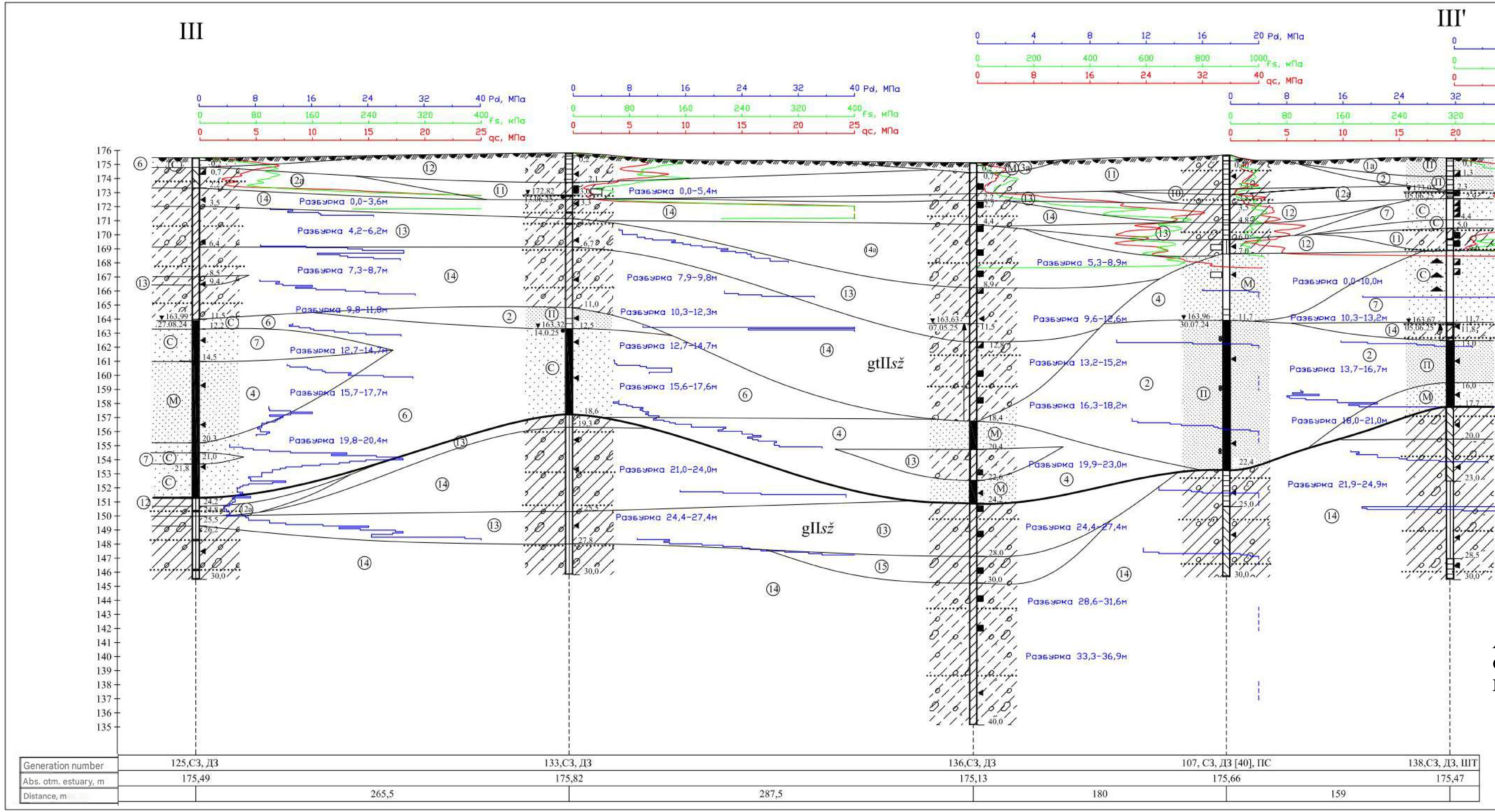
Job title	Surname	Signature	Date
Chief Geologist	Zaika Yu.V.		11.2025
Head of Department	Drozd V.I.		11.2025
Executor	Maevsky B.V.		11.2025
The draughtsman	Litvinchuk K.M.		11.2025

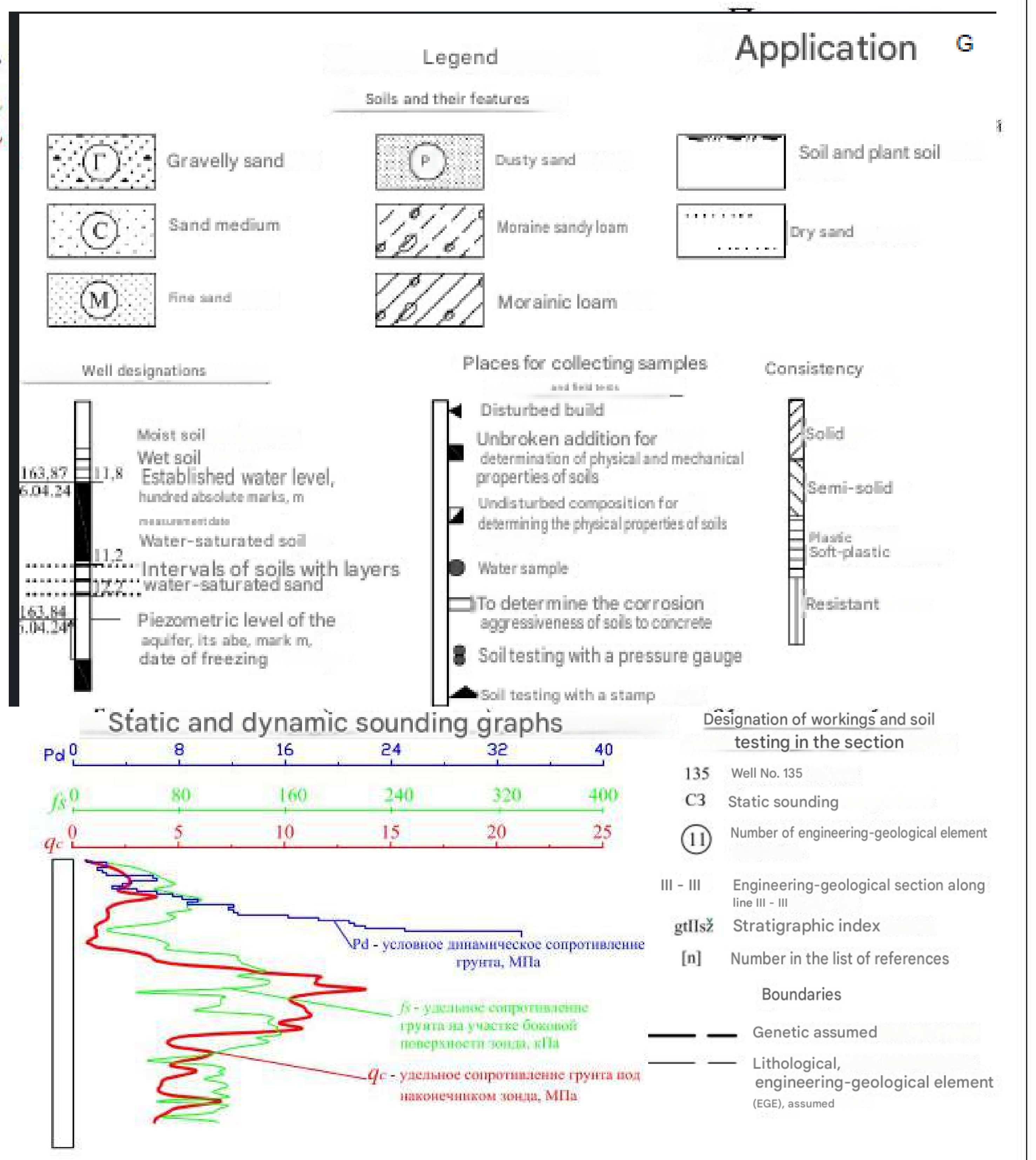
"Environmental Impact Assessment (in terms of the subsoil, including geological, hydrogeological, engineering-geological and other conditions) of the planned radioactive waste disposal activity. Site 2-1" Map showing the location of engineering-geological sections along lines III-III' and VIII-VIII'

Stage: Pre-project		M 1:5000
Sheet 1	Sheets 3	A3 format
documentation object		
No. 332-25-02		Customer
Top-base: Customer		232

Customer: RUE "Belnipienergoprom"

State enterprise "GEOSERVIS"
Engineering Survey Department



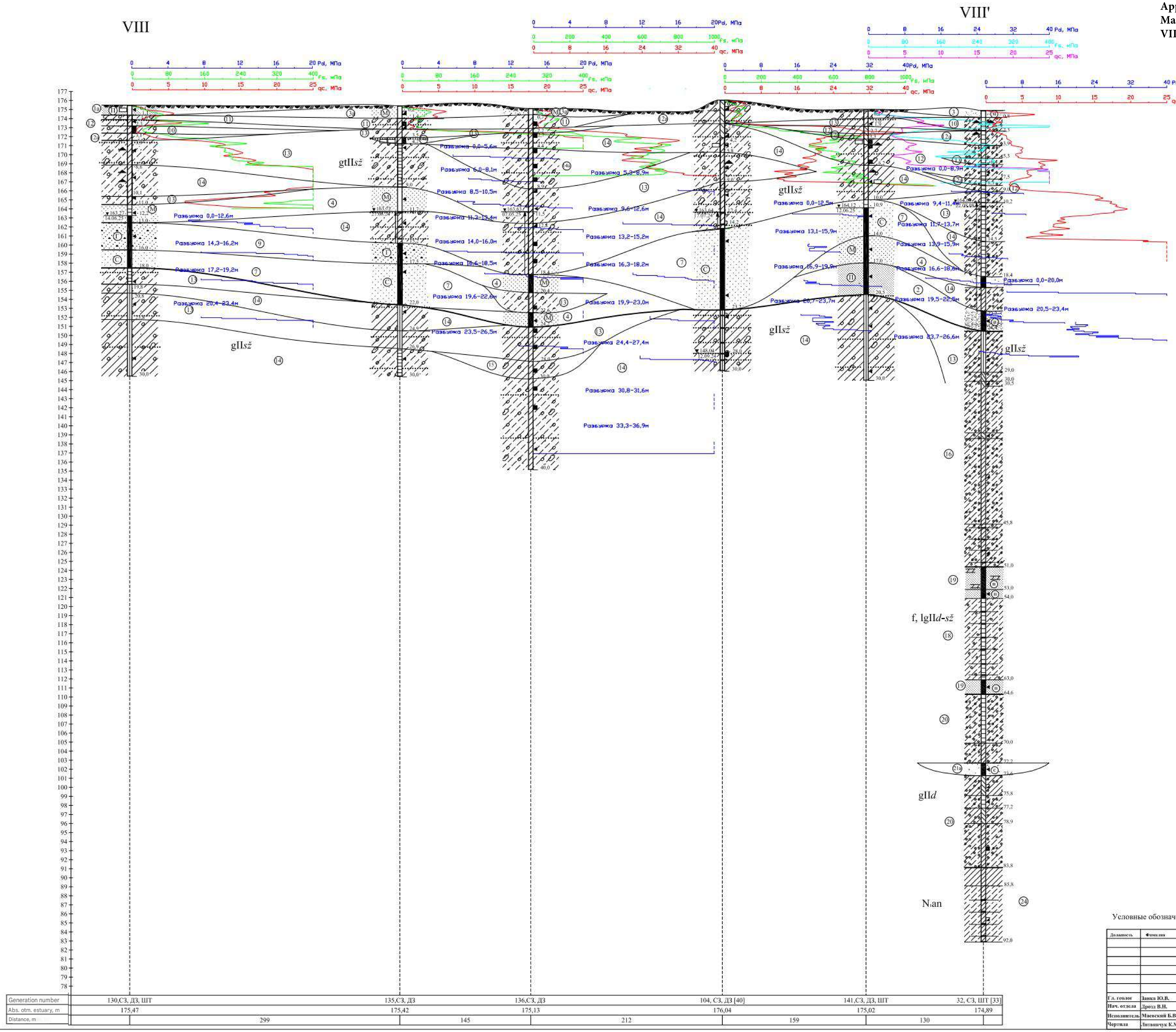


Appendix D Map of Geotechnical Cross-Section Locationg along lines III-III'

Инв. № 57150

Должность	Фамилия	Подпись	Дата	«Оценка воздействия на окружающую среду (в части недр, в том числе геологических, гидрогеологических, инженерно-геологических и иных условий) планируемой деятельности по захоронению радиоактивных отходов. Площадка 2-1»	Стадия: Предпроектная документация	Мв 1:200 Мг 1:2 000
				Инженерно-геологический разрез по линии III-III' [34]	Лист 2 / Листов 3	Формат А3х2
				Заказчик: РУП «Белнипиэнергопром»	Объект № 332-25-02	Заказчика
Гл. геолог	Занка Ю.В.		11.2025	Государственное предприятие "ГЕОСЕРВИС" Отдел инженерных изысканий	Топоснова: Заказчика	233
Нач. отдела	Дрозд В.И.		11.2025			
Исполнитель	Маевский Б.В.		11.2025			
Чертила	Литвинчук К.М.		11.2025			

Appendix E
Map of Geological Cross-Section Location along VIII-VIII'



Условные обозначения см. лист 1

Инв. № 57150

Должность	Фамилия	Подпись	Дата
Гл. геолог	Занка Ю.В.		11.2025
Нач. отдела	Дрозд В.Н.		11.2025
Исполнитель	Маевский Б.В.		11.2025
Чертила	Литвинчук К.М.		11.2025

«Оценка воздействия на окружающую среду (в части недр, в том числе геологических, гидрогеологических, инженерно-геологических и иных условий) планируемой деятельности по захоронению радиоактивных отходов. Площадка 2-1»

Стадия: Предпроектная документация

Мв 1:200
Мг 1:2 000

Лист 3 | Листов 3 | Формат A1

Инженерно-геологический разрез по линии VIII-VIII' [34]

Объект

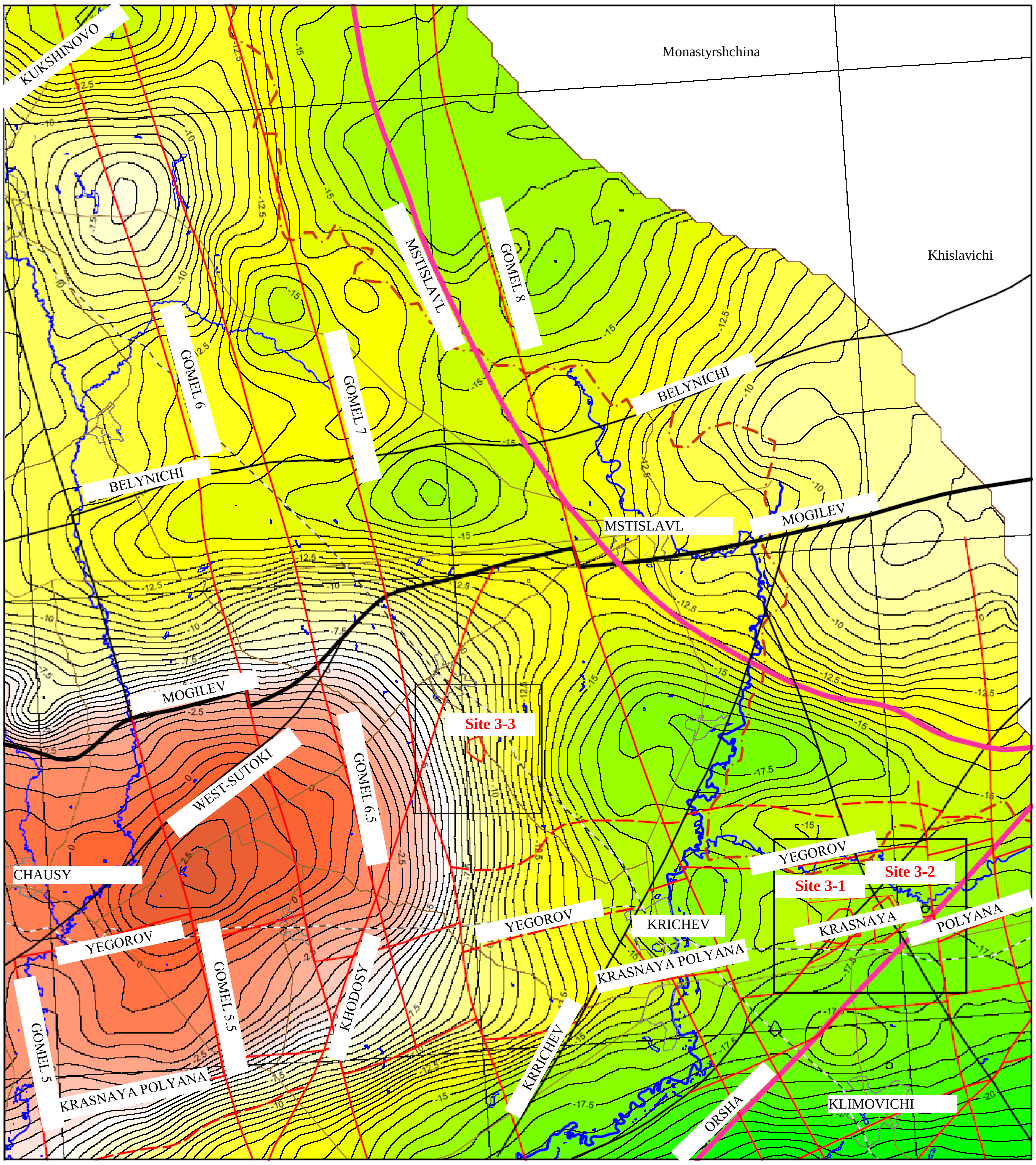
Заказчик: РУП «Белнипиэнергопром»

№ 332-25-02

Заказчика

Государственное предприятие "ГЕОСЕРВИС"
Отдел инженерных изысканий

Топоснова: Заказчика



Legend

Faults

Structure-forming
a) active
b) inactive

other
active
inactive

distinguished diffidently

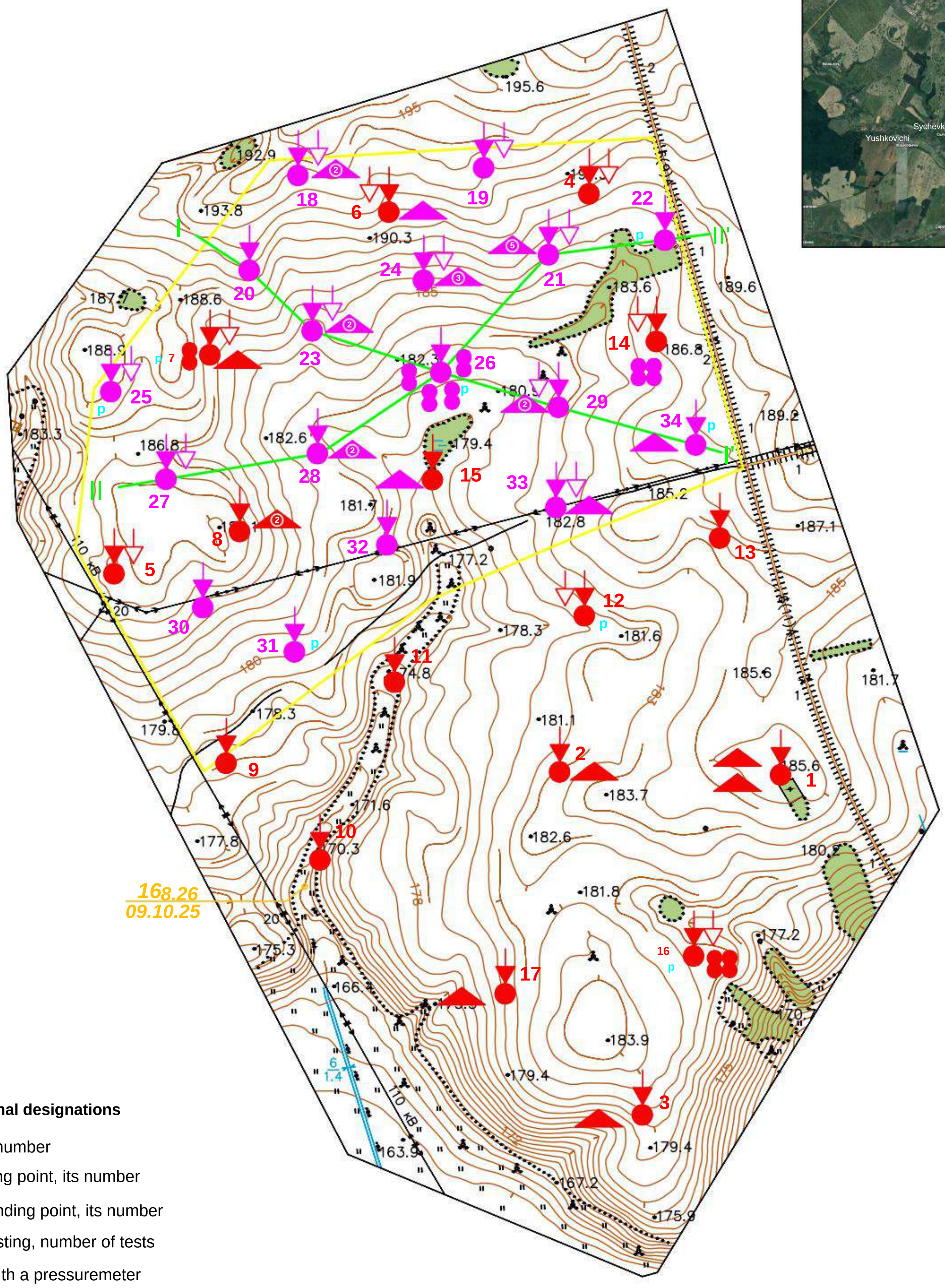
Prospective site 2-1 for siting the Radioactive Wastes Landfill

Studied area in the scale 1:25,000

GL(-500), mGal

12, 10.5, 9, 7.5, 6, 4.5, 3, 1.5, 0, -1.5, -3, -4.5, -6, -7.5, -9, -10.5, -12, -13.5, -15, -16.5, -18, -19.5, -21, -22.5, -24, -25.5, -27, -28.5, -30

Scientific and Practical Centre for Geology RUE Belarusian Integrated Geological Exploration Expedition Branch Geophysical crew	**Construction of the landfill for radioactive wastes of the 3rd and 4th classes and site for permanent storage of radioactive waste of the 2nd class. Determining the engineering geophysical conditions of siting District No.3: Yegorov-Klimovichi** Contract No.58-GP/24 dated May 3, 2024 and Additional Agreement No.1 dated August 30, 2024 with the Belnipienergoprom RUE Responsible officer: Chief Geophysicist of the Belarusian Integrated Geological Exploration Expedition Branch A.V.Belyashov		2024
Appendix H Sheet No.	**Map of the gravitational field (G(-500)) scaled to the depth of 500 metres (Site 3-3)**		
Scale 1: 200,000	Topographic base of the scale 1:200,000		
Developed Computer design	Chief Geophysicist First-category geophysicist	(Signed) (Signed)	A.V.Belyashov A.V.Nezhevets



Situational diagram

Conventional designations

26 Drill hole, its number

27 Static sounding point, its number

24 Dynamic sounding point, its number

Soil stamp testing, number of tests

Soil testing with a pressuremeter

Well with pumping

I–I' Line of engineering-geological section, its number

16 8.26 / 09.10.25 Absolute elevation of the bottom of the dry trench, m, date of measurement

Survey site outline

Survey materials completed earlier Object No. 183-24-02. Inv. No. 2398-10 [37]

1 Drill hole, its number

2 Static sounding point, its number

5 Dynamic sounding point, its number

Soil stamp testing, number of tests

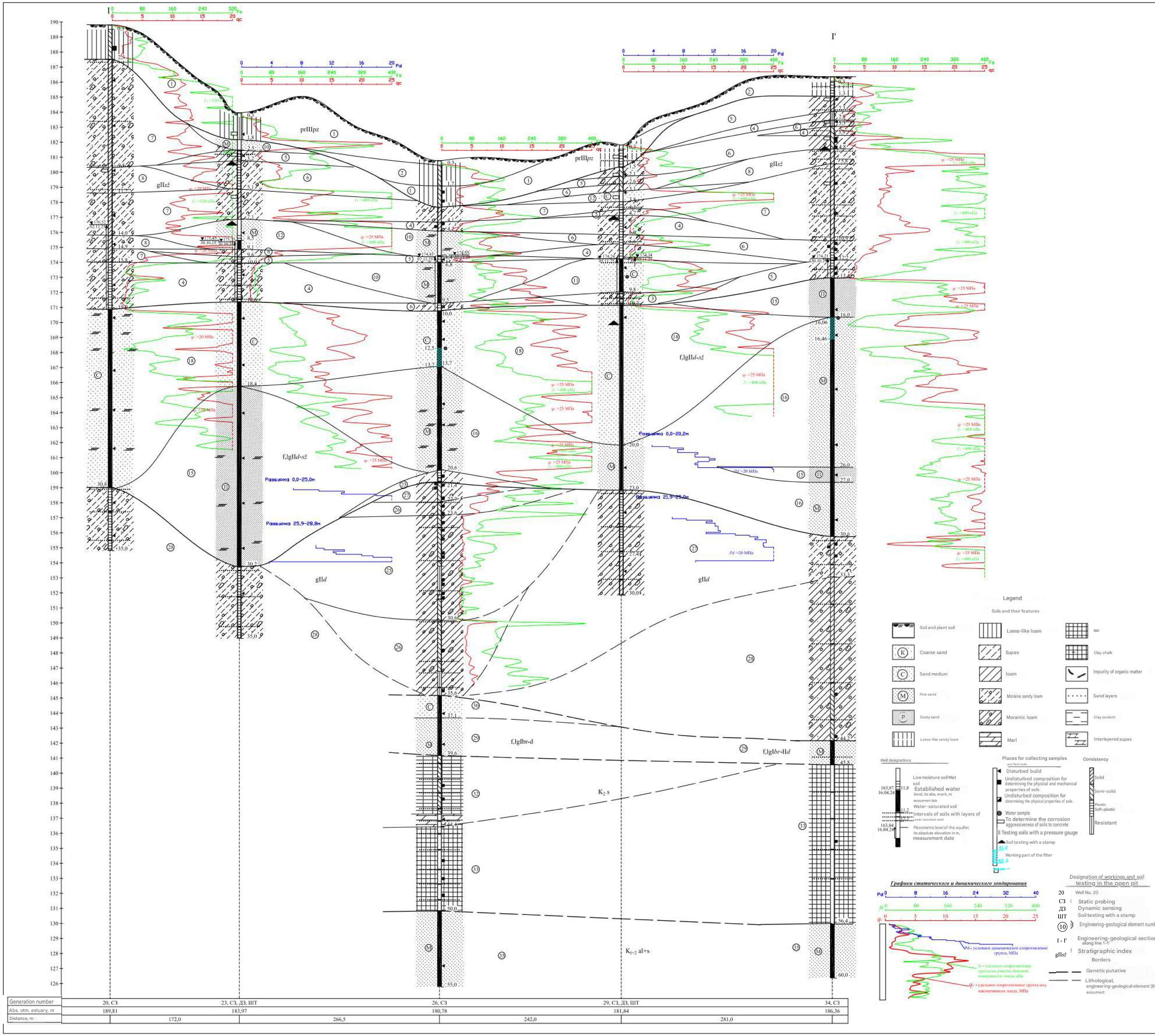
Soil testing with a pressuremeter

Appendix G

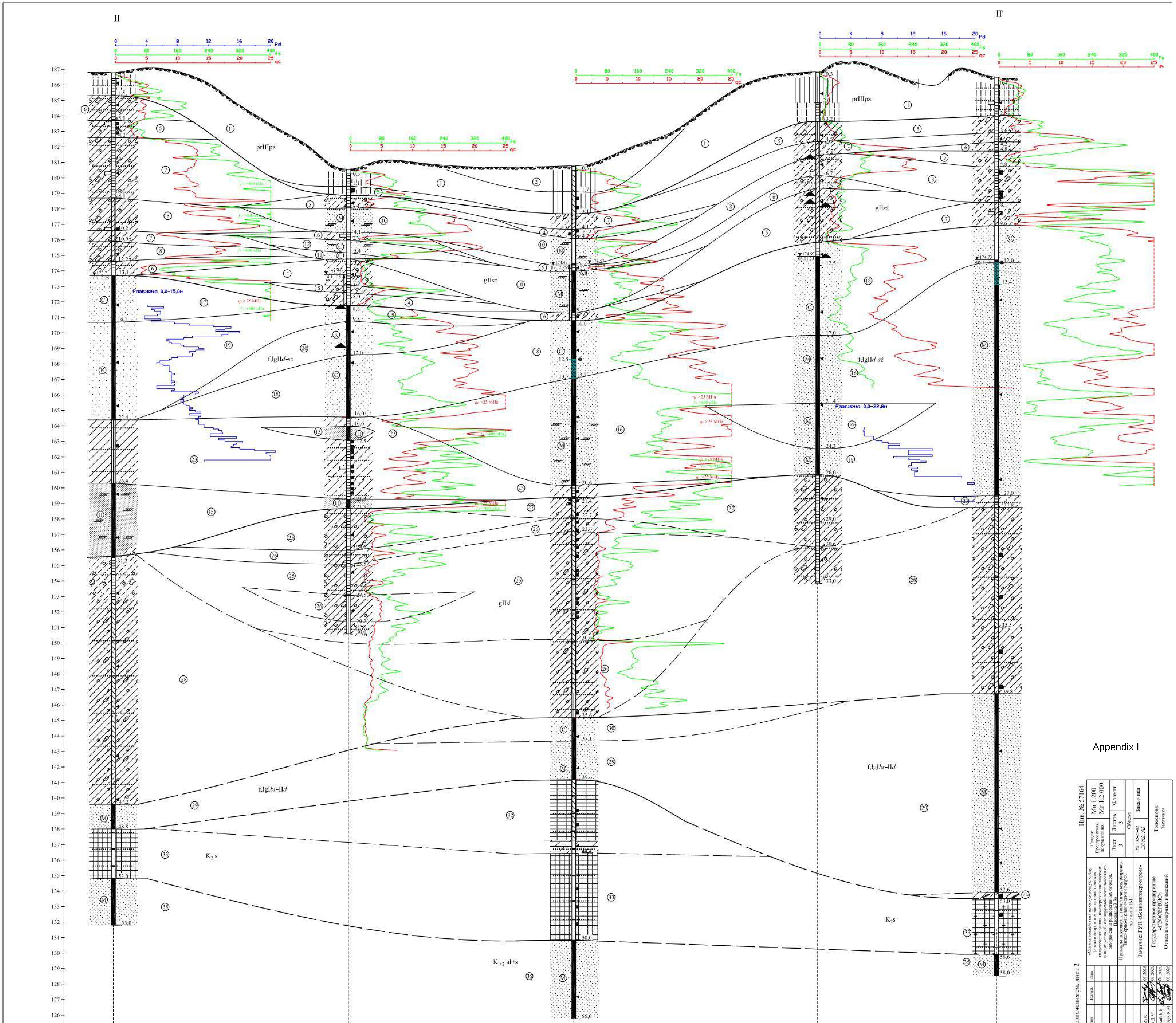
Inv. No. 57164

Job title	Surname	Signature	Date	"Environmental impact assessment (in terms of subsoil, including geological, hydrogeological, engineering-geological and other conditions) of the planned activities Radioactive Waste Disposal. Site 3-3" Examples of engineering-geological sections. Map showing the location of engineering-geological sections along lines II' and II-II'	Stage: Pre-project documentation	M 1:5000
					Sheet 1	Sheets 3	A3 format
					Object Объект	
				Customer: RUE "Belnipienergoprom"	No. 332-25-02 DS No. 2, No. 3	Customer
Chief Geologist	Zaika Yu.V.		01.2026			
Deputy Head of Department	Senko D.M.		01.2026	State Enterprise Государственное предприятие "GEOSERVIS" "ГЕОСЕРВИС" Department of Engineering Surveys	Topic basis: Customer	
Executor	Maevsky B.V.		01.2026			
The draughtsman	Litvinchuk K.M.		01.2026			

Appendix H



Legend
Soils and their features
Soil and plant soil
Loess-like loam
Mel
Coarse sand
Supes
Clay chalk
Sand medium
Loam
Impurity of organic matter
Fine sand
Moraine sandy loam
Sand layers
Dusty sand
Morainic loam
Clay content
Loess-like sandy loam
Marl
Interlayered supes
Well designations
Low moisture soil Wet soil
Established water level, its abs. mark, m measurement date
Water-saturated soil
Intervals of soils with layers of water-saturated sand
Piezometric level of the aquifer, its absolute elevation in m, measurement date
Places for collecting samples and field tests
Disturbed build
Undisturbed composition for determining the physical and mechanical properties of soils
Undisturbed composition for determining the physical properties of soils
Water sample
To determine the corrosion aggressiveness of soils to concrete
8 Testing soils with a pressure gauge
Soil testing with a stamp
Working part of the filter
Consistency
Solid
Semi-solid
Plastic Soft-plastic
Resistant
Графики статического и динамического зондирования
Designation of workings and soil testing in the open pit
20 Well No. 20
СЗ Static probing
ДЗ Dynamic sensing
ШТ Soil testing with a stamp
10 Engineering-geological element number
I - I' Engineering-geological section along line I-I'
gIIsž Stratigraphic index
Borders
Genetic putative
Lithological, engineering-geological element (EGE), assumed
Generation number
Abs. otm. estuary, m
Distance, m
20, СЗ
23, СЗ, ДЗ, ШТ
26, СЗ
29, СЗ, ДЗ, ШТ
34, СЗ
189,81
183,97
180,78
181,84
186,36
172,0
266,5
242,0
281,0
prIIIpz
gIIsž
f,lgIId-sž
gIId
f,lgIbr-d
f,lgIbr-IId
K2 s
K1-2 al+s
Инв. № 57164
Мв 1:200
Мг 1:2 000



Generation number	27, СЗ, ДЗ		28, СЗ, ШТ		26, СЗ		21, СЗ, ДЗ, ШТ		22, СЗ
Abs. otm. estuary, m	186,80		180,57		180,78		186,84		186,52
Distance, m		303,0		291,0		314,5		231,0	

Appendix I

Инв. № 57164

Условные обозначения см. лист 2

Должность	Фамилия	Подпись	Дата
Гл. геолог	Занко Ю.В.		01.2026
Зам. начальника отдела	Сенько Д.М.		01.2026
Исполнитель	Маевский Б.В.		01.2026
Чертил	Литвинчук К.М.		01.2026

«Оценка воздействия на окружающую среду (в части недр, в том числе геологических, гидрогеологических, инженерно-геологических и иных условий) планируемой деятельности по захоронению радиоактивных отходов. Площадка 3-3»

Стадия: Предпроектная документация

Мв 1:200
Мг 1:2 000

Примеры инженерно-геологических разрезов. Инженерно-геологический разрез по линии II-II'

Лист 3 | Листов 3 | Формат

Объект

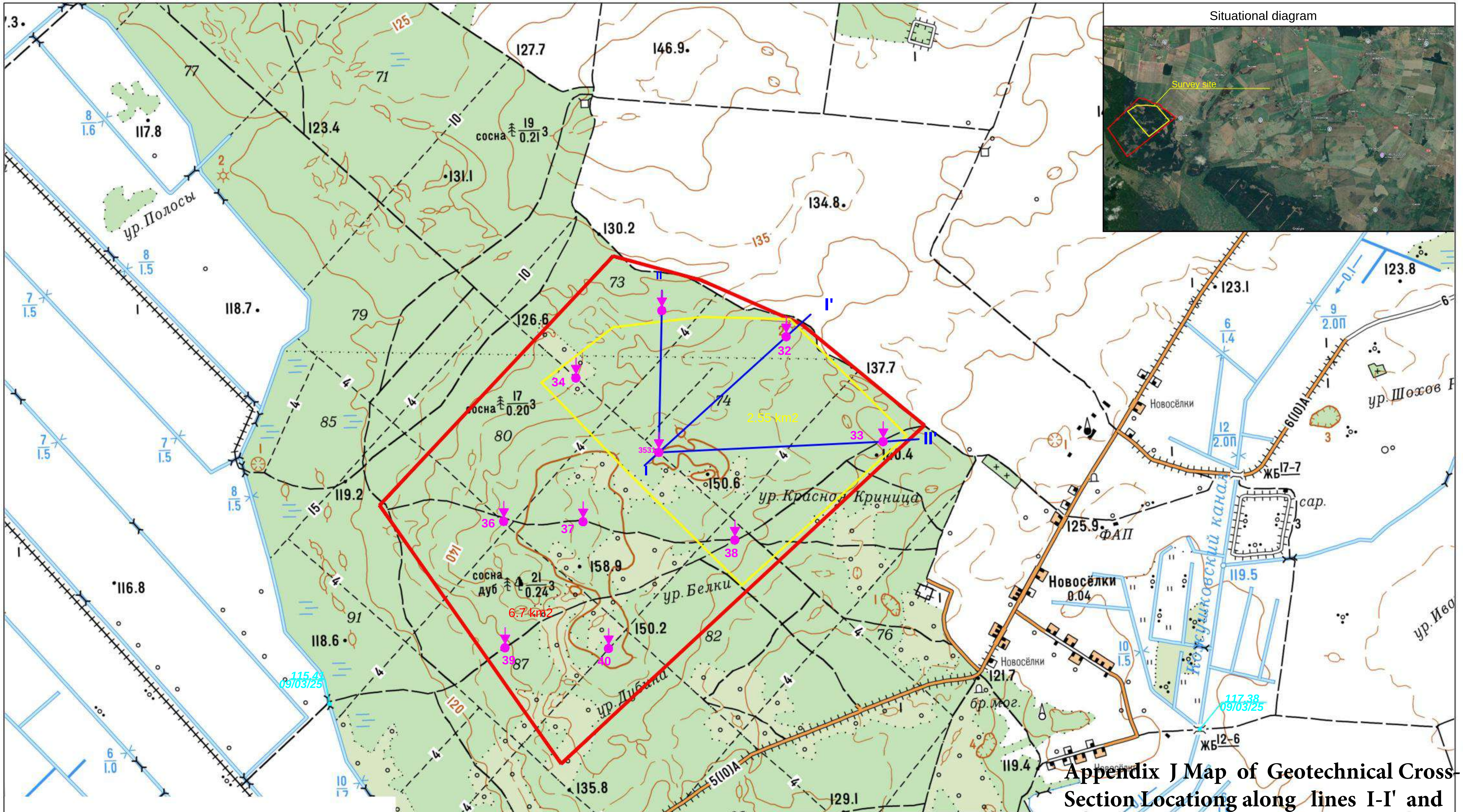
Заказчик: РУП «Белнипиэнергопром»

№ 332-25-02 ДС №2, №3

Заказчика

Государственное предприятие «ГЕОСЕРВИС» Отдел инженерных изысканий

Топооснова: Заказчика



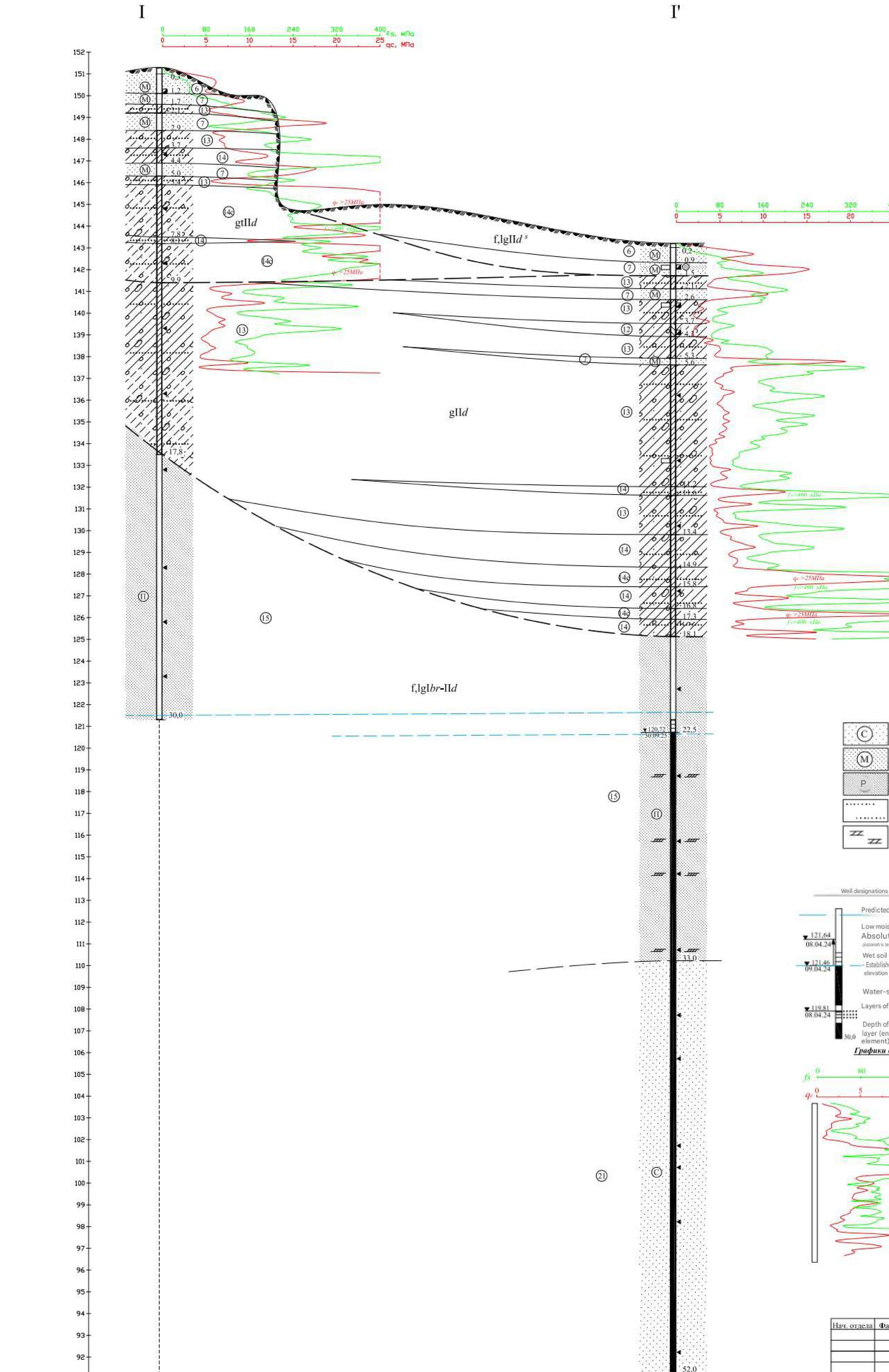
Appendix J Map of Geotechnical Cross-Section Locationg along lines I-I' and II-II'

Conventional designations

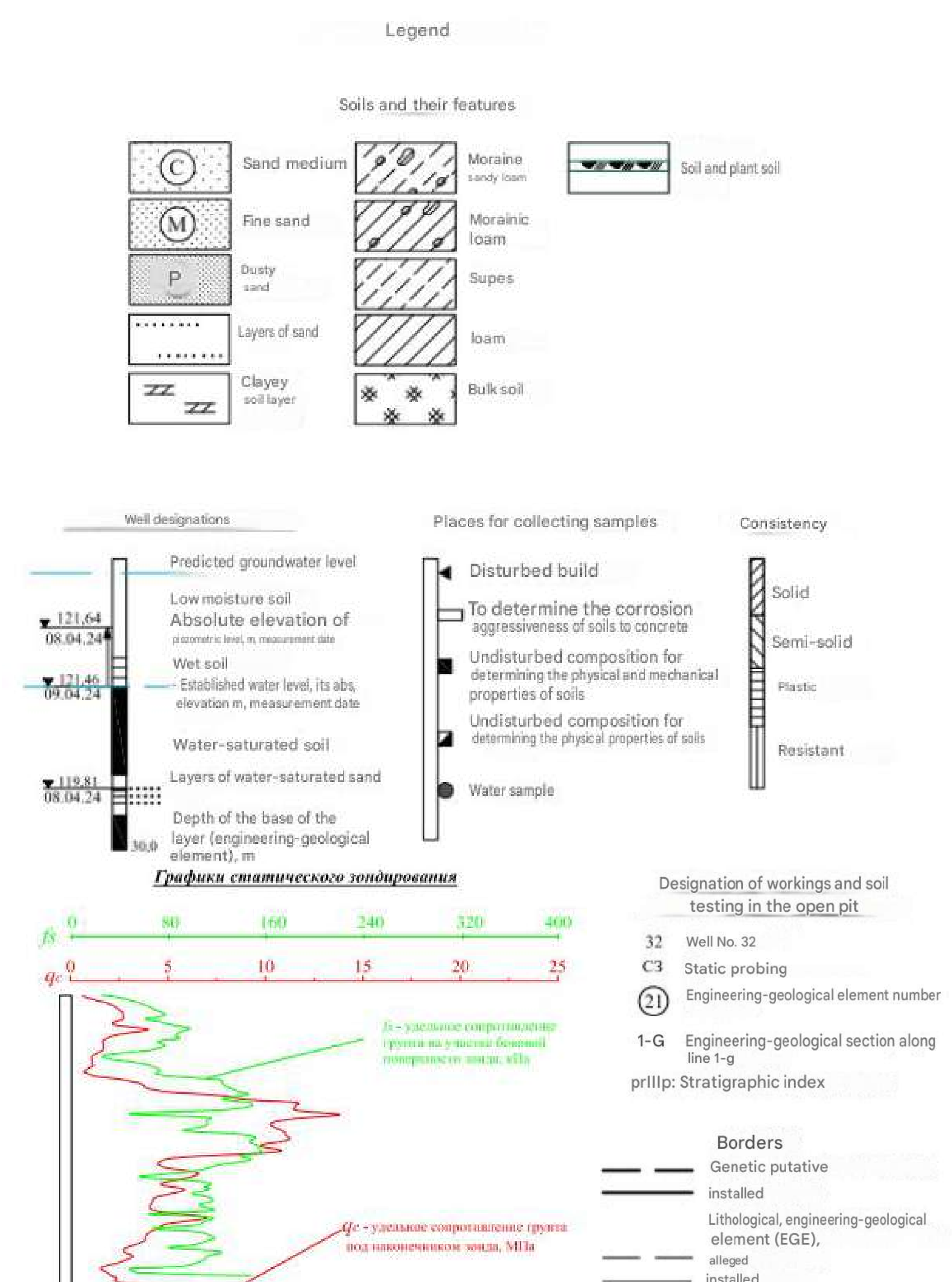
- Drill hole, its number
- 3132 Static sounding point, its number
- I — I' Line of engineering-geological section, its number
- The outline of the survey site at the engineering-geological survey stage, scale 1:25,000
- The outline of the survey site at the engineering-geological reconnaissance stage

Application Inv. No. 57168

Head of Department	Last Name	Signature	Date	"Environmental Impact Assessment (with respect to the subsoil, including geological, hydrogeological, engineering-geological, and other conditions) of the planned radioactive waste disposal activity. Sites 1-5"	Pre-project documentation	Scale: 1:25,000
				Examples of engineering-geological sections. Map showing the location of engineering-geological sections along lines II' and II-II'	Sheet 1 Stage: Sheets 3	A3 format
					Object	
Chief Geologist	Zaika Yu.V.		02.2026	Customer - RUE "Belnipienergoprom"	State enterprises Geoservice" No. 332-25-02.DS No. 2	Customer 2184-PPZ-OVOS5.4
Head of Department	Drozd V.I.		02.2026	State Enterprise "GEOSERVIS" Department of Engineering Surveys	Topic basis: Customer	213
Executor	Bogdevich O.Yu.		02.2026			
The draughtsman	Litvinchuk K.M.		02.2026			



Generation number	35, C3	32, C3
Abs. otm. estuary, m	151.30	143.22
Distance, m	1181,0	

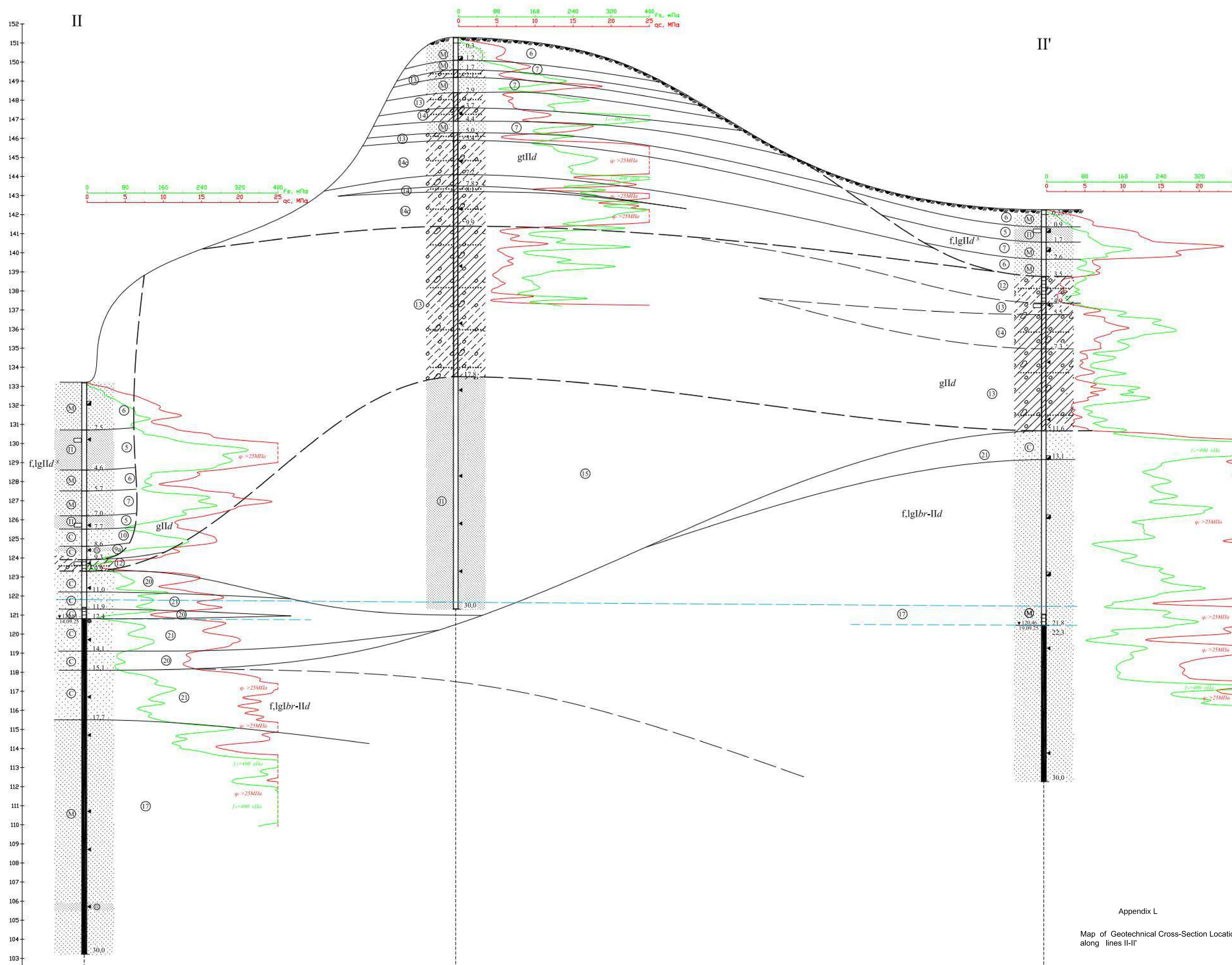


Appendix k

Map of Geotechnical Cross-Section Locationg along lines I-I'

Инв. № 57168

Нач. отдела	Фамилия	Подпись	Дата	«Оценка воздействия на окружающую среду (в части недр, в том числе геологических, гидрогеологических, инженерно-геологических и иных условий) планируемой деятельности по захоронению радиоактивных отходов. Площадка I-5»	Стадия: Предпроектная документация	Мв 1:100 Мг 1:5000	
				Примеры инженерно-геологических разрезов. Инженерно-геологический разрез по линии I-I'	Лист 2	Листов 3	Формат
					Объект		
Гл. геолог	Занка Ю.В.		02.2026	Заказчик - РУП «Белнипиэнергопром»	Государственного предприятия "Геосервис" № 332-25-02 ДС № 2	Заказчика 2184-ПП3-ОВОС5.4	
Нач. отдела	Дрозд В.И.		02.2026	Государственное предприятие "ГЕОСЕРВИС" Отдел инженерных изысканий	Топооснова: Заказчика		
Исполнитель	Богдевич О.Ю.		02.2026				
Чертила	Литвинчук К.М.		02.2026				



Appendix L

Map of Geotechnical Cross-Section Locationg along lines II-II'

Generation number	31, C3	35, C3	33, C3
Abs. otm. estuary, m	133.21	151.30	142.26
Distance, m	973,5	1541,0	

Условные обозначения см. лист 2

Инв. № 57168

Нач. отдела	Фамилия	Подпись	Дата
Гл. геолог	Занка Ю.В.		02.2026
Нач. отдела	Дрозд В.И.		02.2026
Исполнитель	Богдевич О.Ю.		02.2026
Чертила	Литвинчук К.М.		02.2026

«Оценка воздействия на окружающую среду (в части недр, в том числе геологических, гидрогеологических, инженерно-геологических и иных условий) планируемой деятельности по захоронению радиоактивных отходов. Площадка 1-5»

Примеры инженерно-геологических разрезов. Инженерно-геологический разрез по линии II-II'

Заказчик - РУП «Белнипиэнергопром»

Государственное предприятие "ГЕОСЕРВИС" Отдел инженерных изысканий

Стадия: Предпроектная документация	Мв 1:100 Мг 1:5000	
Лист 3	Листов 3	Формат
Объект		
Государственного предприятия "Геосервис" № 332-25-02.ДС № 2	Заказчика 2184-ППЗ-ОВОС5.4	
Топоснова: Заказчика		

Table of Changes

Rev. No.	Sheet (page) numbers				Tttl sheets (pages) in the document	Doc.No.	Signature	Date
	amended	replaced	new	cancelled				

Repl. Inv. No.

Signature and Date

Orig. Inv. No.

Rev	Qty	Sheet	Doc n	Signature	Date	2184-ППЗ-ОВОС-ТЧ	Sheet